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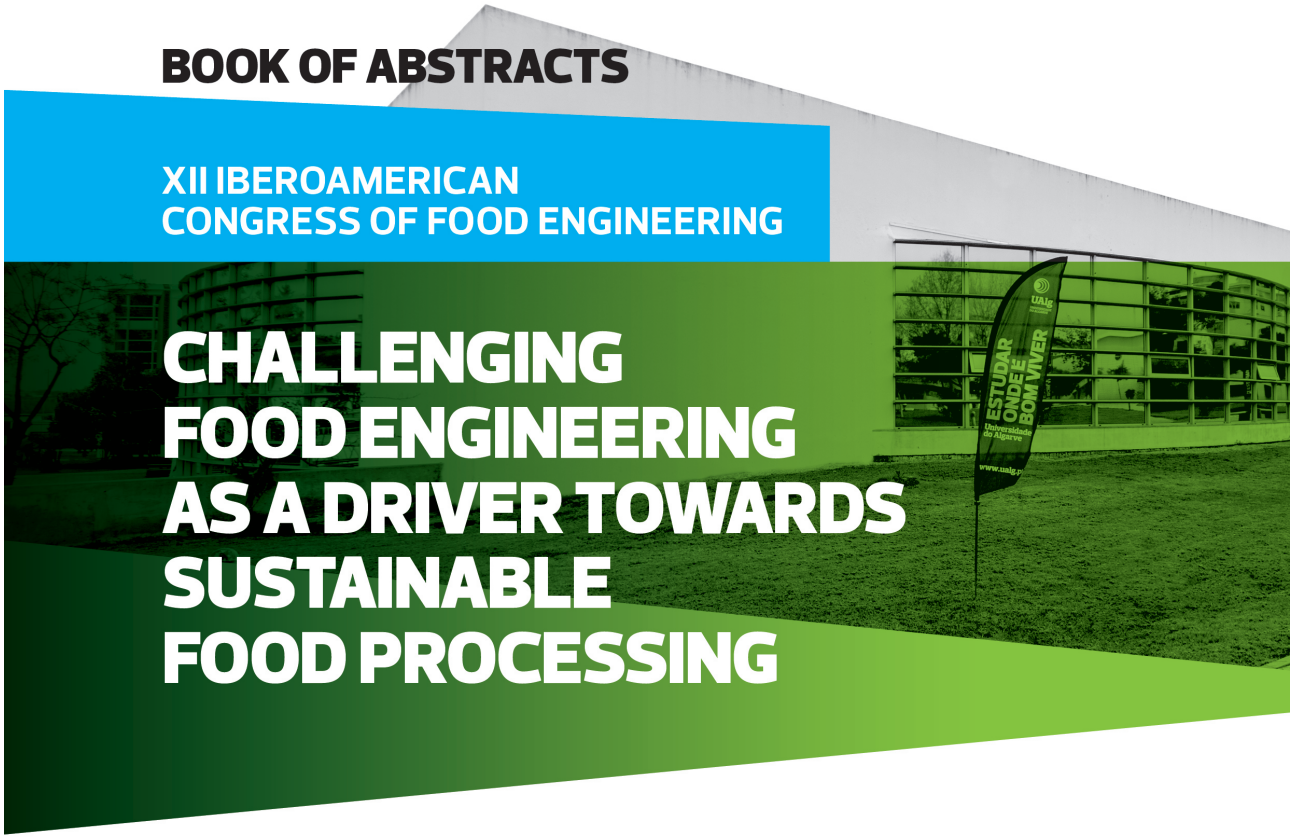
BOOK OF ABSTRACTS

XII IBEROAMERICAN CONGRESS OF FOOD ENGINEERING



CHALLENGING FOOD ENGINEERING AS A DRIVER TOWARDS SUSTAINABLE FOOD PROCESSING

UNIVERSITY OF ALGARVE, GAMBELAS CAMPUS
FARO / ALGARVE / PORTUGAL
1 > 4 JULY 2019

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"Challenging Food Engineering as a Driver Towards Sustainable Food Processing"

e-Book of Abstracts

Editores

Margarida Vieira

Rui Cruz

Célia Quintas

Gil Fraqueza

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XII CIBIA IBEROAMERCAN CONGRESS OF FOOD ENGINEERING

Challenging Food Engineering as a Driver Towards Sustainable Food Processing

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✞ Our colleague Paula Carrasquinho Pires Cabral, PhD in Agro-Industries Engineering, Assistant Professor in the Department of Food Engineering of the Instituto Superior de Engenharia of Universidade do Algarve and researcher at the Center for Biological Resources and Mediterranean Food (MeditBio). She developed and published research in the production of food flavors, Mediterranean diet food and characterization of physicochemical, nutritional and sensory properties of food.

Paula was an active member in the Scientific Committee of the CIBIA XII, having reviewed several abstracts. Unfortunately, she passed away on 31 March of 2019. We will always remember an exceptional teacher, a good and insightful researcher, a hard worker, a resilient colleague, a friend with a huge sense of humor.

We will never forget her!

Preface

The XII edition of CIBIA, Iberoamerican Congress of Food Engineering will take place, for the first time, in Portugal next July 1 to 4, having as theme “Challenging Food Engineering as a Driver Towards Sustainable Food Processing“. The host institution is the University of Algarve, Faro, in the Algarve region.

The importance of the Food Engineering field was enhanced by the number of Iberoamerican researchers who participated in this XIIth edition of CIBIA. We received 530 abstracts submitted by researchers from the Iberian Peninsula (Portugal and Spain), and from all the South and Central American Continent: Brazil, Chile, Peru, Mexico, Colombia and Ecuador, among others. About 350 participants will be present with around 100 accepted abstracts for oral presentations and more than 300 poster presentations. These numbers reveal that Food Engineering is very alive and strong in the Iberoamerican world as many young researchers are pursuing their graduate studies in various disciplines of this field and senior researchers keep facing and studying new challenges such as the main Congress Theme “Challenging Food Engineering as a Driver towards Sustainable Food Processing”. Nowadays lies on humanity a big question: Will we have enough food for the world population in 2050? In order to address this problem, the issue of food sustainability has been worrying recently most research fields in Food Engineering and it was mandatory for this Congress to focus on this theme! The main topics under discussion are:

- Study of new processes of sustainable food conservation, involving less power and less heat, less affecting the physico-chemical, sensory and nutritional properties of food. As examples of these new processes, high pressure, processing by pulsed electrical fields or even active packaging can be mentioned.
- Sustainable Development of novel foods especially based on the valorization of food industry wastes towards "zero food waste".
- Development of new biodegradable packaging to replace the enormous amounts of plastic that is threatening the environment.
- Study of the behavior and change of properties in foods during digestion
- Sustainable management of food chain-food safety Engineering.
- Study the consumer behavior when choosing food at individual, family, or community level.

The international and multidisciplinary dialogue is one of the hallmarks of this meeting.

Of the 10 guest speakers, 4 are Portuguese, Isabel Ferreira (Instituto Politécnico de Bragança), Dr. Ondina Afonso (Sonae), António Vicente (Universidade do Minho) and Jorge Saraiva (Universidade de Aveiro). From Spain were invited, José María Lagaron (Universidad Politécnica de Valencia) and Antonio Valero Dias (Universidad de Cordoba) and from the other side of the ocean Prof. José Aguilera (Pontificia Universidad Católica do Chile), Prof. Gustavo Barbosa-Cánovas (University of Washington State, USA) and Paul Singh (University of California, Davis, USA). Over the 4 days of the event, there will be opportunity for participants to interact, communicate and establish partnerships.

A workshop will also be held on the importance of professional associations in the course of Food Engineering in the Ibero-American world with the participation of the Coordinator of the Food Engineering Specialists of Ordem dos Engenheiros and the participation of the Brazilian CONFEA. The aim is to discuss strategies to disseminate and increase young people's interest in this area of engineering and contribute to the valorization of the Food Engineer in society.

Another outcome of the past CIBIA Congresses is the creation of the Iberoamerican Association of Food Engineering (SIBIA), which will have a registered office in Mexico. Conceived as a permanent group which main objective is to promote research and knowledge dissemination on Food Engineering in Latin America and in the Iberian Peninsula and its projection to the whole world. The main activities of SIBIA were defined

as the organization of live and multimedia events as well as to disseminate knowledge about our field. The main management of SIBIA is to assist in holding the Iberoamerican Congress of Food Engineering (CIBIA), participating in the selection of the place where it will take place and on the choice of the group that is going to organize it and support the activities of the different organizing committees of these congresses. Currently, there are already provisions governing the functioning of SIBIA, to be reviewed by the Executive Board or the Board of Directors of the new organization. During CIBIA XII held in Faro, Portugal, an Opened Assembly of this Association will be held.

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Engineering Packaging for a Sustainable Food Chain

Plenary lectures

Tailoring structures at nanoscale: from food-grade ingredients to food packaging applications

ANTÓNIO A. VICENTE [a*]

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Nowadays, nanotechnology has applications in virtually all areas of scientific and technological research and it is developing at a very fast pace. Its impact and advances are very significant, thus leading to a justified growing attention from both academy and industry.

In particular, food engineers, scientists and technologists are also dedicating their attention to nanotechnology, while searching for solutions in the various areas of their activity: from new ingredients to new processes and new packaging materials.

Particularly, the applications aimed at improving food functionality (e.g. nanoencapsulation of functional ingredients) and food packaging (e.g. nanolayered coatings or nanoencapsulated active compounds for active packaging applications) are seen as very promising. However, there are two main issues which are a concern for the application of these solutions: 1) ingredients must be food-grade and 2) safety of the consumers must be guaranteed.

In this lecture these issues will be addressed: starting from the use of food-grade materials in the production of nanotechnology-based structures and ending with a view on the actual food safety concerns regarding the use of nanomaterials in or in contact with foods.

Novel high barrier and active circular bioeconomy electrospun biopapers of application interest in food packaging

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The main goal of this review presentation was to develop optimized water barrier, antioxidant, antimicrobial and oxygen scavenging mono and multilayered electrospun biopaper coatings made of poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) derived from municipal and industrial waste and containing different extracts and nanomaterials. The resultant electrospun mats were coated over conventional cellulose fiber based paper over which morphology, thermal properties, mechanical, antioxidant, antimicrobial, water vapour barrier, and oxygen absorption properties of the nanocomposites and multilayers were investigated for their application interest in fully biodegradable food packaging.

Engineering Packaging for a Sustainable Food Chain

Sustainable, Active and Intelligent Packaging

Oral Communications

Desintegración de películas a base de biopolímeros en condiciones de compostaje

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Gelatina (GEL), quitosano (CH) y caseinato de sodio (SCas) son biopolímeros reconocidos como materia prima para la producción de películas para el envasado de alimentos. Bonilla & Sobral (2016, 2017) desarrollaron películas activas a base de estos tres biopolímeros, incorporando extracto de Boldo do Chile (B), como fuente de principios activos, con potencial aplicación para mantener la calidad y vida útil de diferentes productos (Bonilla et al 2018; Bonilla & Sobral, 2018). Sin embargo, la biodegradabilidad de esas películas no fue estudiada hasta el momento. Así, el objetivo del presente trabajo fue estudiar la desintegración de estos filmes, pasivos y/o activos, en condiciones de compostaje. Dispersiones de GEL (4%), CH (1%) y SCas (4%) fueron preparados por separado (GEL100, CH100, SCas100) y posteriormente mezcladas (GEL50:CH50, GEL50:SCas50), incorporando B (0.5%) para producir películas por el método de casting. La desintegración de los filmes se determinó siguiendo la Norma ISO 20200, considerando condiciones aerobias de compostaje (58^{o}C-50%HR). Las películas (espesor 0.080mm) se cortaron de forma circular (1.5cm de diámetro) y fueron colocadas en mallas de forma individual (3 películas/formulación/día de análisis). Posteriormente fueron enterrados (7cm de profundidad) en recipientes (10x10cm^2) conteniendo el compost previamente preparado. Los análisis de desintegración fueron realizados diariamente, entre 0 y 5 días. Pérdida de peso (%), espectros FTIR (Spectrum One FTIR-Perkin Elmer), y el aspecto visual del área de desintegración (usando una cámara digital Canon EOSReflex) fueron estudiados. Todos los análisis se realizaron por triplicado. Nuestros resultados no mostraron una tendencia lineal en la pérdida de peso de las películas en función del tempo, posiblemente debido a una difusión del agua (incorporada para mantener la condición de 50%HR) en cada matriz de los biopolímeros estudiados, ya conocidos como altamente hidrofílicos. El análisis de FTIR fue realizado al día 0 y 1, excepto para SCas100 y SCas100+B, que presentaron una desintegración total al día 1. Los espectros de las películas, con o sin extracto de B, mostraron cambios (aparición, desaparición, intensidad), en las bandas típicas de las películas puras y/o mezcladas, indicando una degradación progresiva de las mismas. Finalmente, el análisis del aspecto visual mostró que las películas CH100 y GEL50:CH50 necesitaron un mayor tiempo para desintegración (5 días), en relación a las otras películas (1-3 días). La incorporación de B, redujo el tiempo de desintegración de las películas puras (CH100) o mezcladas (GEL50:CH50), a 3 y 4 días respectivamente.

Keywords: Películas, Biopolímeros, Boldo do Chile, Desintegración, Compostaje

Development of biodegradable thermoactive packaging using phase change material particles onto cellulosic materials

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Food packaging no longer has a passive role in the protection and commercialization of the food product. Active packaging offers numerous innovative solutions to maintain or improve the quality and safety of food products. Many examples are commercially available regarding absorption of undesirable substances or release of desirable ones, but concerning the temperature maintenance of food products, thermoactive packaging is still in the development stage. Phase Change Materials (PCMs) can be used aiming the control of the product temperature because they have the ability to release or absorb large amounts of thermal energy during their phase transition, preventing the product from reaching temperature conditions that could lead to loss of nutritional or microbiological quality. Many works in the literature reporting on the efficacy of PCMs, did not reach the application tests. In this way, the goal of this work was to develop a thermoactive packaging based on sustainable material aiming oven-food products and hot beverages market. We have tested the application of coated carnauba wax particles onto cellulosic packaging materials to measure the maintenance of high temperatures in food products. Biodegradable cellulosic material was uniformly coated with two mass fractions of carnauba wax particles (10 and 20 wt.%) and the temperature profile was recorded during heating and cooling cycles simulating two conditions: the loss of heat from a pre-heated cup to the air (empty cup) represents the “thermal capacity” of the material, and the heat transfer from the hot oil to the cup represent the heat maintenance of a food product. The PCM particles were firstly characterized using thermogravimetric (TGA) and Differential Scanning Calorimetry (DSC) analyses and the thermal conductivity of the package materials were measured. The particles were stable up to 230 °C which allows the use of this particle in more drastic processes for obtaining packages. Microscopy taken after experiments confirmed that the particles were kept intact, resisting to the temperature variation. During heating, PCM-packaging started to absorb energy at 60 °C, taking more time than the control to reach the maximum temperature. The PCM-cellulosic material demonstrated a remarkable difference in the cooling process in relation to the original cellulose, keeping longer the temperature of the product. The results show that this effect starts when reaching the PCM melting temperature. ie, 80 °C. As expected, the packaging with larger amounts of particles had better temperature maintenance. The heat transfer was governed by the packaging material regardless of the product.

Keywords: Encapsulation, Food packaging, Sustainable packages, Heat management materials, Carnauba wax

Fabricación de nano y micropartículas de β-quitina a partir de la pluma del calamar gigante (Dosidicus gigas) y evaluación de su efecto en las propiedades mecánicas y barrera al vapor de agua de películas PVOH/quitosano

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Debido a la necesidad de aumentar la vida útil y mantener la calidad de diversos frutos, han surgido los envases activos elaborados de polímeros sintéticos y biopolímeros, que buscan obtener envases económicos, amigables con el medio ambiente, con buenas propiedades físicoquímicas y propiedades barreras al oxígeno y humedad. La mezcla de polivinil alcohol – quitosano (PVOH-Qo) muestra una buena compatibilidad, biodegradabilidad, con buenas propiedades físico-mecánicas pero una deficiente barrera a la humedad. Es así que en este trabajo se planteó el fabricar micropartículas de β-quitina, provenientes de la pluma del calamar, y evaluar su efecto de barrera al vapor de agua en películas de PVOH-Qo. Las películas de PVOH-Qo fueron mezcladas en diferentes relaciones (90:10; 80:20 y 70:30) y se les incorporó micropartículas de β-quitina (128 y 530 µm). El espesor de las películas control aumentó a medida que se incorpora Qo variando entre 0,030 ± 0,006 mm y 0,042 mm ± 0,003, siendo controlado por el tamaño de partículas que se incorpora a las mezclas. El valor de ETR para la película PVOH80:Qo20 muestra una tendencia hacer mayor a las demás mezclas, con un valor de 17,8 ± 0,5 MPa probablemente a una formación mayor de puentes de hidrogeno y de enlaces OH-NH_2 entre los polímeros en dicha proporción. El A% aumenta en la proporción 70:30 al incorporar MpQ128 pasando de 54, 6 ± 2,9% a 115,3 ± 10,1%. La incorporación de Qo al PVOH provoca que el comportamiento de la pérdida del vapor de agua pase de un sistema bifásico a trifásico, mientras al agregar MpQ128 pasa de trifásico a monofásica su cinética). El valor de PVA para la película 70:30 MpQ128 5% muestran una disminución significativa ($p<0,05$) con un valor de 0,086 ± 0,002 g*mm/(KPa*h*m^2 en comparación a su muestra control.

Keywords: Micropartículas de β-quitina películas quitosano/polivinil alcohol propiedades mecânicas-propiedades de barrera

Sustainable smart packaging: potential ph change indicator for food packaging

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Current smart packaging studies involve synthetic polymers and color indicators as synthetic chemical dyes of limited use in the food industry. However, in pursuit of sustainable development, companies and researchers have been constantly encouraged to develop packings from renewable resources. The objective of this work was to develop sustainable smart packaging based on starch and a natural indicator of pH change, anthocyanin, by extrusion. The pH indicator action was evaluated with this material capping Falcon tubes with beef or or chicken meat at room temperature (22 °C) and under refrigeration (6 °C) during three days. The pH indicator activity was evaluated by means of color change analysis of the film correlated with the pH of the meat. Anthocyanin was incorporated into the optimum formulation biodegradable film determined in earlier works by the same authors. The formulation used in this work was composed of starch: glycerol: stearic acid (70:28:2) g/100 g, varying three concentrations of anthocyanin (ATH) as indicator of pH change (0.005, 0.010 and 0.020) g/100 g solution. The films were processed in a twin-screw extruder (screw diameter of 16 mm, and L/D ratio of 40) (Process11, ThermoElectron, Germany) and then pelletized (Varicut, ThermoElectron, Germany). The extruder zone shows eight temperature zones finishing in a die with diameter of 3 mm. The thermoplastic starch films were characterized by mechanical, functional (moisture, water solubility and wettability), optical (color difference, luminosity and opacity), crystallinity, and morphological characteristics. The incorporation of ATH generated films thicker, less resistant at break, flexible, and rigidity, and more colored. The incorporation of ATH did not affect the crystallinity profile, however the microstructure of this films showed less homogeneity. Thermoplastic starch films incorporated with 0.005 g/100 g of anthocyanin stored in a refrigerator at 6 °C showed the better ecologically interesting alternative to indicate pH variations. When this material was exposed to pH near neutrality, there was a gradual change from purple to blue / gray as much as to beef or fish meat. The results obtained were promising, since the films evaluated showed good pH indicators, as they changed color to the naked eye in response to pH variation, and this change was more pronounced in films with lower anthocyanin

Keywords: Cassava starch, Extrusion, Smart packing, Anthocianin, pH

Development and characterization of biopolymeric film comprised mostly of galactomannans recovery from spent coffee grounds

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Coffee is one of the most popular beverages in the world with strong cultural and social impacts. In 2017/2018, the coffee world production was approximately 159,7 million bags of 60 Kg, and consequently, are produced more than 2 billion tons of by-products, such as husk, mucilage, parchment, coffee silverskin and spent coffee grounds (SCG). The main waste produced in the processing of coffee is SCG, with an average of 650 kg of SCG residues being generated per ton of green coffee beans. Due to the significant amount of waste produced, numerous studies have been carried out to find alternatives for its proper disposal as inadequate procedures lead to negative environmental issues and other specific problems, such as its use for the adulteration of roasted and ground coffee. SCG is rich in organic compounds such as fatty acids, caffeine, amino acids, polyphenols and especially polysaccharides, which enable potential applications. Galactomannans are the most abundant polysaccharides in SCG, presenting a low degree of branching and a high degree of polymerization, which enables excellent emulsifying and stabilizing properties. In view of the aforementioned, SCG is a potential alternative source for the production of biopolymers, which have received attention in recent years, especially due to the large environmental impacts caused by synthetic packaging. Thus, the objective of this work was to develop a biopolymeric film comprised mostly of galactomannans recovered from spent coffee grounds by alkaline and enzymatic treatment. Initially, the effects of three pretreatments were analyzed to remove lignin from SCG, one with alkaline peroxide solution, the other with alkaline solution and the lastly with alkaline potassium permanganate solution assisted by ultrasound. All pretreatments resulted in considerable removal of lignin, with the remaining lignin content in the range of 6-11%. The delignified materials were submitted to enzymatic treatment using commercial cellulase enzymes produced by Trichoderma reesei ATCC 26921. In order to optimize the hydrolytic process, different concentrations of SCG, cellulase and incubation times were evaluated, as well as the combination of extraction methods assisted by techniques such as ultrasound, autoclave, and microwave. Characterization of the delignified material was performed before and after the enzymatic treatment. Furthermore, the galactomannan-rich delignified material was used to produce biofilms, as the material before enzymatic treatment. The biofilms produced with the delignified cellulose-laden material and with the material consisting of galactomannans presented small differences in physical appearance, texture, and resistance. In conclusion, the material predominantly of galactomannans can be used as raw materials in the production of biomaterial with different properties of the film produced with the spent coffee ground without removal of cellulose.

Keywords: Spent coffee ground, Galactomannan, Biomaterial, Enzymatic treatment

Engineering Packaging for a Sustainable Food Chain

Sustainable, Active and Intelligent Packaging

Poster Communications

Carboxymethyl xylan functional films containing licorice essential oil: characterization and evaluation of antioxidant and antibacterial properties

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Objective: To develop antioxidant and antibacterial edible films based on carboxymethyl xylan incorporating licorice (*Glycyrrhiza glabra* L.) essential oil.
Methods: The films were prepared by the casting method and characterized by FTIR. The grammage, thickness, contact angle, mechanical and optical properties of the films were measured, together with the evaluation of their antioxidant, antibacterial and anti-biofilm properties against common foodborne pathogens (namely *Listeria monocytogenes* and *Enterococcus faecalis*).
Results: The FTIR spectra of the films clearly show the successful incorporation of the essential oil, being isopropyl palmitate its major compound. It was possible to verify that the films with essential oil had a significantly higher (P-value<0.05) contact angle (median: 66.94º; range: 53.38-80.96) using distilled water, indicating that they are more hydrophobic than the control ones (median: 39.33º; range: 32.98-47.32). The antioxidant properties of the films assessed by the ability to scavenging free radicals and to inhibit the lipid peroxidation were maintained even after a storage period at room temperature (20 days, 25ºC). In addition, the ability of these films to inhibit the growth of *Enterococcus faecalis* (median: 12.64 mm; range: 11.88-12.93) and *Listeria monocytogenes* (median: 12.25 mm; range: 11.82-13.20) has been demonstrated. The SEM images also suggest the anti-biofilm potential of the films incorporated with licorice essential oil against those foodborne pathogens.
Conclusion: The biodegradable films developed in this work can be used in active food packaging, improving the shelf life of food.

Keywords: Carboxymethyl xylan, Licorice essential oil, Functional films, Antioxidant activity, Antimicrobial properties

Embalagem bioativa incorporada com óleo essencial de cardamomo *(Elettaria cardamomun* (l.) Maton) no controle de *Staphylococcus aureus*

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Fatores externos e alguns micro-organismos podem causar alterações indesejáveis nos alimentos, assim como, a presença de patógenos como *Staphylococcus aureus*, podem representar riscos à saúde do consumidor, uma vez que é considerado como o principal agente causador de intoxicações alimentares, no Brasil. Como alternativa de controle, alguns pesquisadores propõem a elaboração de embalagens biodegradáveis, utilizando substâncias bioativas como extratos vegetais. Dentre os extratos naturais, destacam-se os óleos essenciais (OE), misturas complexas de compostos voláteis com atividade antibacteriana. Os compostos bioativos presentes nos OE, são altamente instáveis quando submetidos a condições ambientais adversas (presença de oxigênio e luz), assim para conferir maior estabilidade aos componentes dos OE, o processo de encapsulação vem sendo bastante aplicado. O objetivo do estudo foi avaliar *in vitro* a ação antibacteriana de filmes biodegradáveis incorporados com óleo essencial de cardamomo *(Elettaria cardamomun* (L.) Maton) contra *S. aureus.* Foram preparados filmes bioativos com duas concentrações de OE através da técnica de *casting* utilizando acetato de celulose e acetona (3% m/v), sendo incorporadas concentrações de OE de 6,25% e 12,5%, e também um filme como controle negativo (sem adição de OE) e um controle positivo (cultura bacteriana). Os mesmos foram avaliados contra *S. aureus* ATCC 25923 através da cinética em caldo, sendo avaliados nos tempos 0, 4, 8, 12, 24, 48 e 72 horas. Os resultados obtidos possibilitaram observar diferenças significativas na inibição da multiplicação de *S. aureus in vitro*, quando comparados os filmes com OE ao controle, porém não foi observada diferença entre as concentrações avaliadas. Foi verificado que as principais reduções da multiplicação bacteriana ocorreram após 12h de exposição aos filmes com OE, onde a concentração de células viáveis foi de 6,8 log UFC/mL, enquanto que nos controles foi de 9,2 log UFC/mL, demonstrando a necessidade de exposição de pelo menos 12h para que o mesmo possa liberar o OE, e assim inibir a multiplicação de *S. aureus.* Acredita-se que, a ação inibitória do filme combinada a refrigeração possua uma ação sinérgica, potencializando a ação inibitória contra a bactéria em estudo. Portanto, a utilização de filmes biodegradáveis incorporados com óleo essencial de cardamomo, demonstra-se como uma alternativa viável para aplicação, no controle de *S. aureus,* em alimentos.

Keywords: Filme bioativo Atividade antibacteriana, Extratos naturais

Physicochemical and antimicrobial properties of gelatin films loaded with nisin

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In order to reduce the environmental impacts brought by the incorrect disposal of synthetic plastics, the production of biodegradable packaging, such as biopolymers-based films, incorporated with natural antimicrobials has been studied. Thus, the aim of this project was the production of gelatin-based films, loaded with nisin and the evaluation of its physicochemical and antimicrobial properties. To produce the films, gelatin was hydrated for 30 min at room temperature and solubilized in a thermostatic bath (60 ºC/15 min). Glycerol was used as plasticizer at a concentration of 30 g/100g of dry weight of gelatin, and the nisin, a bacteriocin, was added at different concentrations (28, 56, 84 and 112 mg/g of gelatin). The film-forming solution was poured in a plate and dried in a forced-air circulation oven at 30 ºC/24 h. In order to characterize moisture content and solubility, optical and mechanical properties, water vapor permeability, and the water contact angle, the samples were conditioned into desiccators containing saturated solutions of NaBr (RH = 58%) at 25 °C for at least seven days. Antimicrobial analysis was performed by the disk diffusion test against S. *Aureus* and L. *Monocytogenes*. Regardless the concentration, the addition of nisin was not able to modify the gelatin hygroscopicity, and consequently, no significant difference was observed on the moisture content of the films (~14%). On the other hand, the addition of nisin increased the films solubility ranging from 32% (control) to 46% (with the maximum concentration of nisin). Concerning the color properties, L* values were around 90 and did not change with the addition of nisin, indicating a light-colored film. However, a slightly increase on the parameters a* and b* can be observed with the nisin concentration. Nisin was also able to increase the elongation at break of the films, suggesting a plasticizing effect on the biopolymer matrix. Regarding the water vapor permeability, no significant changes occurred with the addition of this bacteriocin, remaining around 0.3 g.mm/m².h.kPa. Besides, the water contact angle increased with the addition of nisin. Antimicrobial analysis showed halos ranging from 12-15 mm diameter. As conclusion, Nisin is an effective natural antimicrobial that could be used to improve the films functionality with no damages to the excellent film forming properties of the gelatin.

Keywords: Nisin, Biodegradable packaging, Natural antimicrobials, Mechanical properties, Bacteriocin

I.FILM: Multifunctional films for application in active and smart packages

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Due to high perishability, poultry products are kept in refrigerated storage within protective packaging and modified atmosphere. Lipid oxidation, while it is not often regarded as a limiting factor in the shelf life of these products, becomes a focal point of when other deteriorative effects are suppressed. Poultry, which is richer in polyunsaturated fatty acids, is even more susceptible to lipid oxidation spoilage, and small gains in shelf-life can be highly profitable. Active packaging can be defined as a material that performs a role other than serving as a simple inert barrier to the outside environment, often with the inclusion of antimicrobial and antioxidant agents directly into packaging. It is a recent technological development that has the potential of extending the shelf-life of poultry products. While the incorporation of antioxidant and antimicrobial agents in packaging films has demonstrated reliable increases in product stability, the synthetic source of these agents and/or their extraction procedures often make them undesirable from an environmental and economical perspective.

Marine macroalgae are an abundant and underdeveloped source of bioactive material, readily available along the shores of the portuguese coast. Thus, the incorporation of marine bioactives in food packaging as a means of extending shelf life presents itself as a novel and effective method of remedying current difficulties in the food industry, while fitting within modern circular economy systems and adding value to marine resources.

Project I.FILM attempts to fulfil this vision through the development of thermoplastic food coatings enriched with marine bioactives from readily available aquacultured macroalgae.

Hydroethanolic extracts of red macroalgae Gracilaria gracilis and Porphyra dioica were evaluated for their antioxidant potential (DPPH and FRAP assays) and phenolic content, as part of the preliminary assays for the selection of algal biomass for the enrichment of thermoplastic films. Upon the statistical optimization of the extraction process using Response Surface Methodology (RSM), the extracts were then processed through electrospinning into a nanofiber coating, using high molecular weight PEO (polyethylene oxide) as the base polymer. Bioactive stability of the electrospun material was then evaluated through the same antioxidant assays.

The project further encompasses the determination of effective shelf life gains from the use of the new active films, as well as the study of compound migration from the nanofiber-enriched films, the effect of electrospinning conditions in the film quality, and the optimization of film design in order to maximize product quality and minimize the complexity of production.

Keywords: Smart packaging, Poultry stability, Macroalgae, Electrospinning, Shelf-life

Response surface methodology in the optimization of extraction conditions for *Gracilaria gracilis* extracts and their antioxidative stability as part of nanofiber food coating additives

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Incorporation of antioxidant agents in edible films and packages often relies in the usage of essential oils and other concentrated hydrophobic liquids, with reliable increases in antimicrobial and antioxidant activities of the overall composite, but with less desirable synthetic sources and extraction methods. As such, using commonly available seaweeds as the source for both the main polymers and the supplementing antioxidant/antimicrobial agents in bioactive films can potentially reduce production costs and create a safer, more sustainable product.

Hydroethanolic extracts of commercially available red macroalgae *Gracilaria gracilis* were evaluated for their antioxidant potential and phenolic content, as part of the preliminary assays for the selection of algal biomass for the enrichment of thermoplastic films. The extracts were obtained through use of solid-liquid extractions, over which yield, DPPH radical reduction capacity, total phenolic content, and FRAP activity assays were measured. Solid to liquid ratio, extraction time, and ethanol to water ratio were selected as independent variables with experimental ranges and configurations obtained using a Box-Behnken design with three factors, resulting in 15 experimental conditions. Response surface methodology (RSM) was then used to estimate the effect of each extraction condition on the tested bioactivities. Maximum ethanolic yields were obtained with a theoretical extraction of 100 minutes and a 1g to 25mL SLR. Aqueous extractions displayed similar results in terms of optimum conditions, but with overall lower bioactivities and higher yields.

Ethanolic and aqueous extracts obtained in this condition were then used in the production of nanofiber inner coatings for food grade PP (polypropylene) films. This was achieved through electrospinning of a 50% ethanol solution containing 1g/100mL of PEO (polyethylene oxide, MW = 900 g/mol) and 0.8g/100mL of dry extract. The coatings were scraped off the PP films for further antioxidant content analysis, with the same assays carried out during extract optimization. Significant declines in antioxidant activity of the electrospun extract were observed, with DPPH activity decreasing 95.5% and 88.5% for ethanolic and aqueous extracts, respectively. Activity decline according to FRAP assay had similar results (>98% for ethanolic and >95% for aqueous). Decreases were lower in Folin-Ciocalteu reaction assay, with only 48.4% decrease in ethanolic extract coatings, and 78.8% in aqueous extract coatings.

Further work within the context of this project will evaluate the influence of coated films in the shelf-life of poultry meat, and the existence of correlation between the observed antioxidant degradation of electrospinning-processed extracts, and their effectiveness as active-packaging agents.

Keywords: Bioactive compounds, Response surface methodology, Antioxidant, Food coating, Electrospinning

Nanofibras poliméricas contendo biomassa de S*pirulina sp*. LEB 18 para aplicação em embalagem inteligente

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A aplicação de nanofibras como sensor de pH para embalagens inteligentes potencializa a capacidade de interação com o meio, melhorando as funcionalidades de superfície e o desempenho dos sensores para alimentos, bebidas e meio ambiente. A utilização de poli(ácido lático) (PLA) auxilia na redução dos gases do efeito estufa e consumo de energia fóssil, por ser biodegradável e pode ser produzidos por fontes renováveis. O óxido de polietileno (PEO) é biocompatível com células e tecidos, solúvel em água e disponível comercialmente a baixo custo. A microalga Spirulina sp. LEB 18 contém diversos pigmentos em sua composição como a ficocianina, carotenoides e clorofila que podem sofrer modificações estruturais e potencial perda da cor devido à alteração de pH ou temperatura. O objetivo do trabalho foi desenvolver nanofibras de PLA e PEO contendo biomassa de Spirulina sp. LEB 18 para aplicação como embalagem de alimentos. As soluções foram preparadas com 8% m v-1 de PLA e 4% m v-1 PEO na proporção 6:4, e 1% m v-1 de biomassa, solubilizadas em clorofórmio/metanol na proporção 8:2. A morfologia e diâmetro das nanofibras foram avaliadas a partir da microscopia eletrônica de varredura. Para a sensibilidade das nanofibras às variações de pH foram preparados tampões com valores de pH de 1,0-10,0, em que as nanofibras foram seccionadas em seções de 20 mm x 20 mm. Com auxílio de um colorímetro foi realizada a diferença total de cores (ΔE). As nanofibras de PLA/PEO e PLA/PEO/biomassa apresentaram diâmetros médios de 728±94 e 835±150 nm, respectivamente. Com relação da avaliação das nanofibras contendo biomassa em diferentes pHs, pode-se afirmar que a maioria (70%) dos valores de ΔE encontrados foi maior que 20, indicando mudança absoluta da cor. Dessa forma, nanofibras de PLA/PEO contendo 1% de biomassa Spirulina são materiais com potencial utilização como sensor de pH para fornecer informações ao consumidor sobre a qualidade dos produtos alimentícios.

Keywords: *Electrospinning*, Microalga, Nanotecnologia, Poli(ácido lático), Sensor

Starch-gellan edible coatings containing thyme essential oil for post-harvest preservation of apples and persimmons

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Considerable research has focused on the control of the physiological activity and microbial decay of fruit and vegetables in postharvest conditions. Treatments with synthetic fungicides are being restricted, and edible coatings (EC) carrying active compounds represent an alternative preservation technology. Direct application of EO shows problems, while the use of biopolymers as carriers could allow for a better retention of the EO. Starch exhibits several advantages, such as its availability, low cost, forming colourless and tasteless films, which properties can be improved by blending with several gums. Starch-gellan blends can be used as coatings since their films exhibited low gas permeability, which can modulate gas exchanges. The potential conservation effect of EC based on these polymer mixtures, with and without thyme EO, emulsified or encapsulated in liposomes, was studied in fresh apples and persimmons. The rheological behavior and contact angle of the coating solutions were characterized, as well as the surface density of solids (SDS), weight loss, respiration rate and firmness of the coated fruits after one and/or two weeks of storage. Coatings were applied to fruit inoculated with *Botrytis cinerea* (apple) and *Alternaria alternata* (persimmon) to evaluate their antifungal activity. Formulations exhibited a pseudoplastic behavior and apparent viscosities at 100 s^{-1} ranged between 25.05 ± 0.03 and 42.2 ± 0.2 mPa s. Coatings more easily spread on persimmon skin (contact angles between 50˚ ± 6 and 72˚ ± 2) than on apple surface (values between 73˚ ± 2 and 96˚ ± 2). SDS was lower than 1 g/m^2 on persimmon surface. In apples, coatings had limited effectiveness at controlling weight loss, but reduced water loss in persimmons after 14 days, from 0.7 ± 0.1 day^{-1} in the control sample to 0.52 ± 0.03 day^{-1} in coated fruit. There were no significant differences in the O_2 consumption rates of apples at 7 days of storage. Persimmon had lower respiration rates than apples and no significant effect of storage time or EC was observed. Regarding fruit firmness, the penetration distance at failure increased in coated persimmon when compared to the control (values between 2.5 ± 0.3 and 6.1 ± 0.9 mm). Coatings with encapsulated EO, reduced the disease incidence of *B. cinerea* in 25 % and the severity in 36 %, as compared to non-coated apples after 12 days. In persimmon, coatings with lecithin were less effective against *A. alternata*, with no significant differences due to the presence of the EO.

Keywords: Starch, Gellan, Edible coating, Antifungal, Postharvest, Fruit

Evaluación de la capacidad antioxidante y antimicrobiana de un envase activo elaborado a partir de proteína concentrada de lactosuero con adición de α-tocoferol y aceite esencial de orégano (*Origanum vulgare*)

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El envasado activo es una nueva tecnología que consiste en incorporar compuestos antioxidantes y antimicrobianos en el envase para favorecer su liberación gradual y extender la vida útil de los alimentos. La incorporación de α-tocoferol y aceite esencial de orégano (*Origanum vulgare*) (AEO) en nuevas formulaciones de películas permite obtener un envase con capacidad antioxidante y actividad antimicrobiana. En esta investigación se elaboró un envase activo con proteína concentrada de lactosuero con α-tocoferol y AEO para aportar capacidad antioxidante y antimicrobiana frente a *Listeria monocytogenes* (ATCC 7644) y *Staphylococcus aureus* (ATCC 6538). Se realizó la extracción del AEO desde la especia fresca y se evaluó su concentración mínima inhibitoria (CMI) frente a las bacterias mencionadas. Los biopolímeros activos fueron elaborados por el método Casting, con 10% de proteína, 5% glicerol, 2% de α-tocoferol. Se evaluaron 3 concentraciones de AEO: 1390, 2160 y 2700 ppm respectivamente. Se determinó la capacidad antimicrobiana de los biopolímeros por la difusión de discos en agar y contenido de polifenoles totales, capacidad antioxidante reductora de hierro y ensayo de decoloración con el radical ABTS.
El rendimiento de la extracción de AEO en base húmeda fue de 0,18% con una CMI para inhibir *Staphylococcus* de 64 ppm y para *Listeria* de 1390 ppm. El efecto inhibitorio del AEO incorporado en las películas a las diferentes concentraciones se mantuvo tanto para *Listeria* como para *Staphylococcus,* presentando halos de inhibición de 0.5 y 2.5 mm, respectivamente. Se cuantificaron valores de polifenoles totales de 64.99 ± 0.29, 68.56 ± 0.36 y 79.34 ± 0.07 mg AG/g en biopolímeros con concentración de AE de 1390, 2160 y 2700 ppm, respectivamente. La capacidad antioxidante reductora de hierro de las películas con la concentración de AE mencionada anteriormente fue 15.66 ± 0.30, 22.11 ± 0.05 y 28.12 ± 0.39 µmol Trolox/g y para ABTS 9.13 ± 0.03, 9.29 ± 0.04 y 9.30 ± 0.04 µmol Trolox/g. Los resultados obtenidos demuestran que el biopolímero con α-tocoferol y AEO.

Keywords: Envase activo, antimicrobiano, antioxidante, α-tocoferol, aceite esencial, proteína concentrada de lactosuero, biopolímero

Shelf life assessment of fresh poultry meat wrapped in chitosan biofilms incorporated with essential oils

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In the past decades, an alternative to the petroleum-based products by the food packaging industry, that could be biodegradable and renewable (e.g. chitosan), has been procured in order to reduce the fossil-based waste disposal problem. Combining natural extracts or essential oils with biopolymers is being considered a promising technology, since it can increment the package activity towards perishable food, allowing the extension of its shelf life.
Accordingly, the aim of this work was to develop novel biopolymers based on chitosan (Ch) incorporated with 2% of rosemary essential oil (REO) or ginger essential oil (GEO) and to evaluate them as primary active packaging to fresh poultry meat. The pristine chitosan film-forming biofilms were produced using the casting method and the oils were incorporated before the last stirring cycle. Biofilms without oil were also produced to be used as the control. To evaluate the activity of the biofilms as primary packaging, the fresh poultry meat was packaged in the biofilms and stored at refrigerated temperatures (5°C ± 2°C) for 15 days. During storage, the meat being packaged was characterized physically and chemically (pH, acidity, humidity, index of substances reactive to thiobarbituric acid and color), and microbiologically (total viable microorganisms and total coliforms). Unwrapped meat was also characterized along the study. The biofilms produced resulted in a homogeneous plastic, predominantly yellowish, flexible and without great variations in thickness. Biofilms have shown to be effective in the meat preservation process, reducing lipid oxidation (to a maximum of 61% at day 15) and microbiological contamination (to a maximum of 24% for total viable microorganisms and 32% for total coliforms at day 10), and retaining color, in comparison to the unwrapped meat samples. Incorporation of GEO was more effective than REO: the antioxidant effect was higher. In conclusion, the incorporation of essential oils, in particular GEO whose antioxidant and antimicrobial activity was higher, contributed significantly to the extension of the chicken meat shelf life, revealing that these biofilms have potential to be applied in food packaging as a food coating.

Keywords: Active Packaging, Chitosan, Essential Oils, Biopolymers

Avaliação do poder antimicrobiano e antioxidante de biocompósitos incorporados com óleo essencial de gengibre

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A indústria alimentar está em constante procura por tecnologias alternativas de forma a prolongar o tempo de prateleira de diversos produtos, constituindo o desenvolvimento de embalagens ativas, com novos materiais, um passo importante neste sentido. A adição de substâncias naturais a estes materiais, substituindo os aditivos sintéticos muito utilizados, vem colmatar a procura dos consumidores por alimentos mais seguros e menos alterados quimicamente. Os óleos essenciais, devido à sua capacidade antimicrobiana e antioxidante, tornam-se uma alternativa para incorporação em embalagens ativas.

Neste contexto, estudou-se o poder antimicrobiano (AM) e antioxidante (AO) de filmes ativos à base de quitosano, incorporados com óleo essencial de gengibre (OEG) em diferentes concentrações (0,5%; 1% e 2%), com e sem incorporação da nanoargila (montmorilonite sódica, MMT). Relativamente ao poder AM, avaliou-se a ação destes filmes na inibição ou redução de cinco bactérias patogénicas e/ou deterioradoras de alimentos (*E. coli*, *P. aeruginosa, S. aureus, L. monocytogenes* e *E.faecali*), através do método da contagem de unidades formadoras de colónias. Ensaios de migração dos filmes em diferentes meios simulantes (etanol 50% (v/v), etanol 10% (v/v) e água) permitiram a avaliação do poder AO destes, ao longo de 250h, através da determinação de compostos fenólicos totais, atividade antioxidante e análise dos coeficientes de difusão.

Quanto ao poder AM, observou-se que a ação de MMT nos filmes melhora a sua atividade antimicrobiana, facilitando a libertação de OEG e permitindo uma melhor ação sobre os microrganismos em estudo. A bactéria que se verificou mais sensível à ação dos agentes antimicrobianos foi a *L. monocytogenes,* e a menos sensível a *E. coli.* Nos ensaios de migração, verificou-se que os filmes com maior poder AO foram os que continham OEG sem MMT, que migrou para o meio simulante com etanol 50%(v/v) e etanol 10%(v/v), mas não para a água.

Keywords: Embalagens Ativas, Quitosano, Óleo Essencial

Efeito da adição de extratos de boldo-do-Chile (*Peumus boldus*) sobre as propriedades de filmes de gelatina

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Os filmes com antioxidantes naturais são vistos, atualmente, como uma das tecnologias mais interessantes para produção de filmes ativos. Diversas pesquisas têm se concentrado, principalmente, no uso de extratos aquosos de vegetais, normalmente ricos em compostos fenólicos, como fonte de princípios com atividades antioxidante e/ou antimicrobiana. Considerando que a propriedade antioxidante de extratos do Boldo-do-Chile (*Peumus boldus*) não tem sido explorada em estudos sobre filmes ativos, o objetivo desse trabalho foi avaliar a atividade antioxidante de seus extratos hidroetanólicos, e o efeito da adição destes extratos nas propriedades físico-químicas de filmes de gelatina plastificados com glicerol. Os extratos de boldo-do-Chile (EBC) foram produzidos a 45°C, utilizando-se soluções hidroetanólicas com as proporções de água:etanol: 0:100, 25:75, 50:50, 75:25 e 100:0, e caracterizados (fenólicos totais pelo método de Folin-Ciocalteau, ABTS e DPPH) em até 24horas. Os filmes foram produzidos pela técnica "*casting*", incorporando-se os EBC nas concentrações de 0, 50 e 150g/100g de gelatina. Eles foram caracterizados para a determinação de propriedades mecânicas (tração e perfuração), cor e opacidade, umidade, solubilidade em água, barreira à radiação UV/visível e microestrutura (MEV). Os dados foram submetidos a análises estatísticas de ANOVA e teste de Tukey, utilizando-se o programa SAS (versão 9.1). O solvente influenciou as propriedades dos EBC produzidos. Os EBC obtidos com proporções água:etanol 100:0, 50:50 e 25:75 apresentaram os maiores conteúdos de compostos fenólicos (7,3±0,4, 7,2±0,4 e 6,6±0,6mg ácido gálico/mL, respectivamente), mas todos apresentaram atividades antioxidante similares, para ABTS (~6,4mg trolox/mL) e DPPH (EC_{50} de ~23µL/mL). De modo geral, a adição dos EBC não afetou a espessura (~0,087mm), nem as propriedades mecânicas (tensão na ruptura= ~25MPa, elongação na ruptura= ~54%, módulo de elasticidade= ~303MPa, força na perfuração= ~27N, e deformação na perfuração= ~6%), opacidade (~0,3), umidade (~15g água/100g filme) e solubilidade em água (~36g/100g filme) dos filmes. A microestrutura dos filmes também não foi influenciada pelos EBC. A diferença total de cor (ΔE*) aumentou com a concentração de EBC nos filmes, de 3,31±0,17 (0g/100g de gelatina) para 8,66±1,88 (50g/100g de gelatina) e 20,64±6,81 (150g/100g de gelatina), e foi maior para filmes com EBC de proporções água:etanol 50:50 e 25:75. A barreira à radiação UV/visível também aumentou com a concentração de EBC nos filmes e foi maior para filmes com EBC de proporções água:etanol 50:50 e 25:75. Assim, os filmes contendo EBC de proporções água:etanol 50:50 e 25:75 foram os que apresentaram melhor potencial de utilização como embalagem ativa para alimentos.

Keywords: Filmes ativos, Propriedade antioxidante, *Peumus boldus*, Propriedades físico-químicas

The effect of soy protein based antioxidant packaging on the shelf-life of linseed oil

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The pinhão is a seed from the *Araucaria Angustifolia*, popularly known as Pinheiro do Paraná and that develops in the south of Brazil, Argentina and Paraguay. Pinhão seeds are usually consumed boiled in water and peeled, and both the cooking water and the peels are widely discarded as residue. According to studies, the pinhão coat and its cooking water have a significant concentration of phenolic compounds with antioxidant properties. In this way, the addition of the pinhão cooking water in films based on soy protein is an option to obtain antioxidant packages that can reduce the oxidation of foods, mainly oils, in addition to e ncouraging the preservation of *Araucaria Angustifolia* and the use of waste. The objective of this work was t o produce soybean protein isolate (SPI) films added of lyophilized pinhão cooking water and to evaluate its e ffect as antioxidant packaging in linseed oil. The films were produced by the casting technique using 7.5% (w /v) SPI and 3 g glycerol/g SPI as plasticizer. Two formulations were produced, control (FC) and with addition of 2% of lyophilized pinhão cooking water (FP2). In the films the concentration of phenolic compounds and t he antioxidant activity were evaluated by FRAP and DPPH methods. The films were sealed for the production of sachet-type packages and 5 ml of flaxseed oil was added. The sachets were conditioned in a desiccator at 53% relative humidity and 25 °C and analysis of peroxide value, iodine value, and specific extinction coefficie nt (conjugated dienes-K_{232}, conjugated trienes-K_{270} and variation of specific extinction-ΔK) of linseed oil were performed during 28 days of storage. The FP2 film presented higher antioxidant activity, correlating with the concentration of total phenolic compounds. After 28 days of storage, the positive effect of the FP2 film on th e oxidative stability of the linseed oil was verified from the lower values of peroxide value, K_{232} and K_{270}, and higher iodine value. This work demonstrate that it is possible to integrate the lyophilized pinhão cooking wat er in SPI biodegradable films, providing antioxidant effects capable to retard the oxidation of linseed oil.

Keywords: *Araucaria angustifolia*, Biopolymers, Active packaging, Antioxidant activity, Lipid oxidation

Coatings based on chitosan and *Origanum vulgare* subsp. *virens* essential oil to control Gram-negative bacteria responsible for color defects in cheese

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The aim of this work was to develop a coating formulation to control the growth of undesirable Gram-negative bacteria involved in the browning of cheese surface using natural products. These color defects, which devalue the quality and economic value of cheeses, are superficial and could be prevented with the use of antimicrobial coatings.

Since the Gram-negative bacteria are known to be difficult to inhibit, this study started with the evaluation of the antibacterial activity, using the plate diffusion method, of different essential oils and aqueous extracts, obtained by hydrodistillation in a Clevenger apparatus, of the species *Cymbopogon citratus*, *Lavandula luisieri*, *Melaleuca armillaris*, *Origanum vulgare* subsp. *virens*, *Rosmarinus officinalis*, *Thymus mastichina* and *Thymus vulgaris* against eleven different bacterial strains belonging to the species *Pseudomonas fluorescens*, *Pseudomonas putida*, *Alcaligenes faecalis* and *Achromobacter xylosoxidans*. Minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) values were determined for essential oils and aqueous extracts which showed some inhibitory effect in the previous assays.

The *O. vulgare* subsp. *virens* essential oil was the only natural product used that exerted inhibition against all bacterial cultures tested, with MIC and MBC values ranged between 0.05% (v/v) and 8.69% (v/v), and was subsequently selected to test in coating formulations based on chitosan (1%), acetic acid (1%), glycerol (2%) and tween 20 (0.56%). The average thickness of these films was 0.23 mm ± 0.04 mm and when tested in an *in vitro* antimicrobial assay against the eleven bacterial cultures inhibition halos between 6.94 mm ± 1.33 mm and 11.13 mm ± 1.54 mm were obtained. Despite the good results of the coating formulation when tested in an *in vitro* assay, the results using artificially inoculated cheeses were not conclusive, demanding new assays, especially with regard to the reproduction of the cheese maturation conditions.

Keywords: Cheese quality, Natural products valorization, *Pseudomonas*, Antimicrobial coatings

Elaboração e caracterização de filmes biodegradáveis obtidos por extrusão contendo microcápsulas de óleo essencial de orégano por *spray drying*

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Foi elaborado e caracterizado um filme biodegradável ativo a base de uma mistura de poli (adipato de butileno-co-tereftalato) (PBAT), amido de mandioca e glicerol por extrusão termoplástica e incorporado com microcápsulas de óleo essencial de orégano (OEO) obtidas por *spray drying* utilizando goma arábica e maltodextrina (1:1) como materiais de parede. Na análise de concentração mínima inibitória (MIC), as microcápsulas demonstraram ação nas concentrações de 0,5; 0,65; 0,55; 0,6 e > 0,4%, frente a *Salmonella Heidelberg, Staphylococcus aureus, Escherichia coli, Proteus* e *Lactobacillus plantarum,* respectivamente. Baseado nestes resultados, estabeleceram-se as seguintes concentrações de microcápsulas a serem adicionadas nos filmes: 5%, 10% e 15% (g/g total da formulação). Um filme controle, sem adição de microcápsulas também foi elaborado nas mesmas condições. Os filmes foram confeccionados em um extrusor monorosca piloto. Primeiramente, os componentes das formulações foram misturados manualmente e extrusados. Os *pellets* obtidos foram reprocessados para formação dos filmes no mesmo extrusor, com a matriz circular para extrusão sopro em balão. Os filmes foram caracterizados quanto às propriedades mecânicas (teste de tração), permeabilidade ao vapor de água (PVA), solubilidade em água e opacidade. Os filmes apresentaram boa processabilidade, visualmente homogêneos, e com boa distribuição das microcápsulas, independente da formulação. A espessura dos filmes variou de 150 a 200 µm. A incorporação de microcápsulas não afetou de maneira significativa ($p<0,05$) o módulo de *Young* dos filmes, apresentando valores entre 59,2±14,2 e 75,1±18,0 MPa. Em relação à tensão na ruptura e elongação dos filmes, observou-se uma diminuição nos valores destas propriedades com a incorporação de concentrações acima de 10% (g/g) das microcápsulas na formulação; no caso da resistência à tração, os filmes apresentaram valores entre 6,50±1,32 e 3,64±1,21 MPa e de elongação na ruptura de 270,91±83,9 a 27,59±5,7%, sendo que os menores valores são referentes aos filmes com 15% (g/g) de microcápsulas. As propriedades de barreira, solubilidade e opacidade dos filmes não apresentaram variações significativas em função do aumento da concentração de microcápsulas, sendo que a PVA dos filmes variou de 3,97±0,3 $x10^{-7}$ $g.m^{-1}.h^{-1}.Pa^{-1}$ a 5,34±0,91 $x10^{-7}$ $g.m^{-1}.h^{-1}.Pa^{-1}$ e a solubilidade de 24,39±1,10 a 33,02±5,64 %. A opacidade dos filmes foi de 0,303±0,001 a 0,406±0,001 %/µm. Conclui-se que, a incorporação de até 10% (g/g) de microcápsulas de OEO obtidas por *spray drying* não afeta as propriedades dos filmes e que estes apresentam grande potencial para serem usados como embalagens ativas para alimentos.

Keywords: Extrusão termoplástica, Amido, Microencapsulação

Products of autochthonous plants as bioactive ingredients in chitosan-based coatings for preservation of *Arbutus unedo* L. fruits

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The aim of this work was to evaluate the effects of chitosan-based coatings enriched with essential oil and aqueous extracts of *Pterospartum tridentatum* and *Lavandula stoechas* subsp. *luisieri* in *Arbutus unedo* L. fruits.

The culture of *Arbutus unedo* L. is large and mainly spontaneous so it became a species with great economical impact in rural areas. Several parts of *Arbutus unedo* L. can be useful in both traditional medicine (antioxidant, astringent, anti-inflammatory and diuretic properties) and popular consumption. The fruit of *Arbutus unedo* L., strawberry tree, has several uses such as fresh fruit, alcoholic beverages, marmalades and jams. Therefore, it is very important to find ways to preserve and extend the conservation of strawberry tree. Edible coatings are efficient for food quality preservation and can also act as a barrier to avoid mechanic damages.

L. stoechas subsp. *luisieri* and *P. tridentatum* are two abundant and spontaneous plants that growth in Beira Interior region, Portugal. The essential oil (EO) of *L. stoechas* subsp. *luisieri* and both aqueous extracts (AE) from *L. stoechas* subsp. *luisieri* and *P. tridentatum* were obtained by hydrodistillation, using a *Clevenger*-type apparatus. The extraction yield was 0,75% (v/v) for EO, 22,6% (w/w) and 17,3 %(w/w), respectively for aqueous extracts.

Different chitosan-based coatings formulations were prepared: chitosan was used as control; chitosan and natamicin as a positive control; combination between chitosan and essential oil; and chitosan with two different concentrations of aqueous extracts for both species. Fresh fruits were previously disinfected, immersed into each formulation during 5 minutes and stored at 6±2°C and 22±2°C. Three different treatments were performed: non-inoculated fruits; filamentous moulds inoculated fruits and yeasts inoculated fruits. The visual observation for moulds development was recorded at 3 days intervals for a period of 30 days.

Antifungal activity of each coating, against *Aspergillus carbonarius, Rhizopus stolonifer, Penicillium brevicompactum, Aureobasidium pullulans* and *Saccothecium rubi*, isolated from strawberry tree, was studied using the plate diffusion method. *A. carbonarius* and *R. stolonifer* were the most resistant to action of bioactive coatings, while the *P. brevicompactum, A. pullulans* and *S. rubi* showed inhibition halos between 4 and 9 mm. Regarding the strawberry tree fruits, the coatings with essential oil and both aqueous extracts revealed the delay of fungi development in relation to fruit without coating, preserving for a few days the conservation of the fruits.

Keywords: *Lavandula* spp., *Pterospartum* spp., Hydrodistillation products, Antifungal coatings, Preservation

Engineering Packaging for a Sustainable Food Chain

New Food Packaging Materials

Oral Communications

A new biodegradable packaging for oil

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The objective of this study was to develop a biodegradable film from a new raw material (red bean flour) and prepare a biodegradable packaging from this film for packaging vegetal oils. The film of red bean flour was developed by the casting method at a concentration of 5% flour and 30% of glycerol. Filmogenic solutions of 10 g (RBFF) and 25 g (RBFF+) were used to obtain films of different thicknesses. The thickness, mechanical properties (tensile strength (TS) and elongation (E)), water vapor permeability (WVP), solubility in water (WS), color parameters and transparency of the films were evaluated. In addition, the properties of the hot sealability and the ability of these films to receive the impression of a possible label were evaluated. Due to the greater amount of filmogenic solution placed on the plate, the RBFF+ presented thickness significantly higher than the RBFF, 0.196 mm and 0.114 mm, respectively. RBFF+ presented higher TS (9.5 MPa) than RBFF, however, did not differ significantly in E. The RBFF+ presented values of WVP (35.8 g.mm/day.m^2.kPa) and a* (36.9) significantly higher when compared to RBFF. WS of the films did not present significant difference, being between 32.0% for RBFF and 33.1% for RBFF +. The RBFF presented higher luminosity (57.7), tended to yellow (31.4) and had greater transparency (5.9 %). It was possible to seal and print on the two films elaborated. However, because it presented better mechanical properties and less transparency (important for the preservation of oil quality), RBFF+ was used in the development of a pouch type package to be used as a refill of different oils. Preliminary tests have shown that this package can preserve olive oil for at least 90 days, without permeating to the outside of the packaging. More studies are being carry out to verify the quality of olive oil for longer periods. It is possible that this package made from this new material can be used commercially, allowing industries to have a refill packaging of their products in the markets. This packaging would bring greater convenience to the consumer, replacing the frequent purchase of glass bottles, for a lighter and more sustainable packaging.

Keywords: Red bean, Biodegrable packaging, Sustainable packaging, Films

Development by extrusion of polypropylene blends with thermoplastic starch from the babassu mesocarp

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Faced with the great accumulation of plastic wastes and the fateful exhaustion of petroleum, it is sought to reduce the content of synthetic resources in the packaging sector. However, currently developed biodegradable materials face problems such as not being so competitive in some properties and cost. This work developed by extrusion polypropylene blends with babassu thermoplastic starch (obtained from the residue of the oil extraction), aiming at the application in the packaging related to the food industry. It was produced TPS (thermoplastic starch) and PP (polypropylene) films for control, and TPS:PP blends (40:60) with different cross-link agents (citric, stearic, palmitic and maleic anhydride). The materials were processed in a twin-screw extruder (screw diameter of 16 mm, and L/D ratio of 40) (Process11, Thermo Fisher Scientific, Germany) and then pelletized (Varicut, Thermo Fisher Scientific, Germany). The films and blends were characterized by mechanical, functional (moisture, water solubility and wettability), optical (color difference, luminosity and opacity), crystallinity, and morphological characteristics. Citric acid and maleic anhydride presented similar behavior in TPS films and blends, generating films more resistant at break [0.80 MPa (TPS:PP, 100:00) until 18 MPa (TPS:PP, 60:40)] and homogeneous, more crystalline, flexible [16 % (TPS:PP, 100:00) until 28 % (TPS:PP, 60:40)], and hydrophilic [20 ° (TPS:PP, 100:00) until 65 ° (TPS:PP, 60:40)], less colored [ΔE: 76 (TPS:PP, 100:00) until 70 (TPS:PP, 60:40)], and more luminous [L*: 3 (TPS:PP, 100:00) until 20 (TPS:PP, 60:40)] than with other crosslink agents. It was observed that the blends (TPS:PP, 60:40) had a reduction of flexibility (70 %), the resistant at break (93 %), and the rigid (82 %), and an increasing in the water solubility, the color difference, and in the opacity when compared to PP control film. Although of the PP control film showed a loss in properties when TPS was added, the use of a renewable source residue represents a differential for a non-biodegradable material that is produced from a polymer of petroleum origin, a non-renewable source that is doomed to depletion.

Keywords: Polypropylene, Babassu, Blends, Agro industrial waste, Cross-link agents, Extrusion

Sensory evaluation of poly (ethylene terephthalate) packaging with biopolymer-based coating

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This work aims at the sensory evaluation of poly (ethylene terephthalate) (PET) plastic packaging with biopolymer-based coating in order to form films capable of remaining stable and adhered to the external surface. Solutions were prepared with combinations of different types of materials and percent variations (80% starch + 20% gelatin, 50% starch + 50% gelatin, 20% starch + 80% gelatin). The solutions were prepared in a thermal bath at 80 °C which was the ideal temperature for the complete gelation of the starch and dissolution of the gelatin. After complete dispersion of the materials, the plasticizer was added. After preparation of the solutions, PET packages with a volume of 250 mL and a mean thickness of 0.350 mm were immersed in the solutions for 1 minute, followed by conditioning and stabilization at 25 °C for 24 hours. A control sample, ie uncoated, was prepared for comparison purposes. Afterwards the samples were submitted to visual sensorial analysis by the affective acceptance test in relation to the appearance and overall impression attributes with a number of 128 evaluators with ages ranging from 18 to 62 years. The samples were coded and presented to the evaluators following the alternation of the complete balanced blocks. There were two different sessions: in the first session with the empty containers and the second, with a simulant product packaged: a soy-based drink. The results showed that the samples with coatings with higher percentage of starch presented higher opacity, perceived by the evaluators, but when the same samples were conditioned with simulant product, this difference was not perceived in a significant way, without affecting the appearance. Thus, the difference in preference among the evaluators was not significant, since the impact of the appearance of the starch-containing coatings with opacity and whitish appearance was minimized with the packaged product. The sensorial analysis was important to verify and receive feedback regarding the evaluators' opinion regarding this new packaging concept. In addition, biopolymer coatings have great potential in replacing synthetic coatings in many applications. While total short-term replacement of conventional synthetic packaging is unlikely, research on films and biomaterial-based coatings is needed to be continued and improved.

Keywords: Poly (ethylene terephthalate), Biopolymer-based, Coating, Gelatin, Starch

Elaboração e caracterização de filmes extrusados a partir de blendas de poli(butileno adipato-co-tereftalato) e farinha de trigo com diferentes *Falling number*

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O trigo é de grande importância para a economia brasileira, devido ao elevado consumo de seus derivados, no entanto, uma parcela dos grãos acaba sendo perdida ou colhida com qualidade de produção inferior para a indústria alimentícia e a farinha obtida desses grãos pode possuir baixo Falling Number (FN), ou seja, apresenta alta atividade da enzima alfa-amilase que pode comprometer a qualidade tecnológica de alguns produtos. Desta forma, a farinha de trigo extraída de grãos de qualidade inferior, com baixo FN, pode ser uma alternativa para realização de blendas com outros biopolímeros, como o poli(butileno adipato co-tereftalato) (PBAT) para produção de filmes biodegradáveis por extrusão termoplástica. O objetivo deste trabalho foi produzir filmes por extrusão sopro em balão a partir de farinha de trigo com diferentes valores de FN, glicerol e PBAT. Foram realizadas análises de FN, alveografia e cor da farinha de trigo e testes de tração, perfuração, permeabilidade ao vapor de água (PVA) e cor dos filmes obtidos. Foram selecionados dois tipos de farinha de trigo com os seguintes valores de FN: 184 s (baixo, FNB) e 364 s (alto, FNA). A formulação dos filmes consistiu de 46% (m/m) de farinha de trigo, 40% (m/m) de PBAT e 14% (m/m) de glicerol e todos os ingredientes foram misturados e processados em extrusora mono rosca em escala piloto. As amostras de farinha de trigo apresentaram diferenças significativas para todos os parâmetros de cor (L*, a* e b*) e essa diferença também se manteve para os filmes. Os filmes apresentaram luminosidade (L*) menor (88,48 ± 0,47 para FNB e 89,31 ± 0,30 para FNA) em relação às farinhas (91,18 ± 0,03 para FNB e 92,64 ± 0,01 para FNA), sugerindo a ocorrência de reação de Maillard durante o processamento de extusão. Com relação às propriedades mecânicas, apenas o alongamento na ruptura apresentou diferença significativa (559 ± 46,94% para filmes FNB e 420 ± 47,00% para filmes FNA) sendo estes resultados semelhantes aos filmes de polietileno de baixa densidade. As farinhas com diferentes FN não interferiram na PVA dos filmes. A partir dos resultados obtidos, concluiu-se que o uso de farinhas com diferentes FN não interferem nas propriedades dos filmes produzidos por extrusão sopro em balão, evidenciando o interesse pela utilização da farinha de trigo de baixo FN como uma alternativa para produção de embalagens biodegradáveis.

Keywords: Biodegradáveis, Filmes, Extrusão sopro, Atividade enzimática

Characterization of crosslinked biodegradable chitosan and sodium alginate emulsion-based films

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Packaging plays an important role in food preservation and the materials used are mainly petroleum-based polymers. Due to the negative environmental impact caused by these polymers the research involved in the development and characterization of edible/biodegradable films and coatings has grown considerably in the last few years. Biopolymers (e.g. polysaccharides and proteins) have been extensively studied for this purpose. Polysaccharide films have a low permeability to gases at low relative humidity conditions and good mechanical properties. Though, due to the fact they are hydrophilic materials, they produce poor barriers to water that limits the range of their applications. To minimize this fact, hydrocolloids are usually combined with lipids to form bilayer or emulsion films.

The aim of this study was to develop edible/biodegradable emulsion-based films with polysaccharides as film forming components (chitosan and sodium alginate) and olive oil as hydrophobic barrier. In this sense, monolayer films where prepared by casting filmogenic emulsions composed of 2% w/v chitosan (dissolved in lactic acid 1% v/v) or 1% w/v sodium alginate, with different lipid contents (olive oil: 25, 50 and 100% biopolymer basis), and different surfactant concentrations (soy lecithin: 5, 10 and 25% w/w lipid basis). Glycerol was used as plasticizer (25% w/w biopolymer basis). After the emulsion drying process, the obtained stand-alone films were sprayed with a crosslinking solution (calcium chloride 6% w/v for sodium alginate-based films and tripolyphosphate 6% w/v for chitosan films), in order to add 3.2 $mgCa^{2+}/cm^2$ alginate film and 4 mg $O_{11}P_3/cm^2$ chitosan film. The effect of oil and lecithin contents, as well the presence of crosslinking agents, on the films water vapor permeability (WVP), mechanical properties and surface and internal morphology, was evaluated.

The results have shown that the lowest WVP values were obtained with formulations containing 25% lipid and 10% surfactant for chitosan films ($WVP=1.57x10^{-11}$ $mmol.m/m^2sPa$), and 100% lipid and 25% surfactant for alginate films ($WVP=1.70x10^{-11}$ $mmol.m/m^2sPa$). The application of the crosslinking agent decreased even further the WVP (by 30% for chitosan films and by 8% for alginate films). However, regarding tensile mechanical properties, a decrease of elongation at break and an increase of Young modulus was observed for both chitosan and alginate-based films, which was attributed to the stiffness induced by crosslinking reactions. Overall, the films developed present a good potential as polysaccharide based barriers with increased resistance to water, which envisages the use of such formulations to produce either biodegradable/edible films or edible coatings.

Keywords: Composite edible films, Biopolymers, Crosslinking, Packaging materials, Food preservation

Films alimentarios reforzados con lignonanofibras de celulosa procedentes de podas de olivo

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España es el mayor productor de aceite de oliva a nivel mundial. Dicha producción genera una cantidad de residuos muy elevada. La gestión y valorización de dichos residuos es una cuestión crucial y necesaria para el sector agrícola, cuyo objetivo es avanzar en un modelo de producción respetuoso con el medio ambiente y basado en una economía circular.

Los cambios en los hábitos de los consumidores han dado lugar al incremento de envases desechables o de un solo uso. En España, la mayor parte de los envases ligeros utilizados en alimentos y bebidas son plásticos, lo cual supone un alto coste medioambiental.

En este sentido, las lignonanofibras de celulosa (LNFC) se pueden emplear como embalajes alimentarios con bajo coste y elevada renovabilidad. En su aplicación como films alimentarios se reduciría el uso de plástico en la formulación de los mismos, contribuyendo así a reducir el problema que suponen para el ecosistema

El objetivo de este trabajo es obtener pasta celulósica a partir de podas de olivo, mediante un primer tratamiento hidrotérmico y posterior pasteado con un proceso respetuoso con el medio ambiente. Posteriormente, mediante un pretratamiento mecánico, se obtendrán LNFC a partir de la pasta celulósica, que serán aplicadas en la formulación de films alimentarios

En este trabajo se opera con concentración de sosa del 16 % sobre materia seca, temperatura de 170ºC y tiempos de reacción de 60 minutos. La pasta celulósica obtenida fue caracterizada fisicoquímicamente y de ella se obtuvieron lignonanofibras de celulosa (LNFC), que fueron caracterizadas químicamente evaluando la transmitancia, rendimiento de nanofibrilación, demanda catiónica y tasa de carboxilos. Así mismo, se les realizó un análisis espectroscópico mediante FTIR y un análisis térmico mediante TGA. Posteriormente se elaboraron films alimentarios con acetato de polivinilo (PVA) incorporando las LNFC a diferentes concentraciones para evaluar el efecto de su incorporación en las propiedades físicas de dichos films.

Keywords: Economía circular, Residuos olivo, Envases desechables, Lignonanofibras de celulosa, Films alimentarios.

Engineering Packaging for a Sustainable Food Chain

New Food Packaging Materials

Poster Communications

Valorização de sub-produto da indústria de óleo: uso da torta de mamona como matéria prima para produção de filmes biodegradáveis

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O sucesso da agroindústria do óleo exige a valorização dos seus sub-produtos, como a torta da mamona, que é rica em proteínas. Uma alternativa seria a extração de parte de suas proteínas para uso na tecnologia de filmes à base de biopolímeros. Assim, o objetivo desta pesquisa foi estudar o efeito do pH (10-11-12) de extração das proteínas sobre as propriedades mecânicas, solubilidade em água e umidade de filmes produzidos com essas proteínas. As proteínas foram extraídas em um extrator de batelada, com 20% de torta em água, a 50^{o}C, sob agitação a 400rpm, e em pH=10-11-12, por 30 minutos. A dispersão foi centrifugada a 4.000rpm/50^{o}C/20 minutos. O sobrenadante foi liofilizado (PL) e analisado para determinação de sua composição química e de aminoácidos, e sua desnaturação, por calorimetria diferencial de varredura (DSC). Isotermas de sorção foram determinadas a 25^{o}C. Os filmes foram produzidos a partir de soluções formadoras de filmes (SFF) com 7,5g PL/100g SFF, 25g glicerol/100g PL, e 0,8g glutaraldeído/100g PL. As SFF foram aplicadas em placas e desidratadas a 30^{o}C/~16h. Os filmes, acondicionados a 58% de umidade relativa/25^{o}C/7 dias, foram submetidos a testes mecânicos de tração e perfuração. A solubilidade em água e a umidade dos filmes foram determinadas gravimetricamente. As PL extraídas a pH=9 apresentaram ~66% de proteínas, enquanto aquelas extraídas a pH=11-12, tiveram 69%. A composição em aminoácidos não foi influenciada pelo pH de extração, sendo os principais: ácido glutâmico (17-20%), triptofano (12-14%), arginina (11-13%). Além da arginina, a lisina (~2%) também permite reação de reticulação na proteína. As proteínas se encontraram desnaturadas, segundo resultados de DSC. E, as PL apresentaram isotermas sigmoidais, representadas satisfatoriamente pela Equação de GAB (R^2>0,99). As PL extraídas a pH=12 tiveram maior valor de umidade da monocamada (X_m=7,6%) e menor valor de C_{GAB} (3,7) diferentemente das PL extraídas a pH=11-12 (X_m=~6 e C_{GAB}>20). Os filmes (~0,120mm) apresentaram umidade ~13%, sem efeito do pH de extração. Mas, os filmes de PL extraídas a pH=10 foram 100% solúveis, enquanto que os outros apresentaram solubilidade de ~60%. Os filmes de PL extraídas a pH=10-11 foram mais resistentes à tração e à perfuração, não se observando efeito na elongação na ruptura e nem na deformação na perfuração. Assim, pode-se concluir que o pH de extração influencia as características dos filmes, e sugere-se o pH=11, como o mais adequado, uma vez que para se atingir o pH=12 o consumo de soda é exagerado.

Keywords: Filmes Proteicos, Extração de Proteína, Propriedades Mecânicas

Production of films and blends using collagen, whey protein and methylcellulose to apply in food packaging

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Over the last decades, the use of synthetic packaging from petroleum has caused numerous social and environmental problems due to several factors such as population increase, inadequate disposal, high degradation time and difficulties in recycling. In this context, natural polymers such as whey protein (WP), methylcellulose (MC) and collagen (COL) stand out as potential alternative materials for use in the production of biodegradable packaging, since they are suitable for the production of films. On the other hand, some of these materials have deficiencies in their mechanical, morphological and barrier properties, which makes necessary to use innovative technologies to improve those properties. The blends are considered an interesting alternative in the improvement of film properties, since it takes into account the complementarity properties of different polymers, resulting in the production of a new and better material. The aim of this work was to produce films and blends from collagen, whey protein and methylcellulose, as well as to make the produced materials suitable for applications in biodegradable food packaging. The *casting* method was used for the production of films and blends. These films were evaluated through mechanical (tensile strength and elongation), optical (transparency and color difference), water vapor permeability and morphology properties. The results showed that the raw materials were able to form films and the produced blends promoted improvements in the properties. MC films presented a compact and smooth surface, higher transparency (30,35%), better water vapor permeability (0.43 g.mm/h.m^2.kPa), tensile strength (15.78 MPa) and higher solubility (100%) when compared to other films. This MC film could be used as soluble sachets for many products such as oil, salt, coffee and juice powder. The use of MC in the production of MC:WP and MC:COL blends showed good interaction between the molecules, causing an increase in the transparency and improvements in tensile strength and water vapor permeability. Thus natural polymers such as collagen, methylcellulose and whey protein have great potential and applicability in the substitution of synthetic materials for biodegradable food packaging.

Keywords: Sustainable packaging, Biodegradable materials, Soluble sachets, Mechanical properties

Aplicación de recubrimientos en quesos para el control del crecimiento fúngico superficial

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En la industria del queso, el crecimiento fúngico superficial durante el periodo de maduración se controla habitualmente mediante aplicación de antibióticos. No obstante, esta práctica no es saludable y, adicionalmente, es conveniente la aplicación de recubrimientos que permitan controlar la pérdida de peso durante este proceso. En este trabajo se analiza el efecto de 8 recubrimientos a base de biopolímeros comestibles aplicados por inmersión a muestras de queso para el control de la pérdida de peso y del crecimiento fúngico en etapas tempranas del proceso de maduración, con y sin la presencia de lípidos. El comportamiento de la pérdida de peso fue ajustado satisfactoriamente mediante un modelo logarítmico, cuyas constantes permitieron comparar formulaciones de forma efectiva. En base a la eficacia observada en la reducción de la pérdida de peso, se seleccionaron la goma gelano con un valor de pérdida de masa total de 25,5%±0,8%, k-carragenato con 25,11%±0,03%, goma xantana con 26,73%±0,01% y metilcelulosa con 27,3%±1,4%. Estos fueron aplicados en una segunda serie de tratamientos con agentes antifúngicos: sorbato de potasio, tanino comercial y gel de Aloe vera. En base a la influencia del antifúngico en la capacidad del recubrimiento para el control de la pérdida de peso, se seleccionó la goma de gelano como portador, dado que fue el único polímero que no disminuyo sensiblemente en esta capacidad con ninguno de los antifúngicos probados. Finalmente se realizaron los análisis de efectividad en el control del crecimiento radial de *Penicillium roqueforti*, inoculado en la superficie del queso recubierto con goma gelano y cada uno de los agentes antifúngicos. Además, se comparó con un control con goma de gelano y natamicina (antibiótico convencional) y una muestra con recubrimiento de gel de aloe vera puro. Se determinó el índice de inhibición del crecimiento miceliar (MGI) para cada tratamiento. Exceptuando el tanino comercial, los tratamientos presentaron altos índices de inhibición (MGI>80%). Particularmente, el sorbato de potasio en goma gelano (MGI=83,72%±5,04%) representa una alternativa viable como recubrimiento efectivo para la reducción de la pérdida de peso y para la inhibición del crecimiento fúngico. Los tratamientos con gel de Aloe vera presentaron altos índices de inhibición del crecimiento fúngico (MGI= 90,78%±8,65), pero no mostraron capacidad para reducir la pérdida de peso. Los resultados obtenidos constituyen un punto de partida en el desarrollo de recubrimientos que puedan solventar la problemática de desarrollo fúngico en el periodo de maduración, con un control adecuado de pérdida de peso.

Keywords: Control antifúngico, Recubrimientos comestibles, Queso, Goma gelano, Control de peso, Sorbato de potasio, Aloe vera

Effect of different biopolymer-based coatings on the barrier properties of poly-ethylene terephthalate (PET) packaging

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This work aims at the barrier properties evaluation of poly (ethylene terephthalate) (PET) plastic packaging with biopolymer-based coating. Solutions were prepared with combinations of different types of materials and percent variations (100% gelatin, 80% starch + 20% gelatin, 50% starch + 50% gelatin and 20% starch + 80% gelatin). The solutions were prepared in a thermal bath at 80 °C which was the ideal temperature for the complete gelation of the starch and dissolution of the gelatin. After complete dispersion of the materials, the plasticizer was added. After preparation of the solutions, PET packages with a volume of 250 mL and a mean thickness of 0.350 mm were immersed in the solutions for 1 minute, followed by conditioning and stabilization at 25 °C for 24 hours. A control sample, ie uncoated, was prepared for comparison purposes. Subsequently, the samples were evaluated for oxygen transmission rate (OTR), water vapor transmission rate (WVTR) and light transmission. Control samples, coated with 100% gelatin, 80% starch + 20% gelatin, 50% starch + 50% gelatin and 20% starch + 80% gelatin showed OTR results of 0.033, 0.022, 0.022, 0.024 and 0.023 cm^3/packing/day, respectively, showing that the coated packagings obtained a reduction of at least 27.7% when compared to uncoated (control) packages. Regarding the WVTR, the packs presented results of 109.00, 108.58, 108.78, 108.55 and 108.57 cm^3/packing/day, respectively. A significant reduction was observed in light transmission results, where the samples had 86%, 84%, 66%, 79% and 83% light transmission at 450 nm. In summary, the coatings that resulted in the highest OTR reduction were 80% starch + 20% gelatin and 100% gelatin, the highest WVTR reduction was 50% starch + 50% gelatin and the highest reduction of light transmission was 80% starch + 20 % gelatine. Therefore, it is concluded that the application of coatings from renewable sources may be an alternative packaging barrier currently used in the food market, which may contribute to the reduction of environmental impact, since it has a biodegradable layer .

Keywords: Gelatin, Starch, Oxygen transmission rate, Water vapor transmission rate, Light transmission

Uso de recubrimientos comestibles activos para la conservacion de papa criolla (*Solanum phureja*)

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La papa criolla es un tubérculo andino de gran consumo en la gastronomía colombiana y de otros países de la región andina. Este tubérculo es apreciado por su alto contenido de carbohidratos y sus características sensoriales, especialmente su color amarillo. A pesar de su alto consumo en los países andinos, la exportación de la papa criolla se ve limitada debido al rápido crecimiento de brotes (raíces), la susceptibilidad al crecimiento de hongos, especialmente *Phytophthora infestans*, además de la rápida perdida de su estructura durante el almacenamiento en postcosecha. Una de las alternativas para evitar los problemas en postcosecha de la papa criolla, es el uso de recubrimientos comestibles activos, es decir películas poliméricas formadas sobre el producto, que cumplen una función activa sobre el alimento. De esta manera, en este trabajo se plantea la aplicación de un recubrimiento comestible formulado a partir de alginato de sodio y nanoemulsiones de aceites esenciales de tomillo (*Thymus, T. vulgaris*), reconocido agente antifúngico, y aceite esencial de prontoalivio (*Lippia alba*) el cual se ha reportado es un agente antibrotacion. Muestras de papa criolla fueron recubiertas y almacenadas en condiciones de refrigeración y temperatura ambiente, evaluando aspectos como crecimiento de hongo, tamaño de brote, cambios en el color y textura. En primer lugar, los resultados obtenidos, mostraron que el almacenamiento en condiciones de refrigeración, permite las mejores condiciones para el manejo postcosecha. De igual manera, se observó que el uso del recubrimiento comestible disminuye considerablemente la aparición de brotes, mientras que se observa una notable disminución en el crecimiento de hongos. Los recubrimientos comestibles activos se muestran como una herramienta que permiten aumentar la exportación de papa criolla, reduciendo los problemas asociados con su almacenamiento en postcosecha.

Keywords: Recubrimientos comestibles, Nanoemulsiones, Papa criolla, Empaque activo

Physical properties of cellulose acetate-carvacrol films

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Cellulose acetate (CA) is a biodegradable polymer derived from cellulose with desirable properties for packaging, such as resistance, non-toxicity, odorless, tasteless, transparency, glossy, non-flammable. CA can be added of carvacrol, a major phenolic compound in oregano essential oil, for an active antimicrobial packaging. This study aimed to evaluate the physical properties of CA films and the effect of adding carvacrol to them. The films were produced by the casting technique, in which 10 mL of a solution containing 5% CA in acetone with or without carvacrol were added in Petri dishes (9 cm diameter). After solvent evaporation, it was obtained three different films: CA only (CA/0), CA with 5% (CA/5), and with 10% (CA/10) of carvacrol in mass. The films were evaluated for opacity in a spectrophotometer at 600 nm wavelength, tensile test in texturometer, and the presence and distribution of carvacrol by fluorescence confocal microscopy using Nile red as a fluorescent marker. Carvacrol increased films opacity from 1.1% to 2.4% (CA/10); however, it is not important for human perception. Also, carvacrol addition resulted in a significant decrease in mechanical properties: stress at break was 59.9 (CA/0), 50.7 (CA/5) and 49.2 MPa (CA/10); elongation was 3,29 (CA/0), 2.1 (CA/5) and 2.9% (CA/10); and Young's modulus was 21.7 (CA/0), 21.2 (CA/5) and 19.4 MPa /% (CA/10). It suggests a low plasticizing effect of carvacrol and absence of important changes in the polymeric matrix structure by adding the active agent, which demonstrate that CA-carvacrol film mechanical properties are relatively stable while using the film, once it is expected the carvacrol migration to food systems. Images of confocal microscopy showed that increasing the amount of carvacrol, it increased the intensity of the red color, indicating that carvacrol was trapped in the film. Furthermore, coloration homogeneity demonstrates a uniform distribution of the carvacrol throughout the polymer matrix. The resulting AC-carvacrol material presented desirable properties for an active food packaging film, once carvacrol has a little influence on transparency and mechanical properties, and was homogeneously distributed. Thus, it can be considered the potential application of these active films for the increase of foods shelf life, with film stability along the sustained carvacrol migration.

Keywords: Cellulose acetate, Carvacrol, Opacity, Mechanical properties, Confocal microscopy

Thermal properties of flexible multilayer packages after high-pressure processing

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High-pressure processing (HPP) has grown as one of the methods of preserving packaged foods. HPP consists of an initial heating (when necessary) of the confined fluid and packaged foods, followed by the application of adiabatic pressure. Many literature studies portray the effect of HPP on food, but information on the effect on packaging still needs to be explored further, with the intention of evaluating whether this technology can lead to changes in the properties of different materials. Therefore, it is important to evaluate the effect of this technology on the thermal properties of the polymer packaging materials. However, the purpose of this research was to evaluate the effect of different conditions of high-pressure processing on the thermal properties of multilayer flexible packaging. Four flexible packaging structures were evaluated: PET/Al/PA/PP; PET/printing-metallizationPET/LDPEcoex; LDPE/PA/LDPE and LDPE/EVOH/LDPE. The packagings were filled with 70 mL distilled water and processed at 600 MPa at 90 °C for 10 minutes (to evaluate the synergistic effect of pressure and high temperature) at 600 MPa at 25 °C for 10 minuntes (to evaluate the effect of pressure at room temperature) and 0.1 MPa at 90 °C for 10 minutes (to evaluate the effect of temperature). In addition, a control (unprocessed) sample was prepared for comparative purposes. After processing the packages were evaluated by differential scanning calorimetry (DSC), melting point (Tm) and melting enthalpy (ΔH) were evaluated. The thermal properties of materials PET/printing-metallizationPET/LDPEcoex, LDPE/PA/LDPE and LDPE/EVOH/LDPE were stable after different processing conditions. However, the Tm of the PA layer of the PET/Al/PA/PP package showed a significant reduction ($p < 0.05$) after the processing at 600 MPa at 25 °C for 10 min and 600 MPa at 90 °C for 10 min, from 219.5 °C to 214.3 °C and 215.4 °C respectively. In addition, the total ΔH of the PET/Al/PA/PP sample increased significantly ($p < 0.05$) from 40.3 ± 1.3 to 48.2 ± 0.9 after processing HPP at 600 MPa 25 °C 10 min. Therefore, the PET/printing-metallizationPET/LDPEcoex; LDPE/PA/LDPE and LDPE/EVOH/LDPE can be used to package high pressure processed foods in terms of thermal stability and PET/Al/PA/PP requires further evaluation to examine whether differences in thermal properties will interfere with material performance.

Keywords: Differential Scanning Calorimetry, Flexible Packaging, High-pressure processing, Pressure-assisted thermal sterilization

Simultaneous intracellular and extracellular biopolymers production by *Mesorhizobium* sp.

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Diazotrophic bacteria are responsible for the nitrogen fixation in the soil by symbiosis due to the conversion capacity of the atmospheric nitrogen in ammonia.These bacteria are currently known for their biotechnological potential to produce biopolymers of industrial importance. Extracellular Polymer Substances (EPS), formed mainly by polysaccharides, are associated with the development of bacteroids and nodules. Polyhydroxyl Butyrate (PHB) is a homopolymer its production is intracellular; therefore a cell disruption technique is necessary. This work aims to investigate the simultaneous production of both biopolymers by *Mesorhizobium* sp. Semia 816, using glucose as the carbon source in the culture medium. The assays were performed in shaken flasks at 30°C, 200 rpm for 96 h. Samples were taken at regular intervals to determine biomass, reducing sugars and pH. At the end of cultivation, EPS was recovered from the supernatant by precipitation with ethanol (1:3) and drying until constant weight. Besides, 2 g wet biomass were submitted to the washing process with saline solution followed by thermal treatment for cell disruption, so extraction of PHB was performed using chloroform as the solvent. The biomass monitoring resulted in 1.11 ± 0.05 g L-1 (dried weight). Acidification of the medium was observed during cultivation until 4.8. The consumption of glucose was 68.3%. The EPS recovered was 3.39 ± 0.31 g L^{-1}. The PHB produced corresponded to a mass of 0.048 g per gram of wet biomass. These results proved that *Mesorhizobium* sp. SEMIA 816 has the potential to produce both biopolymers in the same cultivation conditions. It has been suggested that the biopolymers produced by this strain can be used in the future. The EPS for their physical-chemical properties can be applied in the production of gels, emulsions and stabilizing agents when in an aqueous medium. The PHB has excellent technological interest for been inert, biodegradable, with thermoplastic characteristics, mainly for having similar properties to polypropylene.

Keywords: *Rhizobium*, Bacterial polysaccharides, Polyhydroxyalkanoates

Superhydrophilic cassava films containing mannosylerythritol lipids; a biosurfactant

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In this study, for the first time, it was evaluated the effect of different surface active agents: a biosurfactant - mannosylerythritol lipids-B (MEL) and surfactant - sodium dodecyl sulfate (SDS) in biodegradable films produced from cassava starch. The films were produced by casting technique using 5 g/100 g of cassava starch, glycerol (25 g /100 g of starch) as the plasticizer, surface active agent (20 g/100 g of starch), and water as the solvent. The mechanical, functional (moisture, water solubility, wettability, and water vapour permeability), crystallinity properties of the films were characterized. The MEL addiction generated films more flexible, water vapour permeable, and hydrophilic than the other films (control or SDS). On the other hand, the SDS led to films with higher rigidity, resistant at break, crystalline, water soluble, less flexible and water vapour permeable than the other films (control or MEL). In this work, we found that the despite of MEL and SDS being surfactants, their chemical structures interact differently with the starch matrix. Thus, each surfactant can be used for a specific purpose, for instance MEL can be used as surface active agent in biodegradable films, since MEL enhanced the wettability - superhydrophilic films (8 °) when compared with the control film (36 °) and with SDS (43 °). Thus, very likely, the hydrophobic moiety of SDS place was at air-film interface, whereas the hydrophilic moiety of MEL was at air-film interface. On the other hand, SDS can be applied mainly as reinforcing agent since it led to tensile strength 5.5 MPa when compared with MEL and control films, 0.44 and 0.43 MPa, respectively.

Keywords: Surface active agents, Mannosylerythritol lipids-B, Sodium dodecyl sulfate, Biodegradable films, Wettability

Efeito do armazenamento nas propriedades de filmes de concentrado proteico de soja incorporados de óleo de orégano livre e microencapsulado

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Os filmes de concentrado proteico de soja (CPS) permitem a incorporação de compostos bioativos como o óleo essencial de orégano (OEO). Entretanto, o OEO é facilmente degradado durante o processamento e uma alternativa para preservar sua bioatividade seria realizar a microencapsulação. Este trabalho teve como objetivo avaliar o efeito do armazenamento sobre as propriedades funcionais de filmes de CPS com OEO livre e microencapsulado. As micropartículas de OEO foram obtidas por gelificação iônica utilizando alginato de sódio como material de parede e íons cálcio, e as mesmas foram caracterizadas quanto à eficiência de encapsulação (EE) e distribuição de tamanho. As formulações dos filmes consistiram de 7,56% de CPS e 25 g glicerol/100 g CPS. Para a formulação contendo OEO livre (OEOL), adicionou-se 3 g OEO/100 g solução filmogênica e 1 g Tween80/100 g solução filmogênica. Para o filme com micropartículas (OEOM), adicionou-se a quantidade de micropartícula para a formulação conter 3 g OEO/100 g solução filmogênica. Nos filmes foram avaliadas as propriedades mecânicas, permeabilidade ao vapor de água (PVA), atividade antioxidante pelos métodos DPPH e ABTS e atividade antimicrobiana frente a E. coli e S. aures durante 90 dias de armazenamento (53% UR e 25°C). As micropartículas de OEO apresentaram diâmetro médio de 250 µm e 79,6 % de EE. Os filmes OEOM apresentaram-se mais resistentes e com menor PVA do que os filmes OEOL e pode estar associado com a boa interação entre a matriz do filme e as micropartículas, resultando no reforço da matriz polimérica. Os filmes OEOM apresentaram maior atividade antimicrobiana, porém menor atividade antioxidante e pode estar relacionada com o solvente (etanol absoluto) utilizado para a extração dos compostos. Após 90 dias de armazenamento, os filmes tornaram-se mais resistentes e menor permeáveis ao vapor de água, sendo em maior proporção em OEOL. Essas alterações ocorrem em razão de novas interações entre as cadeias proteicas que são formadas, causadas pela mobilidade molecular. As atividades antioxidante e antimicrobiana foram reduzidas, principalmente em OEOM. Acredita-se que a microencapsulação auxiliou na incorporação do OEO nos filmes, protegendo-o nos processos de homogeneização e secagem. Porém, durante o armazenamento, devido ao elevado pH do filme, as micropartículas podem ter sofrido hidrólise ou rompimento da estrutura e liberaram o ativo para a matriz do filme. A microencapsulação protegeu os compostos bioativos presentes no OEO durante a produção e secagem dos filmes, possibilitando obter materiais com propriedades antimicrobianas e antioxidantes.

Keywords: Atividade antioxidante, Atividade antimicrobiana, Gelificação iônica

Envases formulados a partir de podas de naranjo

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La economía sostenible, o circular, debe llegar también al sector agrícola. La población mundial crece cada minuto, y por tanto la actividad agrícola, necesaria para alimentarla, también. Este crecimiento origina una enorme cantidad de residuos, de naturaleza lignocelulósica, que pueden y deben ser valorizados. Todos los cultivos sin excepción consumen recursos, humanos y materiales, y no solamente en la formación del fruto y/o semilla, sino también en el crecimiento de la estructura vegetal que lo sustenta. Esta estructura está formada principalmente por celulosa, lignina y hemicelulosas, de ahí el nombre de biomasa lignocelulósica que estos residuos reciben.

De la fracción celulósica la industria papelera produce papel y cartón desde hace decenas de años. En las últimas décadas, la fabricación de cartón para embalajes ha ido aumentando el porcentaje de fibras secundarias, procedentes del reciclaje, presentes en la formulación de sus productos. Los procesos de reciclado conllevan, generalmente, una pérdida de las propiedades físico-mecánicas, principalmente debido a la hornificación de las fibras. Además, hay que considerar que, dada la diversa y heterogénea procedencia del cartón reciclado, se hace necesario incluir procesos destinados a suplir las mermas en la calidad de la fibra. Estos procesos generalmente pueden ser más clásicos como el refino mecánico, aporte de fibra virgen, o bien adición de químicos, o más innovadores como el refino enzimático y la adición de nanofibras de celulosa (CNF).

En este trabajo se ha empleado podas de naranjo para obtener fibras celulósicas mediante un proceso a la sosa, ambientalmente favorable. La pasta celulósica fue analizada en términos de composición en celulosa y lignina, siguiendo las correspondientes normas TAPPI. A partir de esta pasta celulósica se obtuvieron lignonanofibras de celulosa (LCNF) mediante dos pretratamientos, oxidación química TEMPO y mecánico, que fueron caracterizadas determinando el rendimiento de nanofibrilación, contenido en carboxilos, demanda catiónica y FTIR. Finalmente se evaluó la capacidad de refuerzo sobre cartón reciclado frente al refuerzo que se consigue con refino mecánico. Para ello se prepararon diez hojas de papel de acuerdo a la siguiente secuencia: suspensión de celulosa (SK), SK más almidón catiónico (Vector SC 20157) y sílice coloidal (LUDOX® HS-40 colloidal silica) (aditivos químicos) (SK_a); SK refinada a 1000 (SK_{1000}), 2000 (SK_{2000}) y 3000 (SK_{3000}) rpm; SK con adición de LCNF TEMPO (o.d.m) (1.5% ($SK_{T1.5}$), 3%(SK_{T3}) y 4.5% ($SK_{T4.5}$)); y finalmente SK con adición de LCNF mecánicas (o.d.m) (1.5% ($SK_{M1.5}$), 3%(SK_{M3}) y 4.5% ($SK_{M4.5}$)).

Keywords: Podas de naranjo, Cartón, Refuerzo, Bioeconomía

Efecto del alcohol de polivinilo (PVOH) en las propiedades físico-mecánicas y térmicas de biopelículas elaboradas con aislado proteico de sacha inchik

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El uso indiscriminado de empaques sintéticos ha generado serios problemas ecológicos contribuyendo a la contaminación ambiental provocada por desechos sólidos de baja degradabilidad. La torta de sacha inchic (Plukenetia volubilis) subproducto agroindustrial generado en la extracción de aceite, tiene un alto contenido de proteínas, de la que se ha elaborado biopelículas. El presente trabajo tuvo por objetivo, estudiar la influencia de la adición de alcohol de polivinilo (PVOH), a las biopelículas elaboradas a partir del aislado proteico de Sacha Inchic (APSI), en las propiedades físicas (humedad, color, espesor, solubilidad y permeabilidad al vapor de agua), mecánicas (fuerza a la ruptura, modulo de Young y fuerza de deformación en la tracción) y térmicas (temperatura de degradación, temperatura de transición vitrea,Tg) de las mencionadas biopelículas. Las biopelículas fueron obtenidas por el método de casting, con la finalidad de obtener espesor constante, se utilizó 7% de macromoléculas en la solución filmogénica. La determinación de las propiedades mecánicas fue realizada con un Texturometro Brookfield Model CT3 50k; las propiedades térmicas con un Discovery DSC2500 y un Discovery TGA550, TA Instrument. Para evaluar la influencia de la adición PVOH, se planteó un diseño completo al azar con cuatro tratamientos, siendo la variable independiente, el porcentaje de adición de PVOH, en los niveles, 0, 3, 6, 9, 12 % p/p, realizándose los ensayos por triplicado. El resultado indicó que el espesor, como se pretendió, no fue influenciado por la adición de PVOH, la permeabilidad al vapor de agua disminuyó hasta una adición de 8%, a partir del cual permaneció constante con el aumento de PVOH; el porcentaje de elongación aumentó exponencialmente con el aumento de PVOH; el módulo de Young disminuyó linealmente con el aumento de PVOH, La fuerza de perforación aumentó linealmente con el aumento de PVOH. En relación a las propiedades térmicas, la Tg y la temperatura de degradación, aumentaron con el aumento de la concentración de PVOH.

Keywords: Películas degradables, Permeabilidad, DSC, TGA, Elongación

Effect of tannins incorporation on properties of protein based films

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The development of active materials containing natural agents to be used as food coatings or for packaging in order to extend shelf-life of food products is a current demand of the food industry. In this work, three commercial tannins from different sources have been used: tannins from white peel grape, tannins from red peel grape and tannins from oak bark, to obtain active films based on two proteins (caseinate and gelatin) on the basis of their natural origin and potential antioxidant and antimicrobial activity. Films were obtained in two different ways: monolayer films, by homogeneously blending the tannins with the proteins and bilayer films, by coating the previously obtained protein film with the different tannin solutions. Microstructure and physicochemical characterisation (thickness, moisture content, water solubility, water vapour permeability, tensile and optical properties), as well as the antioxidant activity and antimicrobial activity of the films, were analysed after two conditioning weeks at 25 ºC and 53% relative humidity. The interactions established between tannins and protein matrices resulted in thicker films and a more heterogeneous microstructure than the tannin-free protein films. Tannin incorporation provoked a significant reduction in the water solubility and water vapour permeability of the films, while also affecting their appearance. Thus, those films incorporating the most brownish tannins (from red peel grape and from oak bark) became less glossy and transparent. Tannins also changed the mechanical behaviour of protein films, making them stiffer, especially when the richest polyphenol tannin was incorporated (tannins from white peel grape). All films incorporating tannins exhibited remarkable antioxidant and antimicrobial activities, in coherence with the properties of the pure tannins. Tannins from white peel grape exhibited the greater antioxidant and lowest minimum inhibitory concentration against E.coli and L. innocua. Among all the films tested, bilayer films containing tannin from white peel grape showed the best antimicrobial activity against both bacteria (5 log of reduction), surely due to the greater availability of the active components when incorporated as a bilayer. Thus, these films incorporating commercial tannins present an interesting potential to act as active packaging materials for food preservation.

Keywords: Protein based films, Tannins, Food coatings, Active packaging

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Oral Communications

Obtención de nanopartículas de almidón succinatadas y su evaluación como materiales encapsulantes de extracto antocianinico del fruto *A. compressa*.

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El objetivo del presente trabajo fue la obtención de nanopartículas de almidón succinatadas y su posterior evaluación como agentes encapsulantes de un extracto alto en antocianinas de la cereza Mexicana *A. compressa.* Metodología: Para la obtención de las nanopartículas succinatadas, se utilizaron 3 tipos de almidón de maíz: normal, alto en amilosa, y alto en amilopectina, que fueron succinatados usando el proceso de extrusión reactiva. Posteriormente, los almidones extrudidos fueron sometidos a energía ultrasónica de alta intensidad para inducir la desestructuración, dispersión y obtención de nanopartículas succinatadas, las cuales se recuperaron por nanoprecipitación en un no-solvente (etanol) como un no-solvente. Dicha etapa de nanoprecipitación fue empleada para encapsulación *in situ* del extracto alto en antocianinas. Para esto, el etanol empleado como no-solvente fue usado como medio conteniendo las antocianinas extraídas del fruto *A. compressa*. Las nanopartículas succinatadas y las nanocápsulas obtenidas fueron caracterizadas mediante estudios de espectroscopia infrarroja (FTIR), calorimetría diferencial de barrido (DSC) y microscopia electrónica de barrido (FE-SEM). Además, fueron investigadas sus propiedades coloidales como tamaño hidrodinámico y carga superficial mediante dispersión de luz dinámica. Resultados: Los valores de grado de sustitución obtenidos fueron de 0.03, 0.018 y 0.014 para las nanopartículas succinatadas obtenidas a partir de almidón alto en amilosa (Nps-Hylon), a partir de almidón alto en amilopectina (Nps-Waxy) y las obtenidas a partir de almidón normal (Nps-Std), respectivamente. El tamaño hidrodinámico obtenido se situó en el siguiente orden: 65>387>480 nm para Nps-Waxy, Nps-Hylon, y Nps-Std, respectivamente. La carga superficial fue negativa para todas las nanopartículas, siguiendo el siguiente orden ascendente: -15>-25>-34, para Nps-Waxy, Nps-Std y Nps-Hylon, respectivamente. La eficiencia de encapsulación fue de 45, 49 y 52% para las Nps-Hylon, Nps-Waxy y Nps-Std. La interacción nanopartícula-extracto promovió un aumento en el tamaño de partícula, ya que Nps-Waxy, Nps-Hylon, y Nps-Std presentaron un tamaño hidrodinámico de 71, 256 y 294 nm después de la encapsulación. La interacción nanopartícula-extracto fue corroborado mediante estudios de FTIR y DSC. Los estudios FE-SEM revelaron una estructura tipo racimo por parte de las nanocápsulas resultantes, donde Nps-Waxy y Nps-Hylon presentaron una mayor definición de tipo nanoesfera con tamaños menores a 100 nm. Conclusiones: El extracto rico en antocianinas del fruto *A. compressa* fue encapsulado satisfactoriamente en nanopartículas de almidón de maíz succinatadas obtenidas por un método secuencial de extrusion y ultrasonidos de alta intensidad.

Keywords: Almidon, Nanoparticulas, Materiales-encapsulantes

Liposomal encapsulation of carvacrol to obtain active polyvinyl alcohol films

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The development of new materials for active food packaging usually implies the inclusion of active compounds that are often encapsulated to control their release, to improve their bioactive properties and to prolong their stability and affinity with the polymer matrix. Encapsulation of bioactives can be addressed by means of liposomes, which are mainly composed of phospholipids, whose self-assemble in aqueous solution forming colloidal vesicles may entrap the active compound of interest. The liposomal encapsulation efficiency is closely linked both to the structural properties of the phospholipids (such as the charge of the head group, the length and degree of saturation of the fatty acids that make up the non-polar tails) and to their affinity with the continuous phase. The aim of this work was to analyze the efficiency of three types of lecithins (soybean phosphatidylcoline (Lipoid S75), soy lecithin (SL) and sunflower lecithin (SFL)) to encapsulate carvacrol (CA) when incorporated into polyvinyl alcohol (PVA) matrices. To this end, free carvacrol and carvacrol-encapsulating liposomes were incorporated into two kinds of PVA (H: Mw 89,000-98,000, 99-99.8% hydrolysed and L: Mw 13,000-23,000, 87-89% hydrolyzed) for obtaining active films by casting. The obtained liposomes were characterized in terms of particle size and zeta potential. The final CA content in the films was determined by methanol-water (50% v/v) extraction and analysed by UV/Vis spectrophotometry at 274 nm. The results showed that the liposomes underwent considerable structural changes after obtaining the films due to the lyotropic mesomorphism of the amphiphilic lipids. These changes depended on the type of lecithin and PVA. In H-films, both SL and SFL liposomes lost their initial vesicular structure, while this structure was better preserved when using Lipoid S75, probably due to its membrane composition (75% phosphatidylcholine) which provides higher interaction forces in the vesicle. This contribute to limit the carvacrol emulsion destabilization (droplet flocculation and creaming), which has been associated with the high loss of essential oil compounds during the drying step of the films by steam drag effect. As concerns the effect of the PVA matrix, L matrix showed better affinity with the three types of liposomes than H, giving rise to a more homogeneous film structure with higher CA-retention. In films containing free CA, the retention efficiency of the bioactive ranged between 48% and 63%. The greatest CA retention in the films (74%) was obtained when using PVA L and Lipoid S75 as encapsulating agent.

Keywords: Liposomal encapsulation, Carvacrol, Polyvinyl alcohol

Antimicrobial films containing cellulose nanofibrils and ethyl lauroyl arginate

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Food packaging is tailored to keep food fresh for a prolonged period of time, to increase shelf-life and prevent microbial degeneration. However, traditional food packaging is made from non-degradable polymers that pose an environmental threat if not disposed of properly.
Cellulose nanofibrils (CNFs) are particularly suited for **sustainable packaging applications** as they are bio-based, renewable, lightweight and easy to recycle or compost. To address this, we here describe preparation of cellulose nanofibril (CNF) films and hydrogels that show antimicrobial activity against common foodborne pathogens (*B. cereus*, verotoxigenic *E. coli*, *L. monocytogenes* and *S.* Typhimurium). Furthermore, negatively charged CNFs were modified with ethyl lauroyl arginate (LAE), which is an antimicrobial compound with proved activity against several types of bacteria that is approved by EFSA as a food preservative in heat-treated meat products. CNF films were able to bind LAE molecules up to a maximum concentration of 145-160 ppm. This novel strategy overcomes the current hurdles with LAE incorporation into packaging materials. LAE-CNF biocomposite films exerted a bactericidal activity against a major foodborne pathogen present in ready-to-eat food (*L. monocytogenes*) even at 1% LAE. Our work show how antimicrobial agents can be incorporated in biopolymer films, offering a green and antimicrobial alternative for packaging of RTE meat products.

Keywords: Cellulose nanofibrils, Foodborne pathogens, Ethyl lauroyl arginate, Food packaging films, Listeria monocytogenes

Use of industrial waste: microencapsulation of carotenoid-rich extract obtained from guarana (*Paullinia cupana*) peel

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Guarana is a species native from Brazilian Amazon region, known for its stimulating and medicinal properties. The seeds of the fruit are used in the production of soft drinks, energy drinks, cosmetics and pharmaceuticals. The reduction and use of waste generated by industries are a current tendency. Guarana peel is a source of carotenoids with great potential for exploration and application in the food industry. Thus, the aim of this study was to encapsulate by spray drying carotenoids-rich extract obtained from guarana peels, evaluating the efficiency of the process and the stability of the particles. The extraction of carotenoids from guarana peels was carried out at 50 °C for 4 hours, considering the ratio of 1:10 (w/v) peel: absolute ethanol. Using a temperature of 140 °C, three formulations were produced by varying the proportions extracts: gum arabic solution (1: 2, 1: 3, 1: 4, v / v) in triplicate, totaling nine products. The content of total carotenoids, moisture, water activity and color parameters, L, a * and b *, were analyzed every 15 days during three months. The total carotenoid content of the free extract was also analyzed in this period. The particles and the free extract were stored at 25 °C and 33% relative humidity. The particles obtained with the 1:2 formulations (extract: gum Arabic solution, v/v) had a higher carotenoid content during storage, reducing from 79.2 to 57.9 µg / g, while the formulations 1: 3 and 1: 4 (extract: gum arabic solution, v / v) presented a reduction from 48.7 to 32.5 µg / g and 33.3 to 24.8 µg / g, respectively. The results showed that after complete monitoring, the carotenoid content reduced 27, 33, 25 and 44% in the formulations 1: 2, 1: 3, 1: 4 and the free extract, respectively. The moisture and water activity of the particles increased significantly after 15 days and proceeded with small oscillations during storage for all formulations. The particles of the 1: 2 formulation had a stronger yellow-red color than the others. In general, the color parameters showed small variations during storage. The results showed that spray drying is an efficient encapsulation technique to guarantee stability during this period for carotenoids, unstable bioactive compounds, reducing the degradation and increasing its applicability.

Keywords: Spray drying, Encapsulation, Bioactive compounds

Aplication of vacuum impregnation and CO2-laser microperforation for the potential acceleration of the marinating process in pork meat

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Marinating is the process to impregnate meat products with an aqueous solution composed of ingredients such as salt, acids, tenderizers, sugar, phosphates, seasonings and flavorings. The objective of this process is to enhance meat flavor and soften texture. The main limiting factor of the marinating process is the large operating time, mainly due to the low diffusion coefficient and the low temperatures required to ensure product safety during processing. One of technologies that have been explored to accelerate the marinating process, is the application of vacuum impregnation. Vacuum impregnation (VI) have demonstrated to reduce the wet-salting time and promoting a more homogeneous distribution of salt. On the other hand, the microperforation by a carbon dioxide (CO2) laser has been studied to accelerate mass transfer process during dehydration of blueberries with good results.

Porcine meats were cut in cylinder (0.04 m diameter and 0.07 m height), and then were microperforated in an 8x8 dot array with two arrangements (square and honeycomb), and two pore sizes (pore diameter of 113 µm ± 7.18 µm and 261 µm ± 5.33). The marinated solutions were prepared using distilled water with sodium chloride (80 g/l) and sodium phosphate (3 g/l). Marinating process was carried out at 6°C during 60 h. Three marinating treatments were carried out, as follows: a) standard marinating as control process, b) pre-treatment, micro-perforating samples with CO2-laser then marinating, c) pre-treatment, micro-perforating samples with CO2-laser and then marinating with the pulsed-vacuum process (pulse with absolute pressure of 6.67 kPa applied to the immersed samples during 5 min of the process, followed by 5 h of marinating at atmospheric pressure). Salt concentration throughout time and moisture content were determined. The marinating process coupled with a VI and microperforations significantly accelerates the mass transfer phenomena compared with the conventional salting process. For example, to reach a 3.5% of NaCl into the pork meat, the processing time was approximately 60% lower than the standard process. The greatest time reduction was obtained with a pore size of 113 µm and coupled with vacuum impregnation.

Keywords: Marinating, Vacuum impregnation, CO2 -Laser microperforation

Engineering Packaging for a Sustainable Food Chain

Nanotechnology and Microtechnology

Poster Communications

Encapsulación de polifenoles de la hoja de Eruca sativa, usando nanopartículas de almidón esterificadas como material de pared

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El objetivo de este trabajo fue el desarrollo de nanopartículas esterificadas de almidón para su estudio en la encapsulación de polifenoles de la hoja de *Eruca sativa*. Metodología Metodología: la obtención de nanopartículas de almidón, su esterificación y la encapsulación de polifenoles se realizó en un proceso simultáneo en un tiempo de 2.5 h. Inicialmente se dispersó el almidón en agua destilada (5 %); la dispersión se agitó y calentó hasta lograr la gelatinización del almidón, posteriormente, el almidón fue desestructurado a nanopartículas mediante energía ultrasónica de alta intensidad, empleando un equipo ultrasónico de 500 W (UIP500hd), con una amplitud de 80 % y un tiempo de reacción de 80 minutos. En un paso simultáneo al desarrollo de las nanopartículas se realizó la esterificación usando el mismo equipo ultrasónico, donde se introdujeron grupos succinatos y fosfatos a las nanopartículas del almidón usando anhídrido octenil succínico y tripolifosfato de sodio respectivamente, con una una amplitud ultrasónica de 60 % y un tiempo de reacción de 15 minutos para cada tratamiento. Posteriormente se realizó la encapsulación de los polifenoles de la hoja de *Eruca sativa* mediante nanoprecipitación, usando etanol como no solvente para las nanopartículas y dispersante de los polifenoles. Resultados: Se obtuvieron 5 tratamientos de nanocápsulas con nanopartículas sin esterificación, 2 tratamientos de nanopartículas fosfatadas y 2 tratamientos de nanopartículas succinatadas con grados de sustitución 0.21, 0.40 y 0.003, 0.01 respectivamente las eficiencias de encapsulación obtenidas fueron cercanas al 17 %, los tamaños de partícula de las nanocápsulas fueron de 173 nm a 286 nm, los índices de polidispersidad (PDI) obtenidos fueron de 0.361 a 0.584, el potencial zeta de las nanocapsulas indicó que las nanocápsulas presentaban una carga ligeramente negativa con valores de -11.43 a -15.93. Las micrografías obtenidas mediante el microscopio electrónico de barrido por emisión de campo mostraron una morfología redonda y con aglomeraciones de tipo racimo. Mediante la espectroscopía infrarroja con transformada de Fourier (FTIR) se confirmó la esterificación de las nanopartículas, además de las interacciones químicas presentes entre el material encapsulante (nanopartículas esterificadas) con los polifenoles de *Eruca sativa.* Conclusión: se obtuvieron nanocápsulas de polifenoles de la hoja de *Eruca sativa* usando nanopartículas de almidón esterificadas como material encapsulante.

Keywords: Encapsulación, Nanopartículas, Almidón, *Eurica-sativa*

Ultrasound to incorporate microencapsulated hydrophilic nutrient into food

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Ultrasound technology has been used as a pre-treatment to improve drying. The present work proposes to take advantage of this pre-treatment to incorporate microencapsulated iron into food matrix. Iron microcapsules were obtained by spray drying using maltodextrin as wall material and ferrous sulfate as iron source, presenting hydrophilic characteristics. Pumpkin was selected as suitable food material to perform the iron incorporation, once it is rich in carotenoids, which are enhancers of iron absorption. By taking account their hydrophilic characteristics, the microcapsules were dispersed in ethanol, in which the pumpkin samples were immersed. Three treatments were performed: control (without any treatment), E (samples immersed for 30 min in ethanol containing iron microcapsules), E+US (samples immersed in ethanol containing iron microcapsules and simultaneously applying ultrasound for 30 min). After treatments, samples were convectively dried (50 °C, 0.8 ± 0.1 $m.s^{-1}$) and then the iron content was determined. The *In-natura* pumpkin presented an iron content of 0.77 ± 0.04 g/100g. Ultrasound allowed more homogeneous iron incorporation compared to E treatment. Compared to control samples, the iron content increased after pre-treatments in about 2186% for E and 1562% for E+US pre-treatments. The iron content of pre-treated samples (E and E+US) were similar or superior to the iron quantity reported in foods considered sources of iron. The results show that pre-treatments with ultrasound can be used to incorporate nutrients into the food matrix. Studies to determine the nutrient bioavailability and bioaccessibility are recommended.

Keywords: Ultrasound, Food processing, Nutrient incorporation, Convective drying

Caracterização de partículas obtidas por meio de diferentes condições de secagem por aspersão de suco de beterraba

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As betalaínas são utilizadas por indústrias de alimentos como corante natural, sendo a beterraba a fonte mais popular desses compostos. Sua estabilidade pode ser aumentada por intermédio da secagem por aspersão, e a qualidade do produto em pó obtido ao final do processo depende dos parâmetros de operação, tais como temperatura de secagem e agentes carreadores utilizados no processo. Sendo assim, neste trabalho foram avaliadas partículas obtidas por meio da secagem por aspersão de suco de beterraba em diferentes temperaturas (130, 150 e 170 °C) e proporções de inulina:isolado proteico de soro (IN:IPS) de 1:2, 1:1 e 2:1. A caracterização do material foi realizada mediante análise de imagens obtidas por meio de microscopia eletrônica de varredura, de difração de Raio-X e da solubilidade. Os tratamentos apresentaram partículas em formato esférico e tamanhos variados, a maioria de superfície enrugada, sem rachaduras ou fissuras, e bastante dispersas. Todas as amostras avaliadas apresentaram estrutura amorfa, que pôde ser verificada por meio de picos largos e difusos presentes nos difratogramas de Raio-X. As partículas apresentaram solubilidade na faixa de 79.6 a 86%. Esses valores podem ser considerados satisfatórios do ponto de vista alimentício, o que corrobora os resultados obtidos por meio da difração de Raio-X, visto que sólidos amorfos apresentam maior solubilidade, desejável em partículas cujo objetivo é aplicar em produtos alimentícios, melhorando sua característica de dispersibilidade e incorporação. Em cada temperatura utilizada na secagem, tratamentos em que se utilizou maior proporção de inulina (2:1) apresentaram valor de solubilidade maior ou intermediário comparado às demais proporções, e maior temperatura de secagem (170 °C) favoreceu solubilidade maior dos pós, de maneira geral. A partir dos resultados obtidos, observa-se a possibilidade de obtenção de um extrato de beterraba em pó com propriedades de interesse, utilizando diferentes condições de secagem. É importante ressaltar também a importância do uso de agentes carreadores diferenciados, que possam agregar valor ao produto em que forem aplicados, uma vez que o isolado proteico de soro é um material rico em proteínas, e a inulina, classificada como prebiótico, representam um potencial de agregação de propriedades funcionais a um produto e inovação no setor alimentício.

Keywords: Corante natural, Morfologia, Prebiótico

Encapsulating jabuticaba extract within gellan gum microparticles using capillary microfluidic devices

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Several techniques of encapsulation have emerged in the last years due to the necessity of entrap and control the delivery of some bioactives. In this context, microfluidics is an outcoming strategy capable of generating emulsions with low polydispersity, in which bioactives can be vehiculated. Different materials have been studied, and gellan gum, an anionic polysaccharide, can be highlighted because of its high resistance to gastric pH. In this sense, gellan was used to incorporate the extract obtained from jabuticaba. This extract is rich in anthocyanins, showing antioxidant effect and providing benefits associated with intestinal issues. However, the antioxidant action of the jabuticaba extract is extremely affected when exposed to light, high temperatures, and mainly high pH values. In addition, the anthocyanins present fast release in the stomach, in where their effects are not relevant. In order to overcome these limitations, the present work aimed to produce gellan microparticles incorporated with the jabuticaba extract using capillary microfluidic devices. The aqueous phase contained gellan and jabuticaba extract, while the oily phase was comprised of soybean oil, PGPR (polyglycerol polyricinoleate) as emulsifier, and calcium acetate as the gelling agent. A systematic study to define the ideal concentrations of gellan and extract was performed before the microparticles obtention in the microchannels. The concentration of gellan and extract should be the highest possible, but with no gel formation. In this sense the concentration values of gellan and extract in aqueous phase were 0.2% (w/w) and 10% (v/v), respectively. Within the microfluidic devices, the effect of the flow rate ratio of the phases on the size and polydispersity of the microparticles was evaluated. Flow rate of continuous phase (Qc) varied from 150 to 250 µL/min, while flow rate of dispersed phase (Qd) achieved up to 30 µL/min. The minimum coefficient of variation (CV = 1.76%) was found for the condition of Qc = 150 µL/min and Qd= 10 µL/min, and, in this case droplet diameter was 298.50 ± 5.24 µm. Moreover, increasing the flow rate ratio (Qc/Qd), droplet size decreased and could achieve 185.12 ± 10.91 µm. These results demonstrate that different conditions in the chips allow the formation of particles with singular features (diameter values and polydispersity), however in all cases emulsions encapsulating jabuticaba extract could be formed.

Keywords: Microchannels, Gelification, Encapsulation, Jabuticaba extract, Gellan gum

Desarrollo de nanoemulsiones de aceite de naranja como vehiculos de curcumina

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Acmella oleracea L., popularly known as Jambu, is a native plant of the Amazon region. It is often used as flavoring in dishes from Northern Brazil, such as Tacacá and Pato-no-tucupi. Also, it is used in the traditional medicine to treat stomatitis, influenza and as an analgesic product. Important chemical property of the plant has aroused the interest of the pharmaceutical industry, due to the presence of the active ingredient known as spilanthol. The aim of this study was to evaluate the microbiological and sensory quality of the Jambu (Acmella oleracea L.) in natura and dried by cold air, and the determination of its drying curve. The microbiological analysis were performed to Salmonella spp, the coagulasepositive Staphylococcus, and coliforms in the both Jambu samples, at 45 °C. Tacacá, the typical food dish of Pará state, Brazil, has showed good consumer global acceptance in the sensory evaluation of Jambu in natura (score of 8.00 ± 1.46) and dried (score of 8.67 ± 0.66). Both samples, Jambu in natura and dried by cold air, were by the current legislation regarding the microbiological aspects, this is the absence of Salmonella spp, coagulase-positive Staphylococcus <1×101 CFU/g, and coliforms <3 MPN/g, at 45 °C. The Jambu *in natura* and dried by cold air is according the current Brazilian Legislation regarding microbiological aspects. The Tacacá samples prepared with Jambu in natura and dried showed good acceptance by consumers. Thus, by taking into account the health and sensory aspects, it is possible stating that the dried Jambu commercialization is viable, since it facilitates its transportation and handling, as well as reduces its vegetable mass.

Keywords: Nanoemulsiones, Curcumina, Nanoencapsulacion, Actividad Antioxidant

Propiedades físicas y antimicrobianas de un aditivo natural activo secado por atomización: Efecto de la adición de maltodextrina como material de pared

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El diseño de aditivos activos antimicrobianos (AA) es requerido para aumentar la vida útil de alimentos procesados utilizando componentes naturales, como el aceite esencial de citral (CIT). Sin embargo, la selección del agente encapsulante (AE) y/o material de pared (MP) es crucial para mantener las propiedades antimicrobianas del aditivo obtenido mediante secado por atomización. El objetivo de este estudio fue evaluar el efecto de la adición de un MP (Maltodextrina) en las propiedades físicas y antimicrobianas de un aditivo activo en polvo a base de aceite esencial de citral utilizando alginato y/o Capsul® como AE.

El aditivo se preparó añadiendo alginato de sodio al 1%p/p (A), CIT al 3%p/p como AA, Capsul® (CAP) en una relación CIT:CAP (1:1), posteriormente se adicionó Maltodextrina (MD) en una relación de CIT:CAP:MD (1:1:4) y la muestra control fue preparada con A y CIT. Posteriormente, el aditivo se obtuvo mediante secado por atomización (120°C) y se evaluaron sus físicas: tamaño de partícula (D_{32}), densidad aparente (δ) por picnómetro, actividad de agua (aw), contenido de humedad (%H), estructura externa por SEM, estructura interna por microscopía Confocal, interacciones por FTIR-ATR y movilidad molecular de la matriz por NMR (Tiempo de relajación T2-FID), además de la actividad antimicrobiana frente *Escherichia coli* mediante halo de inhibición (HI).

Los resultados indican que no se observaron diferencias significativas ($p>0.05$) al adicionar MD en la estructura externa e interna. Los espectros de FTIR muestran los enlaces característicos de MD y CAP, y una disminución en la señal de CIT, indicando una protección de ~50% respecto a la muestra control. Por otro lado, se observó diferencias significativas ($p<0.05$) en el D_{32} y %H, en donde al adicionar MD (D_{32}=5,3µm; %H=1,6±0,4%bs) el tamaño y %H disminuyó significativamente ($p<0,05$) en comparación a la muestra con CAP (D_{32}=6,4µm; %H=2,8±0,5%bs) y muestra control (D_{32}=6,6µm; %H=7,95±0,06%bs). También, se obtuvo un aumento de la δ al adicionar MD (0,30±0,03g/cm^3) comparado a la adición de CAP (0,18±0,03g/cm^3), indicando una menor posibilidad de oxidación. Por otro lado, la actividad antimicrobiana fue mayor al adicionar MD (HI=1-1,5cm) en comparación a la muestra con CAP (HI=0,5-0.8cm). En conclusión, la adición de MD presentó mejores resultados tanto en las propiedades físicas como antimicrobianas, debido a un menor tamaño de gota, aw y %H, mayor densidad y actividad antimicrobiana. Por lo que, la adición de maltodextrina como MP permitió una mayor protección del compuesto activo sin afectar sus características antimicrobianas.

Keywords: Aceite esencial de citral, Secado por atomización, Capsul®, Aditivo activo

Encapsulación de aceite de neem (*Azadirachta indica*) y natamicina mediante gelación iónica sometido a luz ultraviolet

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RESUMEN: La encapsulación es una de las técnicas más utilizadas en el desarrollo de compuestos con principios activos sensibles a factores externos como la luz o el oxígeno, influyendo en la biodisponibilidad y estabilidad de los mismos. OBJETIVOS: El objetivo de este proyecto fue identificar el efecto de la luz ultravioleta tipo C en un encapsulado de aceite de neem y natamicina en una matriz de alginato. METODOS: Tras análisis previos, se estableció que la encapsulación sea a una concentración de 0,5ml de aceite de neem, 10g/l. de natamincina y 10g/L de fosfatidil colina y se obtuvo una emulsión homogénea. Se preparó la mezcla con glicerol y tampón fosfato a pH 7.0, luego se sometió a sonicación en un disruptor celular ultrasónico a 5 pulsos, 750 Watts, amplitud 100%, 60 segundos; a continuación, se realizó un proceso de gelación iónica en matriz de alginato. Para determinar las mejores condiciones de microencapsulación, se evaluó la concentración de los compuestos, flujo de alimentación al dispositivo con luz UV-C, y tamaño de partícula. Las microcápsulas formadas se analizaron de acuerdo con su morfología mediante microscopía electrónica de barrido SEM. RESULTADOS: Los factores de flujo en lámpara de luz UV-C de 30 w de intensidad, en flujo turbulento, con tratamiento de ultrasonido influye en la emulsión a concentraciones de 1.0; 1,5 y 2,0 ml. En el tratamiento a volumen de 0,5ml se observó un liposoma con tamaño medio de partícula 145nm y es estable al tiempo de exposición por lo que la formulación posee un incremento en la fotoestabilidad de los compuestos. El espectro en FTIR del compuesto encapsulado posee correlación con el valor del componente azadiractina de la semilla con un valor de 3574,2 cm-1 y transmitancia=61,8% a concentración de 0,5ml del aceite, por lo que no hay interacciones químicas entre los ingredientes formulados. Las características del espectro a valores entre 3108 y 3886 existe (O-H), entre 1410 y 1098 (C-O) con torsión de los C-H en el grupo -CHO. CONCLUSIONES: Los resultados mostraron que la composición de las micropartículas es un factor determinante para la expresión de la actividad biológica que presentan los principios activos de los aceites naturales. A concentración de 0,5 ml de aceite de neem y 10g/l de natamicina presenta fotoestabilidad por lo que se concluye que alginato provee protección a las micropartículas. Los resultados indican que la emulsión del aceite de neem y natamicina en cantidades variables se encapsulan con éxito en cápsulas de alginato de sodio y fosfatidilcolina de soya.

Keywords: Neem, Gelación iónica, Eficiencia, Luz ultravioleta, Fotoestabilidad

Optimización de las condiciones de cargado de diferentes aminoácidos en matrices mesoporosas de óxido de silicio

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Los aminoácidos constituyen los elementos básicos de las estructuras proteicas. Muchos de ellos son clave en diferentes procesos biológicos, por lo que administrarlos en las dosis adecuadas es vital para lograr un óptimo estado de salud. Para administrar estos compuestos en las dosis adecuadas y sin degradación, en los últimos años se ha recurrido a la encapsulación. La encapsulación y liberación presenta en ocasiones problemas de eficiencia relacionados con la polaridad y carga de los mismos. El presente trabajo tiene por objetivo optimizar las condiciones de cargado de diferentes aminoácidos en matrices mesoporosos de óxido de silicio. Para lograr este objetivo se han sintetizado dos tipos de partícula (MCM-41 y SBA-15), y seguidamente se han funcionalizado con diferentes proporciones de amina. Seguidamente se ha estudiado la eficacia de la encapsulación de diferentes aminoácidos en medios tamponados a diferentes pH (pH 7,5 y pH 9,5) mediante cromatografía líquida de alta resolución utilizando un detector evaporativo de dispersión de luz (HPLC-ELSD). La síntesis de los dos tipos de partícula se confirmó por difracción de rayos X, comprobándose la presencia de los picos que indican el orden hexagonal. Los sólidos sin funcionalizar presentaron valores de potencial zeta de ca. -25 mV. Dicho valor ascendió a ca. 0 mV en los sólidos funcionalizados con 0,025 mL/100g de sólido, a +10 mV en los funcionalizadps con 0,5 mL y a +30 mV cuando se añadieron 4 mL de APTES, confirmando que a mayor cantidad de amina utilizada en la funcionalización, mayor la carga superficial del sólido. Respecto a la encapsulación, la MCM-41 desnuda encapsuló 31.83 (pH 9.5) o 54.98 mg de tirosina/100mg de partícula (pH 7.5). Tras funcionalizar con 0,5 mL de la poliamina, la cantidad de aminoácido encasulado fue de 22 (pH 9.5) y 130 mg de tirosina/100mg de partícula (pH 7.5), observándose una mejor encapsulación en partícula cargada positivamente y a pH 7.5 (cercano al punto isoeléctrico). En el caso de la SBA, los valores fueron de 23, 102, 20 y 135 mg de tirosina/100mg de partícula para partícula desnuda y funcionalizada a pH 9.5 y 7.5, respectivamente. Estos resultados demuestran que tanto el tipo de partícula, como la funcionalización y el pH del medio donde se realiza el cargado tienen un efecto significativo en la eficiencia de encapsulación.

Keywords: Encapsulación, Aminoácidos, Mesoporoso

Effect of the incorporation of bare and amino functionalized nanoclays in gelatin gels

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The design of new functional foods with nutritional and/or health claims often requires the encapsulation, protection and subsequent controlled release of bioactive molecules. Among the most novel encapsulation systems, laminar nanoclays are receiving great attention due to their ability to encapsulate a large quantity of an active compound and release it in a controlled way to the medium, once they have been functionalized with organic molecules. If these organic molecules have the ability to hinder or allow the realease of the encapsulated molecule, they receive the name of molecular gates. Recent studies show that amines act as molecular gates able to regulate the release of the encapsulated cargo depending on the pH of the medium. The objective of this study is to characterize three types of nanoclays (montmorillonite –Mon-, hectorite –Hec- and saponite –Sap-) and to evaluate the impact of their incorporation, both nude and functionalized with amines, in gelatin gels. The particle size measured by light scattering and expressed as D[43] was 4.81 µm in the case of bare Mon, 27 µm for bare Hec and 34 µm for bare Sap. After functionalization values changed to 440, 19 and 21 µm for Mon, Hec and Sap, respectively. In order to confirm the efficiency of the functionalization, the zeta potential of each of the clays was determined before and after the functionalization. The bare nanoclays have values of ζ of -41.36 mV (Mon), -21 mV (Hec) and -26.46 mV (Sap). After functionalization ζ reached values of 31.33 mV (Mon), 26.23 mV (Hec) and 27.43 mV (Sap). This change from negative to positive is a proof of the effectiveness of functionalization with amines, which at neutral pH have many positive charges. On the other hand, the rheological properties of the gels were evaluated by oscillatory tests with temperature sweep. The results have shown that the addition of both naked and functionalized particles at a 1% concentration does not modify the gelation temperature of the gel to which it is added (20.7±0.5ºC), nor the viscoelastic properties of the resulting gel when the particles are functionalized with amines (G' at 15 ºC = 400±30 kPa; G' at 15 ºC = 6±2 kPa). In this way, their incorporation as controlled release systems would not significantly modify these properties of the food in which they could be added.

Keywords: Nanoclay, Functionalization, Rheology, Gelatin

Viability of microencapsulated *Lactobacillus casei* (DSM20011) in pineapple and orange juice under refrigeration conditions

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Probiotics microorganisms need to be alive to exert their health benefits.
The minimum concentration of live probiotic bacteria to exert this effects should be around 10^6 - 10^7 CFU/mL at the expiry date of the product. Microencapsulation is a technique that can be used for protect probiotics from its passage through the stomach, where microorganisms must survive acidic conditions, bile acids, antimicrobial compounds, degradative enzymes, hydrogen peroxide and temperature variations before reaching their target site.
The aim of this study was to use microencapsulation technique to confer protection from the acidity of non-dairy product, specifically low pH fruit juice.
Pineapple and orange juice pH obtained were 3.28 and 3.45, respectively. Natural fruit juices were prepared from fresh fruits. They were used directly from the juice extractor and citrus juicer container and then were pasteurized at 72°C by 90 s.
To make the microcapsules, a solution with lyophilized *Lactobacillus casei* at 5g/L (10^8 CFU/mL) was prepared and mixed (1:1) with sodium alginate solution at 2%. As a hardening solution, calcium chloride (0.1M) with gently stirring was used. Microencapsulation in a sophisticated technology provide by BÜCHI (Encapsulated B-390) was used. Viability of microcapsules was 7.36 log CFU/g spheres.
40 mL of fruit juice was mixed with 4 g of microencapsulated *Lactobacillus casei* and maintained in refrigeration conditions (4°C) during 4 weeks. At the end of storage period more than 60 % of microcapsules were recovered from pineapple and orange juice with more than 90% of viability (respect to the initial). Therefore, the microcapsules that remained intact in the juice did not decrease their content of *Lactobacillus*, which confirms that sodium alginate be able to protect them. On the other hand, some probiotics released from microcapsules to media (juice fruit) use media to grow and increase *Lactobacillus* content and get closer to suggested value in the final product.

Keywords: Microencapsulation, Probiotic, Lactobacillus

Produção e caracterização de micropartículas lipídicas sólidas de vitamina D_3

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Componentes bioativos hidrofóbicos, como vitaminas lipossolúveis, muitas vezes precisam ser incorporados em meios aquosos para que sejam adequados para administração oral, por exemplo, em alimentos, suplementos ou produtos farmacêuticos. A *Dietary Reference Intakes* do *Institute of Medicine* (Estados Unidos da América) recomenda que a maioria dos adultos ingira 10 µg de vitamina D por dia, mas poucos alimentos contêm níveis substanciais da vitamina, exceto peixes e óleos de peixe. O enriquecimento de sistemas aquosos com vitamina D3 (VD3) é altamente desafiador devido à sua insolubilidade em produtos com baixo teor de gordura. Uma alternativa para esse desafio é a encapsulação da VD3 em microcarreadores lipídicos, que comprovadamente permitem um aumento significativo na biodisponibilidade dos compostos encapsulados. Micropartículas sólidas lipídicas compostas por cera de carnaúba (16,7 g) e migliol 812 (8,3 g) foram produzidas por homogeneização a quente em água (250 mL) com caseinato de sódio (0,27 g) como estabilizante, a fim de encapsular vitamina D3 (0,28 g). A homogeneização foi realizada a quente (95℃) com Ultra-Turax (IKA-T25) a 16.000 rpm por 5 min. Então a dispersão foi vertida em banho de gelo e mantida sob agitação manual até a que a temperatura alcançasse 40℃. A dispersão foi congelada em ultrafreezer e liofilizada. As micropartículas obtidas tiveram sua morfologia caracterizada por Microscopia Eletrônica de Varredura (MEV), características térmicas avaliadas por Calorimetria Diferencial de Varredura (DSC) e a eficiência de encapsulação determinada por Espectroscopia UV-Vis. Foi possível observar pelas imagens obtidas por MEV que foram produzidas micropartículas esféricas com superfície rugosa e diâmetro médio de 15 µm. A análise de DSC da vitamina D3 pura indicou uma fusão cristalina localizada em 88°C (ΔH = 176,8 J/g) e nas partículas branco (sem vitamina) em 83°C (252,6 J/g). As partículas com vitamina encapsulada apresentaram a fusão localizada em 84°C (241,2 J/g) indicando que esta encontra-se encapsulada e na sua forma amorfa, devido à semelhança da temperatura de fusão com as partículas branco, bem como pela redução na entalpia relativa à transição, quando comparada com a vitamina pura. A análise de eficiência de encapsulação indicou que 83,9 ± 1,2% da vitamina foi efetivamente encapsulada com sucesso.

Keywords: Microencapsulação, Colecalciferol, Homogeneização a quente

Microencapsulación de pigmentos extraídos de la cascara de tuna y su aplicación en productos de confitería

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El crecimiento del etiquetado limpio en alimentos procesados va en aumento aunque los colorantes sintéticos son necesarios para lograr alimentos atractivos para los consumidores. Por lo anterior, es necesario tener otras fuentes de colorantes naturales con estabilidad comparable a los sintéticos. El objetivo del presente trabajo fue evaluar la capacidad del mucílago y microfibras de celulosa extraídos de la penca de nopal para microencapsular colorante rojo extraído de la cáscara de tuna, evaluando su estabilidad a la luz y pH mediante la determinación de cambio de color durante el almacenamiento en productos de confitería. El mucílago se extrajo por molienda y centrifugado de la pulpa previamente escaldada de la penca de nopal forrajero. En el sobrenadante se encuentra el mucílago y los sólidos (fibra) y la cáscara de la penca se utilizaron para obtener las microfibras de celulosa (40 µm) mediante una digestión ácida-alcalina y con asistencia de ultrasonido (amplitud 50% y frecuencia 0.5). El pigmento se extrajo de la cáscara de la tuna, se molió con agua destilada (1:4 p/v) y centrifugó (3,500rpm/30 min). El pigmento microencapsulado se obtuvo liofilizando la dispersión fibra-mucílago-pigmento (0.5-0.5-1.0 en base seca). El pigmento microencapsulado se aplicó en formulaciones para caramelo duro, gomitas de grenetina y gelatinas. Las formulas de gelatina se ajustaron a 3 diferentes pHs (3.5, 4.0 y 4.5), un lote se expuso a luz blanca durante tres meses y otro manteniéndolas en oscuridad el mismo periodo. Como control se elaboraron gelatinas con pigmento sin encapsular bajo las mismas condiciones antes mencionadas para comprobar que la matriz de encapsulación (mucílago-microfibras) daba estabilidad al pigmento. Cada semana se midieron las coordenadas de color CIEL*a*b* de los diferentes tratamientos para obtener la cinética de deterioro de este atributo de calidad (ΔE vs t). Todos los tratamientos presentaron una cinética de deterioro de orden cero aplicando la ecuación $dA/dt = kA^n$. La constante de cambio (k) para los tratamientos sin luz con pigmento microencapsulado oscilaron entre 0.08 y 0.088 con coeficientes de correlación de 0.843 y 0.992, mientras que el control presento un valor de k de 0.1708 y 0.1923 con R^2 de 0.9961 y 0.9026. Para los tratamientos con luz los valores obtenidos fueron control (0.3867 y 0.2923) y con pigmento encapsulado de 0.2196 y 0.1785 con correlaciones de 0.7314 a 0.9754. En el caramelo duro no se evaluó la cinética porque las micropartículas de celulosa presentes en el pigmento provocaban la cristalización de la sacarosa dando productos opacos y quebradizos. Las gomitas de grenetina presentaron comportamientos similares a los expuestos para las gelatinas. Se concluyó que el mucílago y las microfibras de celulosa de nopal presentaron capacidad para usarse como matriz de soporte en la microencapsulación del pigmento extraído de las cascaras de tuna rojo y estas tienen potencial para ser usadas en la Industria Alimentaria como colorante natural. El pigmento microencapsulado presentó mayor estabilidad al pH que a la luz.

Keywords: Subproductos, Estabilización de pigmentos, Micropartículas

Development of sodium alginate/chitosan microparticles containing sacha inchi oil (*Plukenetia volubilis* L.)

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The sacha inchi oil (SIO), native from the Peruvian Amazon, is characterized by the high concentration of polyunsaturated fatty acids (PUFA), presenting micronutrients such as tocopherols, phenolic compounds and carotenoids. In view of the SIO properties, the encapsulation technique becomes an alternative for the PUFA protection and for its application in foodstuffs. The goal of this work was to produce microparticles containing SIO by the ionic gelation technique combined with the electrostatic interaction process with chitosan. Oil-in-water emulsions were produced with the continuous phase composed by 2 wt% sodium alginate and 1 wt% Tween 20, while the dispersed phase consisted of SIO at concentrations of 45, 60 and 75% in relation to total solids. Three microparticle formulations were obtained by emulsions extrusion in spray nozzle in a crosslinking solution of calcium chloride (2% w/v); and they were submerged in chitosan dispersion (1% w/v). The hydrogel particles were characterized in relation to encapsulation efficiency (surface washed with hexane), moisture content, water activity, mean diameter ($D_{[43]}$), morphological structure and oxidative stability. The microparticles presented high values of moisture (81.50 ± 1.21 to 90.66 ± 0.27% on wet basis) and water activity (0.995 ± 0.001 to 0.997 ± 0.001). These results are characteristic of samples obtained by ionic gelation technique. They showed a spherical shape with no apparent roughness, with size $D_{[43]}$ from 355.7 ± 21.3 to 419.5 ± 9.1µm. The preservation of the three-dimensional structure occurred due to the content of guluronic acid blocks present in the alginate. The microparticles presented high encapsulation efficiency (≥ 99%) that can be attributed to the oil uniform distribution in the alginate matrix, which did not allow the oil migration to surface. This oil homogeneous distribution is characteristic of systems added of surfactants. In relation to oxidative stability after 4 weeks, SIO encapsulated exhibited lower peroxide values (52.67 ± 5.55, 57.46 ± 3.23 and 36.18 ± 3.32 $meqO_2.kg^{-1}$ for formulations with 45, 60 and 75% of SIO, respectively) compared to SIO free (131.26 ± 9.26 $meqO_2.kg^{-1}$). Thus, it can be said that the process proposed here promoted the SIO protection.

Keywords: Sacha Inchi Oil, Polyunsaturated fatty acids, Ionic gelation and oxidative stability

Effect of particle size on free fatty acid release during *in vitro* intestinal lipid digestion of soybean oil/water emulsion-filled gels

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In solid food chewing process can be considered as a key step in the digestion due to generation of a particle size distribution which can determine the hydrolysis yield of food components during digestion. Considering this, the aim of this research was to evaluate the effect of particle size distribution on intestinal *in vitro* digestion of emulsion-filed alginate gel cubes using the pH-stat method and Weibull functions to model the digestion process. The methodology consisted in the preparation of oil/water emulsion-filled calcium alginate gel which were cut in cubes of 15x15x15 mm. Then, the cubes were continuously compressed/sheared between two plates applying 5, 10 and 15 cycles with a force of 30N in order to produce three different particle size area distribution, which were analyzed through Rosin-Rammler model parameter (x_{50} and b). Then, compressed cubes were *in vitro* digested simulating the intestinal digestion under pH-stat method, measuring percentage of free fatty acid released (%FFA) and analyzed by Weibull function parameters (k and β). The results showed that as compression cycles increased from 5 to 15, the particle size distribution presented smaller values of x_{50} from 216 mm^2 to 88.8 mm^2, respectively. Respect to %FFA release behavior, it was dependent on the particle size distribution obtained for each compression cycle showing a sigmoidal behavior in the three particle distribution. However, the main differences occurred before inflexion point in the curves, which was related to the dissolution of calcium alginate due to pH-7 coupled with lipolysis process. This sigmoidal behavior allowed to fit two Weibull functions obtaining β values of for the first stage and for the second stage. The results showed that for the first stage the constant k increased as particle size was smaller from $2.17x10^{-8}$ min^{-1} to $1.05x10^{-6}$ min^{-1}, while β remained relatively constant between 4.31-5.26. All β values for the first stage, had values greater than 1 indicating that the presence of the matrix is controlling FFA release. For the second stage, the values of k (around 0.05 min^{-1}) and β (around 0.8) were similar for the three particle distribution (all calcium-alginate was complete dissolved). Then, $\beta<1$ indicate that digestion was initially rapid but levels off at a lower FFA release rate. This study showed that the particle size of an emulsion-filled alginate gel affected free fatty acid release during *in vitro* digestion. In particular, smaller particles promoted faster FFA release during the first 30 minutes of digestion.

Keywords: Oil/water emulsion, *in vitro* digestion, pH-stat method, Particle size distribution

Pineapple peel as a source of natural antioxidants for fruit juices preservation

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Processing of pineapple generates large quantities of byproducts, where the peel is the major portion. This byproduct still contains an important amount of phenolic compounds and vitamins with valuable antioxidant activity. In this way, the aim of this study was the recovery of the bioactive compounds from pineapple peel using environmentally friendly and low-cost techniques, for further application to stabilise food products, replacing synthetic antioxidants. From the solid-liquid extraction conditions tested, the one delivering an extract with higher total phenolics content and antioxidant capacity was a single extraction step with pineapple peel-solvent ratio of 1:1 (w/w) for 25 minutes at ambient temperature, using ethanol-water (80-20%) as solvent, followed by ethanol evaporation under vacuum. The resulting extract revealed a total phenolic content value of 0.71 mg gallic acid equivalent/mL extract and antioxidant activity by DPPH method (8.24 µmol Trolox/ g dry extract) and FRAP method (15.66 µmol Trolox/ g dry extract). However, the direct incorporation of this extract into food products may reduce its antioxidant efficiency due to degradation/oxidation reactions during processing and storage, which limits their utilization. As such, the stabilization of that antioxidant rich extract encapsulation by spray drying technique was studied. In this context, the effect of different wall materials (maltodextrin, inulin, and arabic gum) and inlet air temperature (150 °C and 190 °C) during spray drying were evaluated. The microcapsules produced presented an average loading of phenolic compounds of 4.2±0.5 mg gallic acid equivalents/g particles. The results showed that all the antioxidant capacity of the encapsulated compounds was maintained after encapsulation, regardless the temperature used. Also, the morphology and size observed by SEM shown that all the particles have a regular and spherical shape with smooth surfaces, without agglomerates. The microparticles diameter ranged between 0.8 and 10.4 µm, from which more than 50% of the particles had a diameter lower than 4 µm. The loaded microparticles obtained, that consist on a bioactive powder, present a great potential to be incorporated in food products or to produce bioactive packaging systems, in order to shield oxidation reactions and enhance shelf life.

Keywords: Bioactive compounds, Encapsulation, Spray Drying, Pineapple peel, Shelf life

Reconstituição de micropartículas de óleo de buriti produzidas por liofilização para aplicação em alimentos

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A microencapsulação através da secagem por liofilização é uma alternativa possível com o emprego do óleo de buriti como composto bioativo, pois a técnica amplia a utilização do óleo encapsulado ou incorporado como ingredientes, aumenta a vida de prateleira, além de agregar valor a um produto alimentício, pois tal método protege os compostos bioativos presentes no óleo, além de facilitar a incorporação de compostos líquidos em sistemas secos. Uma propriedade importante para esse tipo de produto é o comportamento de reconstituição como avaliação da molhabilidade e solubilidade, uma vez que a capacidade de reidratação das micropartículas produzidas é uma etapa limitante no processo de reconstituição e posterior aplicação em alimentos. O objetivo desse trabalho foi avaliar a reconstituição de micropartículas de óleo de buriti produzidas por liofilização em diferentes combinações de encapsulantes através das análises de molhabilidade e solubilidade para futura aplicação em alimentos. Os encapsulantes inulina (IN) e goma arábica (GA) foram utilizados nas combinações de 25%, 50% e 75%, obtendo-se os seguintes tratamentos: GA25IN75; GA50IN50; GA75IN55. O percentual de solubilidade foi calculado pela diferença de massa entre o sobrenadante seco em relação a quantidade de pó adicionado inicialmente. A solubilidade foi medida pelo tempo que as microparticulas levaram para sendimentarem. Os tratamentos GA25IN75; GA50IN50; GA75IN55 obteve uma solubilidade de 65,95%, 71,71%, 55,44% respectivamente. Observou-se que o tratamento GA50IN50 apresentou solubilidade igual a 71,71% e maior em relação aos demais tratamentos. A molhabilidade encontrada variou de (59 -71) segundos valores considerados ótimos para alimentos em pó, considerando as exigências da indústria e do mercado consumidor. O tratamento GA50IN50 apresentou maior valor de solubilidade (71,71%) comparado aos demais tratamentos. A molhabilidade das micropartículas de óleo de buriti variou de 48 a 59 segundos, os valores encontrados podem ser considerados ótimos para tempo de reconstituição, visto que os valores ótimos para parâmetros físico-químicos de molhabilidade de alimentos em pó, considerando as exigências da indústria e mercado consumidor, está entre 10 a 60 segundos. Conclui-se que o tratamento teste contendo 50IN50GA apresentou maior valor de solubilidade (71,71%) em relação aos demais tratamentos, e valor de molhabilidade considerado ótimo (59 segundos), para alimentos em pó considerando as exigências da indústria e do mercado consumidor. Portanto, a combinação em proporções equiparais de IN e GA é uma alternativa viável para aplicação de micropartículas de óleo de buriti liofilizadas em alimentos que apresentem caráter hidrofílicos.

Keywords: Mauritia flexuosa, Freeze-dryer, Compostos bioativos

Antifungal activity of chitosan nanoparticles containing carvacrol

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Fungal infection is one of the most frequent causes of fruit spoilage. The shelf- life of food products can be prolonged by using naturally occurring molecules, which have showed antifungal activity, hence limiting fungal decay. Carvacrol (CA) is a monoterpenoid phenol with reported antimicrobial capacity, which is the major compound of oregano essential oil. Chitosan (CH) is a non-toxic biodegradable cationic polymer, with interesting antimicrobial properties, which can be crosslinked with negatively charged substances, such as sodium tripoliphosphate (TPP) to develop CH-based nanoparticles (NP) that can encapsulate active compounds. The aim of this work was to evaluate the antifungal performance of CH nanoparticles loaded with carvacrol against *Botryotinia fuckeliana* (BF). For this purpose, 0.5% (w/v) CH solution was prepared in 0.25% (w/v) acetic acid solution at pH 4.65. Separately, a 0.27% (w/v) TPP solution was incorporated into CH solution to obtain the NP (CHNP) with a molar ratio of CH:TPP of 7.4. To obtain the loaded nanoparticles (CHNP-CA), CA was primarily emulsified with the CH solution at 1 mg/mL and then the TPP was incorporated in the same CH:TPP molar ratio. The obtained dispersions were solved in previously autoclaved potato dextrose agar (PDA) to reach a final concentration in the plate of 0 (control), 10, 25 and 50% (v/v), and the pH was adjusted to 4.65 with 10% acetic acid solution. The antifungal effect of the different formulations against BF were determined by measuring the radial fungal growth in petri dishes of 15 cm in diameter. The results showed that fungal growth was not affected by the pH of the medium and that the growth rate of the control plate was 6.16 mm/day. CH dispersion exhibited significant antifungal activity, which increased with the increase in CH concentration. CHNP did not promoted a significant improvement as regard pure CH in terms of fungal growth. The incorporation of carvacrol significantly decreased the growth rate of BF and two different trends were observed in terms of growth kinetics: a slower initial growth rate around 1 mm/day, and a subsequent faster growth (with rate between 3.78 and 4.63 mm/day). Future studies will deal with the application of the loaded nanoparticles for the shelf-life extension of highly perishable fruits.

Keywords: Chitosan, Molecular Weight, Nanoparticles, *Botryotinia fuckeliana*, Carvacrol.

Encapsulação de vitamina B_2 em nanoestruturas proteicas formadas por α-Lactoalbumina e Lisozima

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As nanoestruturas de proteínas ganharam atenção considerável devido à sua capacidade de ligação com vários nutrientes e fármacos e por serem bem toleradas, sem efeitos secundários ao organismo. As nanoestruturas podem ser aplicadas para intensificar propriedades funcionais de proteínas em formulações alimentícias, na produção de biosensores para embalagens ativas e inteligentes, em filmes comestíveis, permitem detecção rápida de contaminantes químicos e biológicos, na encapsulação e liberação controlada de compostos bioativos em alimentos. Na forma concentrada ou purificada, beneficiam a saúde além de fornecer características específicas para diferentes produtos alimentícios. Elas intensificam propriedades funcionais de solubilidade, formação e estabilidade de espuma, emulsificação, gelificação, formação de filmes e cápsulas protetoras. As proteínas podem ser versáteis no transporte e liberação de nutrientes e fármacos, e são atóxicas. Portanto, as proteínas são ideais para produzir nanoestruturas para uso alimentício. O trabalho teve como objetivo avaliar a encapsulação de vitamina B_2 nas nanoestruturas formadas por α-Lactoalbumina e Lisozima aquecidas a 75º C/15 min. A vitamina B_2 é hidrossolúvel, anfipática, pertencente ao grupo das flavinas com propriedades importantes, por exemplo, essencial para o crescimento, desenvolvimento e manutenção normal do organismo humano. As nanoestruturas obtidas foram caracterizadas pelo método do DLS (espalhamento dinâmico de luz) em termos de tamanho médio (nm), índice de polidispersão (PDI), potencial ζ, eficiência de encapsulação (EE) da vitamina B_2. O tamanho médio das nanoestruturas proteicas encapsuladas com a vitamina B_2 após o aquecimento foi abaixo de 47 nm e apresentando baixa polidispersão enquanto que as partículas sem aquecimento apresentaram tamanho médio superior a 320 nm e valores mais elevados de polidispersão. Os valores da eficiência de encapsulação EE (%) e da capacidade de ligação LC (%) da vitamina B_2 nas nanoestruturas foram de (95,82 ± 0,59) %. A morfologia das nanoestruturas proteicas encapsuladas com vitamina B_2 foi analisada pela microscopia eletrônica de transmissão – MET, demonstrando serem partículas associadas esféricas. As análises de quantificação da vitamina B_2 foram realizadas pelo método de espectroscopia de fluorescência a λ_{EX} = 450 nm , λ_{EM} = 480 nm e 650 nm. Foi realizada a avaliação da estabilidade durante a estocagem a 4 ºC por 60 dias, avaliando-se o tamanho (nm) e PDI das nanopartículas. A metodologia aplicada mostrou-se que as nanoestruturas proteicas foram eficientes e promissoras na encapsulação de vitamina B_2, sendo mais uma alternativa de aplicação para esse campo da indústria de alimentos.

Keywords: Nanotecnologia, Encapsulação de vitamina B_2, Nanoestrutura proteicas, α-Lactoalbumina e Lisozima

Industry 4.0 Applied to Food

Plenary lectures

On the use of decision-making tools for improving food quality and safety of Spanish-style table olives

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Table olives are one of the most representatives and consumed fermented vegetables in Mediterranean countries. However, there is an evident lack of standardization of production processes and HACCP systems thus implying the need of establishing decision-making tools allowing their commercialization and shelf-life extension. Oleica Sentinel is defined as an expert computational system for supporting food safety and quality activities by Health Authorities and the food industry. It integrates four modules related to implementation of ISO standards, Prerequisites Programs (PRPs), an On-guard system for detecting non-conformities and a Data Expert Analysis Module (DEAM) aiming at quantifying the degree of quality and safety fulfilment based on a probabilistic scenario analysis. They represent a breakthrough in the assessment and management of food safety based on scientific evidence. The main features of Oleica Sentinel system will be presented, providing stakeholders with an easy-to-use, flexible and useful probabilistic decision-making scoring system for Spanish-style table olives and potentially be applied within the agrifood sector.

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Oral Communications

Avaliação sensorial eletrônica de pão enriquecido com polpa de pescado (*Rachycentron canadum*)

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O objetivo do trabalho foi avaliar e comparar sensorialmente, de forma eletrônica, pães elaborados com polpa de pescado e convencionais. Os pães foram elaborados com duas farinhas: a) 100% farinha de trigo (FF); b) mix de 10% de polpa integral de pescado e 90% de farinha de trigo (FPN). Ambos foram formulados com 1% de NaCl, 1,5% de fermento biológico seco e 60% de água. A massa foi dividida em pedaços de 250g, fermentada em estufa a 30ºC / 90 minutos e forneada a 200ºC / 20 min em forno elétrico pré-aquecido. Os pães foram analisados por nariz (EN) e língua eletrônica (ET), em triplicada, a 25°C, durante quatro tempos após o forneamento (t0 = 1 hora; t1 = 24 horas; t2 = 48 horas; t5 = 120 horas). Foi utilizado o EN PEN2 da Win Muster Airsense Analytics (Alemanha), composto por 10 sensores químicos. Foram colocados 10g de amostra em frasco hermético de 100mL. Condições: taxa fluxo=300mL/min, tempo injeção=60min, tempo descarga=180min. As análises de ET foram realizadas através do Taste-Sensing System SA 402B (Japão), com cinco sensores de detecção e dois eletrodos de referência. Foram pesados 3 gramas de amostra e adicionados 3g de água destilada. A solução foi homogeneizada e centrifugada a 5000 rpm por 5min. O sobrenadante foi filtrado e diluído 1:4 (p/p) com água destilada. Os dados coletados foram processados por análise de PCA (Análise dos Componentes Principais), mostrando a relação entre as amostras e as variáveis. Para o EN, a distribuição das amostras na zona definida pelos dois principais componentes (que explicaram 83,1% da variância total), foi observado uma evolução dos aromas ao longo do primeiro (PC1) e segundo (PC2) componentes, conforme o tempo de armazenamento. Nas primeiras 24 horas, o FPN não apresentou odores a pescado, o mesmo ocorrendo com o tempo 2, o qual se manteve intermediário entre os tempos t1 e t2 do FF. Após 5 dias, o EN foi capaz de discriminar acentuadamente diferenças entre as amostras. A ET detectou diferença entre os pães pelo PC1 e PC2, explicando 81,5% da variância total. Maiores transformações de gostos aconteceram nas primeiras 24h. Não foi observado grandes diferenças entre gostos das amostras nos demais tempos. O FF foi caracterizado inicialmente como “gosto levemente ácido e adstringente”, e após como “menos amargo e salgado”; o FPN foi caracterizado inicialmente como “sabor amargo”; e após o “salgado” e o “umami” se tornaram mais perceptíveis.

Keywords: Cobia, Pão enriquecido, Nariz Eletrônico, Língua Eletrônica

Evaluation of the evolution of the morphostructure of popcorn by means of high-speed imaging

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Expansion is a common phenomenon in the food process chain, thermal and pharmaceutical industries. Moisture content and water activity influence popping and the resulting structures are associated to morphostrutural geometries, which are classified as different popcorn morphologies (mushroom, unilateral, bilateral, and multilateral). Relations between the morphology of popcorn and structural properties are complex and poorly studied due to the short times taken for popping the corn and the heterogeneity of shapes and sizes of the obtained products. In this work, corn kernels were conditioned to 14% moisture content (DB) and then popped at 180°C by using a hot-air popper chamber, specially designed to pop individual kernels. High-speed videos were acquired with a MEMRECAM GX-1 LTD. Popcorn kernels were classified according to their morphology and were evaluated by digital image analysis by using the ImageJ software. Also, morphostructure parameters such as perimeter and projected area were evaluated. Results showed that high-speed imaging allowed to identify macrostructures from popcorn kernels. Individual popping method has different morphology probabilities of occurrence compared to bulk popping due to the absence of contact between kernels which induces the formation of microfractures in the pericarp and thus the occurrence of the different popcorn morphologies, in such a way that unilateral morphology predominated in single-popping. The behaviour of the perimeter and surface area displacement in the pane X,Y allowed determining the progress of the expansion for each morphology, showing that the occurrence of each morphology was dependent on the initial air-kernel contact and were associated to different popping duration. These findings support that it is possible to classify popcorn morphologies as well as determine the behaviour of popping perimeter and area by means of high-speed camera images acquisition and digital image analysis.

Keywords: Popcorn morphology, Image analysis, Morphostructure, High-speed imaging

Non-invasive assessment of textural properties on sliced avocado by using air-coupled ultrasound

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In recent decades, there has been a notable increase in the demand of avocados, especially in U.S. and Europe. This has caused the fruit and vegetable industry to demand non-destructive techniques that can be implemented online to characterize avocado's textural properties, thus allowing its post-harvest maturity to be estimated. Conventional ultrasonic techniques have previously been used to characterize different physical-chemical parameters in agri-food products.

The objective of this work was to determine the feasibility of non-contact low intensity ultrasound (air-coupled) to estimate firmness in avocado slices. For this purpose, an instrumental texture analysis and an ultrasonic analysis (250 kHz) were performed on different pieces of avocado throughout post-harvest (0-5 days at 20±1 ºC). The analysis has been made in slices of different thicknesses (up to 5 mm) because the high attenuation did not allow the ultrasonic signal to travel through the whole fruit. Thus, we determined different textural parameters such as firmness, elastic modulus or relaxation capacity in the avocado slices, afterwards they have been related to the ultrasonic parameters measured, mainly maximum wave amplitude and velocity.

The maximum amplitude of the ultrasonic wave decreased significantly ($p<0.05$) during ripening. Thereby, initial average amplitude was 0.38±0.17 V/m, which was reduced to 0.06±0.05 V/m for 5 days of ripening. Amplitude was significantly related ($p<0.05$) with the textural parameters from linear models. The best correlation was found between the maximum amplitude of the ultrasonic wave normalized by the sample thickness and the firmness, measured as the maximum compression force ($R = 0.96$, Eq. 1).

$$Firmness\ (N) = 32.39\ Amplitud/Thickness(V/m)\ - 0.57 \qquad \text{(Eq. 1)}$$

Therefore, this work has shown the viability of non-contact ultrasonic technology for the measurement of textural properties in avocado. The future work should address the improvement of the air-couple technique that allows to carry out the measurement in whole fruit, and its possible implementation in the process lines as a non-destructive and non-invasive characterization technique.

Keywords: Air-coupled ultrasounds, Avocado, Ripening, Textural parameters

Analisis de impurezas en quinua (C*henopodium quinoa*) trillada mediante el uso de reconocimiento de patrones por análisis de imágenes como herramienta de la cadena de suministro de exportacion

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La Quinua (*Chenopodium quinoa*) es un alimento nutritivo apreciado por diferentes países del mundo, Perú exportó 79 269 toneladas para el 2016, existe un reto pendiente de estandarizar las operaciones de cosecha y poscosecha, para el control de calidad de impurezas (piedras, pajillas, heces de ratones, etc.), la cual representa costos importantes para el productor y procesador. El objetivo de la investigación fue desarrollar un sistema de reconocimiento de patrones de impurezas encontradas en la quinua, mediante el análisis de imágenes, considerando las propiedades físicas y ópticas de la mayor cantidad de impurezas presentes en quinuas trilladas y acopiadas en la región Puno - Perú. Se desarrolló un dispositivo de campo con tamices estandarizados (malla ASTM-11 de 1.40 y 1.70 mm) para el análisis de impurezas, acoplado a un móvil con un aplicativo, que usa algoritmos de visión computacional para el reconocimiento de patrones de forma, tamaño y color. Se analizaron 50 muestras de la región, a las cuales se realizaron un determinaciones físicas de clasificación; se determinó la densidad de cada impureza por métodos oficiales AOAC (2000), y las impurezas por NTP 205.062 – 2014, posteriormente se adquirió las imágenes con una cámara réflex digital (Cámara Nikon D810 c/24-120mm), el análisis de las imágenes se hizo con las librerías de Deep Learning en el software Python (Python Software Found - Copyright ©2001-2018), la aplicación y el dispositivo se validaron en campo con la metodología tradicional. Se caracterizaron en forma por contorno (pajillas, piedras, cuarzo, heces de ratones, granos dañados, inmaduras, inflorescencias, germinados, parte de insectos y larvas), color (granos contrastantes, granos germinados, granos inmaduros, heces blancas y heces negras) y tamaño (piedras, cuarzo, granos quebrados y dañados). Los patrones de reconocimiento permitieron clasificar todas las impurezas en estudio, con un nivel de confiabilidad del 98%. Se puede concluir que la visión computacional acoplada a dispositivos móviles es una herramienta válida para el control de calidad de quinua trilla y acopiada en campo, como una herramienta en la cadena de suministro de exportación de quinua del Perú.

Keywords: Impurezas en quinua, Análisis de imágenes, Python, Calidad

Industry 4.0 Applied to Food

Industry 4.0 Applied to Food

Poster Communications

Study and monitoring of the milk sweet production process using an electronic prototyping tool

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A peculiar latin American product, dulce de leche is technically characterized as a dairy product obtained through a concentration process. Its tecnology of production consists on the water evaporation by indirect application of heat with equipments called evaporators. During the processment the milk pass through a series of physical e and chemical modifications that give desirable flavor, smell and color, besides. Through the reduction of the water activity, increase of viscosity, reduction of pH, increase of acidity, changes in the saline equilibrium, modification in the protein conformation and alteration of color. The development of dark color is the result of reactions of non enzimatic darkening, mainly the Maillard reaction. With the appearing of the Arduino technology, the task of sensoring and monitoring, processes as the dulce de leche production earn more credibility, serving as an option for the aplication of a larger production system. The present study aims to develop a production and monitoring system of the obtainment process of dulce de leche. For this, fatorial planning 2^2 was performed with the concentration factors of saccharose and initial acidity of milk. Then, were collected manually the parameters of pH, Aw, soluble solids and color via a digital colorimeter and, automatically measure the temperature with a DS18B20 sensor, and the color parameters (RGB) with the TCS230, connected to Arduino. The variation curves of soluble solids, pH and water activity presented coherents profiles with those found in the literature, showing a rise in the °Brix, reduction of pH and water activity during the process. The trials performed had different production periods due to the amount of sugars. The parameters of color by the colorimeter and by the sensor (RGB) presented variations due to the process, observation diferents escalas of color, in funcion of time. The products obtained from all the trials were into acceptable values of humidity, ashes and proteins estimated by the current brasilian legislation. However, the trials 1 and 2 were out of the limit determined to fat percentage. Finally, the trial 3 was the most viable in terms of time and yield, and the use of Arduino technology as a especial fator to the monitoring of temperature and color during the fabrication process of dulce de leche.

Keywords: Dulce de leche, Arduino Uno, Colorimeter, Sensor of color TCS230

Food Processing Technologies

Plenary lectures

New possibilities for the drying of fruits and vegetables

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The production of dehydrated fruits and vegetables with attractive characteristics is still a challenge. Microwave vacuum drying and dehydration by multiflash drying (MFD) result in high-quality, crisp foods. MFD is based on the application of successive cycles of heating-vacuum pulse to the food to be dried. For that, the food is heated to a desired temperature (e.g., 60 ºC) before the application of a vacuum pulse, which leads to fast evaporation and product texturization, which in turn result in dry products with porous structures. The heating step can be carried out by convection, conduction or microwaves. On the other hand, the production of dehydrated fruit powders is commonly performed by spray-drying, but there are alternatives to this operation, based on the drying of thin layers of fruit pulps or vegetables (1 to 2 mm thick) spread on flexible support (cast-tape drying). This thin layer is heated by hot water or steam in contact with the underside of the flexible support, while the evaporated water is removed by a flow of air over the pulp. It is possible to obtain films, flakes or powders (after milling) of fruits and vegetables with drying times between ten and twenty minutes.

Creating functional foods through processed foodstuff innovation

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With the increasing consumer's demand for innovative foodstuff, food industry is facing a huge challenge. Through food processing, practical aspects such as perishability or color issues, among others, can be overcome, which makes it an asset for modern society. With that in mind, the possibility of using natural ingredients in processed foodstuff and alongside create novel functional foods, has led to the exploitation of natural resources like plants and mushrooms.

Regarding bioactive compounds, phenolic acids (rosmarinic acid), flavonoids (quercetin derivatives), and ellagitannins (sanguiin H-10 and lambertianin) from mushrooms, wild strawberry, rosemary, mountain sandwort, and flowers of silva brava were incorporated in gelatin, yogurt, and cottage cheese [e.g. 1]. Other compounds such as polyphenols extracted from strawberry-tree, basil, lemon balm, sweet chestnut flowers, fennel, and German chamomile were used for preservative purposes in loaf bread, cupcakes, yogurt, cheese, and cottage cheese, namely flavonoids (catechin, and quercetin and luteolin derivatives), phenolic acids (rosmarinic, chicoric, lithospermic, caffeic, and caffeoylquinic acids), and hydrolysable tannins (trigalloyl-HHDP-glucoside) [e.g. 2]. Moreover, colouring molecules like betalains (gomphrenins and isogomphrenins) from purple globe amaranth and anthocyanins (cyanidin, delphinidin, and malvidin derivatives) from rose, dahlia, centaurea, strawberry-tree, roselle, and blueberry were applied in ice-cream, yogurt, and waffles [e.g. 3].

Food Processing Technologies

Kinetics Modeling

Oral Communications

Kinetics of spent coffee grounds oil extraction using renewable solvent

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Spent coffee grounds are the main residue from the industrial production of soluble coffee, as well as from the home daily preparation of the coffee based beverage. This material has a considerable lipid content, around 20% mass, opening the possibility of use of the oil, if adequately recovered, in the food and energy production fields, for instance. The main aim of this work was to obtain experimental data of the extraction kinetics of spent coffee grounds oil using absolute and hydrous ethanol (6% mass of water) as solvent, solid:solvent mass ratio of 1:3, temperatures of 60, 70 e 80 °C, 400 rpm of agitation speed, at different contact time intervals (from 5 up to 50 minutes). The extracts were analyzed in terms of the total soluble solids by evaporation at 100 °C for 24 hours, and of the water content, by Karl Fischer titration. Experimental data were mathematically described by Fick's diffusion law, considering spherical geometry (mean particle diameter of 562 ± 8 μm) and the resolution procedure proposed by Perez et al. (2011). The steady state of the extraction process was reached around 30 minutes. The hydration of the solvent negatively impacted the oil extraction while increased temperature led to higher oil extraction yields (up to 61%). The mathematical modeling provided high values of coefficient of determination (at least 0.999) and low values of average relative deviation (up to 3.5%). The diffusion coefficients showed higher values for higher temperatures of extraction, being calculated values between 1.2×10^{-11} and 2.6×10^{-11} $m^2 \cdot s^{-1}$. These results are important to understand the process of extraction of spent coffee grounds oil using renewable solvent, enabling its production in an industrial scale.

Keywords: Green solvent, Solid-liquid extraction, Diffusion coefficient, Coffee byproduct, Ethanol

The laser-CO_2 drilling coupled to moderate electric fields to enhancement the mass transfer phenomenon in tomato (*lycopersicon esculentum*) peeling process: analysis of operational variables and quality parameters

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Tomatoes are listed as the most consumed vegetables in the world, with a total of 177 million ton cultivated in 2016 with an average harvest yield of 3.7 $kg \cdot m^{-2}$. As consequence, the quantity destined to the processed products is almost 30% of total production, requiring generally a peel removal processing as the first step, resulting with significant effects on nutritional and economic issues. Thus, instead of different alternatives proposed in literature, the lye-peeling method remain as the principal technique because of its higher effectiveness, deeply studied, available machinery, greater efficiency, and better stability in the storage, but with larger water and energy consumption followed by serious environmental problems. In particular, this method has been extensively studied varying its operational conditions (temperature, time and NaOH concentration) and with different novel techniques combination that support the traditional technology, for instance infrared radiation heating, ohmic heating, ultrasound-assisted lye, and peeling aid among others. In this sense, this present phenomenological study will focus in the feasibility in modifying the tomato (*Lycopersicon esculentum*) skin by Laser-CO_2 drilling under different pore size (127.92 ± 5.45 – 194.39 ± 12.05 µm), and pore density (2 – 9 $pore \cdot cm^{-2}$) coupled with moderate electric field (MEF) at 1333 V/m. In addition, the modified surface will be exposed to different NaOH concentration (0.1 – 0.5 % w/w), evaluating the effective diffusion coefficient (D_{eff}) of NaOH throughout tomato skin, the mechanical properties (Total Work [W_T], Peak Load [F_M], and Young's modulus [E]) by using the ball indentation analysis, and the thermal properties by using differential scanning calorimeter (DSC). In general, the results showed for D_{eff} values with pre-treatment were ranged between $4.45 \cdot 10^{-11}$ ($m^2 \cdot s^{-1}$) to $24.95 \cdot 10^{-11}$ ($m^2 \cdot s^{-1}$), being around two times greater than the surface without pre-treatment (p-value<0.05). Furthermore, the textural parameters W_T, F_M, and E showed to decrease their values – even lower than control sample – when both pore diameter and pore density were increased after being exposed to peeling agent. However, the E magnitudes showed a tendency on samples before being exposed to NaOH, which might be attributable as consequence of the energy delivered by Laser-CO_2 onto surface and pore density. Finally, the thermal analysis showed the presence of three melting point in the range of 298 - 473 K, being associated principally to waxes and complexes carbohydrates phase transitions present into cuticle of tomato skin.

Keywords: Laser-CO_2 drilling, Peeling process, Skin of tomato, Tomato processing

Predictive modeling of the growth curves of *Leuconostoc mesenteroides* and *Weissella viridescens* in mixed culture using SYBR® green QPCR

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The lactic acid bacteria (LAB), especially *Leuconostoc mesenteroides* and *Weissella viridescens* species, have been reported as responsible for the spoilage of vacuum-packaged cooked meat products and stored under refrigeration. In order to identify, to quantify and to model these bacteria growth in mixed culture (simulating a food matrix), a quantitative Polymerase Chain Reaction (qPCR) assay with SYBR® Green detection was developed. To confirm the efficiency and sensitivity of the SYBR® Green qPCR-based assay, it was performed a melting curve analysis to check the specificity of the amplification reaction. The growth curves for each LAB species in pure culture enumerated by plate count were compared to the curves of each species in mixed culture quantified by SYBR® Green qPCR. Experiments were conducted in optimal growth temperature (30 °C) until the stationary phase (24 hours of cultivation). Baranyi and Roberts' model (BRM) and modified Gompertz model (MGM) were fitted to the growth data using the Matlab® R2013a Software. Results showed that the primers were specific for the DNA of *L. mesenteroides* and *W. viridescens* with melting temperatures of 82 °C and 81 °C, respectively. Thus, the Cycle Threshold (C_T) values obtained from the SYBR® Green qPCR reactions of the mixed culture were correlated to the equations of the standard curves in pure culture, established in previous studies of the group, to quantify (log CFU/mL) specifically each LAB species in the mixed culture. In general, it was observed that the growth curves of the both LAB species were not similar and only the curve of *L. mesenteroides* presented a sigmoid format, evidencing an inhibition of the growth of *W. viridescens*. Comparing the performance of the predictive models, the MGM model presented a suitable fit to the experimental data, with values of RMSE statistical indexes close to zero, bias factor and accuracy factor close to 1.0 and $R^2 > 0.97$. Thereby, it can be stated that the use of fast methods as qPCR method to identify and/or to quantify LAB is important for the food industry because it allows the knowledge of the predominant bacteria in the spoilage. In conclusion, these results highlight the importance to combine molecular techniques with classical and predictive microbiology, with the purpose of providing a new tool to study the mechanisms of inhibition and/or bioprotection of LAB in meat products, thus allowing the establishment of parameters that may lead to an increase in the shelf-life of these foods.

Keywords: Lactic acid bacteria, quantitative PCR, Mathematical modeling, Spoilage, Shelf-life

Degradation kinetics of carotenoids during storage of papaya chips obtained by vacuum frying with saturated and unsaturated oils

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The degradation kinetics of carotenoids (CTs) during storage were investigated in papaya chips (PC) obtained by vacuum frying. Different storage conditions were evaluated: package conditioning (air and nitrogen), temperature (15-45 ^{o}C), and time (0-52 and 0-94 days). In addition, the effect of lipid composition in chips was taken into account: type of oil, saturated (palm) versus unsaturated (soy), and oil content in the chips, minimum (24%) versus maximum (29%).

The different CTs were identified by HPLC-DAD using a C30 column and measuring at 450 and 470 nm. A kinetic study was carried out for the different carotenoids found in PC (all-E-β-cryptoxanthin, BCX; all-E-β-carotene, BC; all-E-lycopene, LYC; Z-β-carotene, Z-BC; Z-lycopene, Z-LYC). In order to evaluate the effect of lipid composition in the chips a comparison of the Arrhenius parameters (rate constant, k_{ref}; and activation energy, E_a) was carried out using the Student's t-test.

Our results showed a clear positive effect of packaging the PC under nitrogen conditions on CTs retention during storage. Kinetic analysis indicated that a second-order kinetic model appeared to best fit the experimental data. The *-trans* form carotenoids were more stable than *-cis* forms. The rate constants for LYC degradation were the lowest, which indicates that LYC was the most stable carotenoid in PC during storage. BCX and BC presented similar rate constants. Among the *-cis* carotenoids, Z-BC showed the highest rate constants. The E_a and k_{ref} values for LYC (the main carotenoid in PC) were 5-21 kJ·mol^{-1} and 0.10-0.70 x 10^{-3} day^{-1}, respectively. A higher oil content in the chips caused a significant protective effect by replacing the voids that could be filled with air and thus reducing the oxidation of CTs. Moreover, it was observed a greater retention ($p<0.05$) of CTs in PC with soy oil. This could be explained by the lower viscosity of soy oil compared to palm oil that favors the oil uptake inside the pores that are generated in the fried product, replacing the voids that could be filled with air.

In a limited storage time and providing good quality of soy oil, this alternative to saturated oil could be nutritionally interesting. Therefore, the matrix lipid composition (oil content and type of oil) affected kinetic parameters of CTs and demonstrated a protective role on CTs, especially for lycopene.

Keywords: Carotenoids, Papaya chips, Kinetics, Vacuum frying, Soy oil, Palm oil, Oxygen, Storage, Temperature

Determinación de propiedades mecánicas de películas de lactosuero durante envejecimiento acelerado: aplicación de perfiles FTIR y herramientas quimiométricas

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La evaluación de la textura en materiales de envase alimentario, realizado mediante técnicas destructivas y equipamientos de alto costo, se viene constituyendo en un campo de aplicación de nuevas técnicas de análisis no destructivas. En este sentido técnicas espectrometrías como FTIR (Fourier Transformed Infra-Red Spectroscopy) han mostrado potencial en la determinación de propiedad físicas, químicas o mecánicas en materiales alimentarios. Por tanto; el objetivo de este trabajo fue evaluar la aplicabilidad del uso de perfiles espectrales y herramientas quimiométricas: regresión de mínimos cuadrados parciales (RMCP), análisis de componentes principales - regresión lineal múltiple (PCA-RLM) para determinar las propiedades mecánicas de películas de proteínas concentradas de lactosuero (PCL). Se elaboraron películas con 10 g PCL en 100 g de solución formadora de película (SFP) con 5 g glicerol en 100 g de SFP usando el método de solvent casting. Las películas se sometieron a acondicionamiento (envejecimiento acelerado) a 30 °C y 60% de humedad relativa por 5 días. Diariamente se recortaron 10 piezas de las cuales de cada una se obtuvieron 10 perfiles FTIR (4000 a 650 cm^{-1}), la tensión a la fractura (TF), el porcentaje de elongación (%E) y el módulo elástico (ME). Se determinaron modelos RMCP, completo y optimizado, y PCA-RLM; en todos los casos la data se dividió en bloques de modelado y validación mediante validación cruzada (k-fold = 10) y se calcularon los estadísticos coeficiente de correlación (R^2) y el error cuadrático medio (ECM). El R^2 varió entre 0,497 a 1,000 para RMCP y 0,929 a 1,000 para PCA-RLM; asimismo el ECM para el modelo PCA-RLM y RMCP completo fueron 0,172, 6,2 y 0,00741 para la TF, %E y ME respectivamente. Sin embargo, el modelo RMCP optimizado mostro una fuerte disminución en el ajuste mostrando este los mínimos valores R^2 y máximos ECM. Por tanto; es posible determinar las propiedades mecánicas de las películas de lactosuero en condiciones de envejecimiento acelerado usando perfiles FTIR y herramientas quimiométricas, principalmente aquellos basados componentes principales.

Keywords: FTIR, PCA, RMCP, Propiedades mecánicas, Envases biodegradables

Application of Temporal Check-All-That-Apply (TCATA) method to assess sensory profile of chewing gum using a consumer panel

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In sensory and consumer science, there has been a growing interest in evaluating how the sensory perception of a food item changes over the consumption process, given that most methods are static in nature. The most commonly used dynamic sensory methods are Time-Intensity (TI) and Temporal Dominance of Sensations (TDS), but these methods either only allow the evaluation of a few attributes (TI) or ask assessors to only select the most dominant attribute at a time. Temporal Check-All-That-Apply (TCATA) is a novel technique allowing consumers to select all the perceived attributes at a given time over the evaluation period. The main goal of our work was to assess the dynamic sensory profile of chewing gum using the TCATA methodology.
Four different commercial samples of melon shape and flavour chewing gum were used in this study and a panel of 30 untrained panellists performed the evaluation of the samples. Evaluation occurred for the 30s, counting from the moment the panellists put the sample in their mouths, during which panellists selected all the attributes they deemed as applicable from a CATA ballot with 12 terms (selected based on a previous open-comment test). The number of terms selected by each assessor for each of the samples was calculated for each time-frame of 1s. Then, the average citation proportions across samples and assessors for the total duration of the evaluation were calculated and used to build TCATA curves with the *R* software. TCATA product trajectories were also calculated, to grasp the attributes evolution during the evaluation period.
Different dynamic profiles were obtained for the samples and the attributes which were most applicable in the samples were “hard”, “difficulty to chew”, “acid” and “presence of liquid”. During the evaluation period, the number of selected attributes increased up to an overall average of 1.5 attributes/product/panellist, achieved at approximately 20 s after the start of the evaluation and decreased until the end of the evaluation period.
The use of untrained panellists for temporal methods revealed good results for product characterization and differentiation. However, it seems that initial training is necessary to allow for the adaptation to the method dynamics and to the associated cognitive effort.

Keywords: Dynamic sensory methods, Sensory analysis, Temporal Check-All-That-Apply, Untrained panelists

Food Processing Technologies

Kinetics Modeling

Poster Communications

Cinética de inativação da pectinametilesterase em suco de laranja submetido ao aquecimento assistido por micro-ondas

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Nos últimos anos houve uma queda das exportações do suco de laranja, o que demonstra a mudança de hábito do consumidor e uma preferência por produtos naturais e minimamente processados. Neste sentido, buscam-se tecnologias alternativas para o processamento de alimentos líquidos, entre as quais as micro-ondas possuem grande potencial. A tecnologia de micro-ondas focalizadas traz como vantagem o aquecimento rápido e volumétrico, o que permite uma melhor retenção dos atributos de qualidade do produto. Dessa forma, o objetivo deste trabalho foi estudar a cinética de inativação da enzima pectinametilesterase (PME) no tratamento térmico assistido por micro-ondas do suco de laranja. Para isto foram extraídos 11,2 kg de suco de laranja da variedade Pera (jun. 2018). Alíquotas de 80 mL de suco foram submetidas ao aquecimento por micro-ondas focalizadas (Discover Reflux, CEM Corporation, EUA) no intervalo de temperatura entre (70 e 90) ºC e tempo de exposição entre (0 e 160) s, com agitação magnética que possibilitou a temperatura uniforme durante o aquecimento. A aquisição de dados foi realizada a cada 0,5 s com o auxílio do termômetro de fibra óptica (Luxtron 812, *LumaSense*, EUA). Com base na redução da atividade enzimática e no histórico de temperatura, o modelo de primeira ordem de duas frações foi ajustado. Foram realizadas análises físico-químicas do suco processado e não processado. O suco não processado apresentou valores de pH (3,77 ± 0,02), acidez (0,746 ± 0,004 g de ácido cítrico/100 g de suco), sólidos solúveis (8,5 ± 0,1 °Brix) e teor de ácido ascórbico (49,72 ± 0,35 mg/100 mL de suco). Os resultados mostraram que o processamento térmico assistido por micro-ondas focalizadas foi efetivo na inativação enzimática da PME, atingindo 89 % de inativação a 70 ºC por 35 s e 99 % a 90 ºC por 8 s. Os parâmetros cinéticos ajustados foram: z = (9,60 e 11,98) ºC e $D_{90ºC}$ = (0,101 e 26,51) s para as frações termolábil e termorresistente, respectivamente, com α de 0,91 indicando 9 % da isoenzima termorresistente presente no suco. Não houve diferenças significativas entre os valores de pH, acidez e teor de sólidos solúveis do suco processado e não processado. O teor de ácido ascórbico diminuiu com o aumento do tempo de processamento, no entanto a retenção do nutriente não foi inferior a 85 %. Os resultados indicam que o aquecimento assistido por micro-ondas é um processo com potencial para a pasteurização do suco de laranja.

Keywords: Tratamento térmico, Micro-ondas focalizadas, Parâmetros cinéticos

Modelo de base fenomenológica para la predicción de los cambios estructurales durante el conchado del chocolate

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El proceso de conchado es uno de los principales procesos en la elaboración del chocolate, allí se desarrollan los atributos sensoriales y las propiedades reológicas del producto en tres etapas: seca, plástica y líquida. En la etapa seca ocurren principalmente cambios químicos, durante la etapa plástica se da un cambio en la reología de la masa, ya que la grasa recubre los sólidos, mejorando la fluidez de la mezcla, mientras que en la etapa líquida la adición de grasa y emulsificante permite obtener la viscosidad adecuada para etapas posteriores. El objetivo de esta investigación fue obtener un modelo semi-físico de base fenomenológica para predecir los cambios estructurales del chocolate durante el conchado, aplicando la siguiente metodología: descripción del proceso, definición de sistemas de proceso, aplicación del principio de conservación y obtención de un modelo computacional. El modelo obtenido relaciona dinámicamente los estados del sistema con condiciones de proceso y variables reológicas del producto. Se realizó un muestreo en las etapas plástica y líquida del conchado de un chocolate semi-amargo con el fin de identificar a partir de un análisis de extrusión las variables reológicas del modelo de Herschel-Bulkley: esfuerzo de deslizamiento (σ_0) [kPa], índice de fluidez (n) [-] e índice de consistencia (k) [kPa]. Se correlacionó la fuerza máxima (F) [N] necesaria para la extrusión del producto y los cambios de viscosidad a medida que transcurre el proceso, mostrando un comportamiento decreciente de F durante todo el tiempo de conchado. Se identificaron los siguientes valores de los parámetros del modelo de Herschel-Bulkley (σ_0, n, k): inicio de etapa plástica: (31.64, 0.049, 42.80) con R=0.93, final de etapa plástica: (4.51, 0.68, 14.04) con R=0.97, final de etapa liquida: (0.54, 0.73, 0.44) con R=0.99. Para validar cualitativamente los cambios reológicos obtenidos, se realizó un análisis de microestructura. Este análisis permitió observar que a medida que transcurre el conchado se da un recubrimiento del azúcar y sólidos de cacao por la grasa liberada mediante los efectos mecánicos ejercidos sobre el producto. El modelo obtenido relaciona las propiedades reológicas del chocolate y las variables del proceso y permite predecir los cambios estructurales con errores menores al 10%. Este modelo es una aproximación al entendimiento de los fenómenos estructurales del chocolate durante el conchado, lo que se convierte en una herramienta para proponer posibles modificaciones al proceso con el fin de optimizarlo, sin afectar la calidad reológica del producto.

Keywords: Conchado, chocolate, Modelo Semi-Físico de Base Fenomenológica, Cambios estructurales, Reología, Microestructura, Extrusión

Analysis of RF heating of chicken meat

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Radiofrequency (RF) heating is a process gaining interest in the food industry thanks to its ability to achieve a more uniform heating in samples with respect to microwaves.
The aim of this work was to evaluate the performances of a RF cavity (40.68 MHz, 50 Ohm, 10 cm electrodes gap, 300 W maximum power) using both experimental and virtual analysis.
Minced breast chicken samples were held in 4x4x4 cm^3 ABS containers and organized as different loads and configurations arranged (for instance, horizontal or vertical arrays of 2 or more bricks). Two different RF powers (225 and 300W) were tested. On each test the heating efficiency was determined by measuring the initial and final temperature on selected locations.
A mathematical model of different sample configurations in the RF cavity was considered in a virtual model, implemented in COMSOL Multiphysics software. The Gauss law for electro-quasi-static conduction was solved for both the air in the cavity and the samples, while heat transfer was modeled only in food samples. For 16 bricks configuration, near 10000 finite elements were used, and simulation time was lower than 30 seconds. The model clearly showed how important was the orientation of the samples and their configurations in determination of the process efficiency.
The experimental results showed that at 225W, for 2 bricks configuration, vertical array was more efficient than the horizontal one (29.6% vs. 9.6%). For 4 bricks, there are 3 configurations: 4 bricks linearly aligned in the floor, 2x2 bricks in the floor, or 2 bricks in the floor and 2 bricks above them; the last configuration was near twice efficient that the others (40.5% vs. 21.5% and 20.7%). For 8 bricks, 3 configurations were tested: 4x2 bricks in the floor, 2x2 bricks in the floor and 2x2 above them, or 4x1 bricks in the floor and 4x1 above them; the last two were more efficient, (46.5% and 43% vs. 18.4%). For 12 bricks, a single array of 3x2 bricks in the floor and 3x2 above them was used, with an efficiency of 44%. Similar trends were obtained at 300W. The model predictions agreed well with experimental trends.
The gap between top electrode and samples plays a major role in the efficiency, which is also improved using higher loads. So, it is very important in the design of new ovens the ability to change the electrode position.

Keywords: Radiofrequency, Mathematical model, Efficiency

Caracterizacion de la liberacion controlada en medio acuoso de albumina de suero bovino (BSA) microencapsulada

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En el presente trabajo se evaluó el comportamiento de liberación de la proteína albumina de suero bovino (BSA) en medio acuoso contenida en microcapsulas de gelatina tamaño 1 - 8 µm. Las microcapsulas de gelatina BSA se prepararon mediante la técnica de emulsificacion y gelificación térmica luego de lo cual se aplicó una cobertura externa de goma arábiga por el método modificado de coacervación compleja. Se utilizaron microcapsulas sin recubrimiento como control, 10 liberaciones en dos niveles de bsa. El estudio de liberación se realizó en agua destilada a 25°C, midiendo el porcentaje de BSA liberado por el método cuantificación de proteínas lowry, se uso un diseño experimental 2^3 con dos niveles de BSA, Goma arábiga, pH final del coacervado y se evaluó el ajuste a los modelos de orden cero, primer orden, modelo Higuchi, modelo Peppas y modelo Weibull mediante el programa Curve Expert 1.3 y para el análisis de los efectos significativos se empleo el programa estadístico Statgraphics Plus 5.1;las liberaciones de microcapsulas sin recubrimiento presentan buena correlación a los modelos de primer orden, Weibull y Peppas, lo que indica que se trata de microcapsulas con poros, al analizar la constantes arrojadas por el modelo Peppas encontramos un n promedio 0.3251 se trata de un caso no Fikiano acorde con la correlación de primer orden presentada; el promedio de las constantes de los modelos para las microcapsulas recubiertas, la constante n del modelo Peppas de 0.3423 se encuentra en un rango no fikiano y el promedio de la constante b del modelo Weibull de 0.6300, encontramos que hay una ligera tendencia a presentarse cierto grado de difusión que es reportado como difusión fractal y trastornos de percolación por algunos autores; se encontró que el efecto pH-Concentración de Goma Arábiga como un efecto significativo en la liberación de BSA.

Keywords: Microencapsulacion, Liberación, Proteínas

Modelagem cinética e avaliação sensorial em iogurte probiótico de leite de cabra sabor chocolate com café durante o armazenamento

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O objetivo da pesquisa foi avaliar a modelagem cinética do *Lactobacillus acidophilus* inoculado em iogurte de leite de cabra sabor chocolate com café e verificar a aceitação do novo produto. A partir de ensaios microbiológicos (contagem de bactérias ácido láticas - BAL) e físico-químicos (pH e acidez titulável) foi avaliado o crescimento do probiótico semanalmente até o período de 35 dias, os dados foram modelados a partir do modelo Baranyi e Roberts e após processamento foi realizada uma análise sensorial de aceitação com 100 provadores a partir de uma escala hedônica compreendida entre 1 e 9 pontos (1 = desgostei extremamente e 9 = gostei extremamente). Verificou-se que durante o armazenamento o iogurte apresentou valores de acidez que oscilaram de 70,50° Dornic (dia 0) até 81,00°D (dia 35), sendo acompanhado por um decaimento do pH de 4,56 (dia 0) até 4,20 (dia 35) o que demostrou coerência a partir do fato que o iogurte se acidifica ao longo do tempo devido a presença de ácido láctico produzido pelas BAL. Na contagem destas, ao longo do período caracterizando a fase lag até os primeiros 28 dias de armazenamento e posterior fase de declínio, sendo representado por valores em log10 UFC/mL de: 8,467 – 11,396 – 12,666 – 12,986 – 15,754 – 11,847, respectivamente dias 0, 7, 14, 21, 28 e 35 dias. Resultados esses que se enquadram em caracterizar o iogurte como probiótico por apresentar uma contagem superior a 7 log10 UFC/mL. Os parâmetros da contagem foram comparados experimentalmente através das funções do modelo matemático e obtivemos valores em log10 UFC/mL: 10,022 – 10,888 – 11,753 – 12,619 – 13,484 – 14,350, respectivamente dias 0, 7, 14, 21, 28 e 35 dias. Na avaliação semanal o erro (R2) foi de 16,832 a partir do 21° dia não se aproximando de zero. Até o 21° dia o crescimento do *L. acidophilus* foi ajustado ao modelo e a partir do 21° dia apresentou dispersão dos valores comprometendo a exatidão dos parâmetros e seu ajuste matemático. Como aceitação sensorial em relação ao sabor, textura e aparência apresentaram média 7,0 caracterizando gostei moderadamente o que é significativo ao estudo por seu um produto novo. Podemos concluir que apesar de adequação aos parâmetros físico-químicos pH e acidez assim como a contagem de BAL dentro do estabelecido nas normas padrão o produto após 21 dias de armazenamento não apresenta adequação matemática ao modelo, contudo o produto avaliado apresentou boa aceitação pelo consumidor.

Keywords: Modelagem matemática, Iogurte, Leite de cabra

Avaliação do modelo matemático barany & roberts e gompertz na fermentação em iogurte de leite de cabra tradicional

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O objetivo do estudo foi avaliar matematicamente a ação do crescimento das bactérias ácido-lácticas (BAL) durante o processo de fermentação na elaboração de iogurte caprino tradicional. Foi produzido 1 litro de iogurte de leite de cabra a partir do leite em pó fluidificado com o fermento de iogurte (*Lactobacillus bulgaricus* + *Streptococcus thermophilus*) adicionado da cultura *Lactobacillus acidophilus* e avaliado a modelagem primária de Baranyi & Roberts e Gompertz. O tempo de fermentação do iogurte foi computado e finalizado em 6hs, atingindo pH final de 4,67 e acidez titulável de 70,50° Dornic em acordo com o que define a legislação que preconiza acidez superior a 60° Dornic. A contagem de BAL da fermentação obteve valores crescente a partir de 9,0 log10 UFC/g na primeira hora até 10,748 log10 UFC/g na 6°hora. A contagem de BAL se enquadrou aos requisitos legais que determina contagem acima de 7,0 log10 UFC/g. Os valores dos índices estatísticos R^2 e RMSE, bem como os fatores bias e exatidão resultantes dos ajustes dos modelos de Gompertz e Baranyi e Roberts aos dados de crescimento microbiano estão apresentados na tabela 1.

Tabela 01 – Valores dos índices estatísticos de validação matemáticas dos modelos primários às curvas de crescimento microbiano no processamento de fermentação.

Modelo	Fator Bias	Fator Exatidão	RMSE	R^2	Diluição
Gompertz	1,003	1,063	0,863	6,829	10^{-8}
Baranyi e Roberts	1,000	1,021	0,111	0,987	10^{-8}
Gompertz	1,004	1,078	1,178	-1,256	10^{-9}
Baranyi e Roberts	1,001	1,031	0,230	0,805	10^{-9}
Gompertz	1,003	1,063	0,863	1,715	10^{-10}
Baranyi e Roberts	1,000	1,021	0,111	0,679	10^{-10}

Analisando os dados é possível verificar através dos índices estatísticos, principalmente pelo fator de exatidão e R^2 os quais devem estar o mais próximo de 1 possível, que o modelo BAR apresentou os menores desvios e valores mais ajustados com melhor capacidade de ajuste aos valores experimentais do que o modelo de Gompertz para as condições (tempo x crescimento) e diluições aplicadas. Um dos principais fatores responsáveis pela interferência dos ajustes dos modelos matemáticos pode ser atribuído à diminuição da população microbiana durante a fase lag. O modelo de Gompertz não descreve muito bem essa diminuição em sua função quando comparado ao modelo de Baranyi e Roberts, o que pode justificar o baixo ajuste do modelo de Gompertz aos dados experimentais. A aplicação dos modelos matemáticos propostos mostrou-se eficiente apenas para o modelo Baranyi & Roberts durante o processamento do iogurte.

Keywords: Modelagem matemática, Iogurte, Leite de cabra

Avaliação do modelo matemático weibull do crescimento microbiano durante o armazenamento de iogurte grego delactosado probiótico sabor manga *(Mangifera indica L.)*

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A pesquisa consistiu em modelar o crescimento microbiano das bactérias ácido-lácticas (BAL) do iogurte grego delactosado sabor manga, semanalmente, por um período de 42 dias de armazenamento, a partir do modelo Weibull. Este modelo propõe que as células e os esporos em uma população microbiana têm resistências diferentes. Podemos estudar uma curva de sobrevivência apenas na forma cumulativa de uma distribuição de agentes letais. Foram produzidos 3 litros de iogurte a partir de 3 litros de leite delactosado UHT e 12%(m/m) de leite em pó desnatado; foi adicionando 2% (m/m) do fermento (*Lactobacillus bulgaricus* + *Streptococcus thermophilus*) e 2% (m/m) da cultura de *Lactobacillus acidophilus* (Globalfood) e 9% (m/m) da polpa de manga. Ao final da fermentação (43°C ± 1°C), o produto atingiu valores de acidez em ácido láctico de (1,70 g .100 g^{-1}) e pH (4,05) desejáveis ao produto. A viabilidade de BAL descrita na Tabela 1 confere ao produto valores acima do preconizado pela legislação (7,0 $\log_{10}$ UFC/g) para iogurte grego probiótico (BRASIL, 2002).

Tabela 1: Viabilidade de BAL durante o armazenamento (4°C ± 1°C) do iogurte grego delactosado sabor manga (*Mangifera indica L.*).

Tempo Dias	0	7	14	21	28	35	42
BAL $\log_{10}$ UFC/g	8,89	9,51	9,75	10,02	10,38	9,94	9,81

Avaliando o modelo de Weibull a partir do crescimento microbiano semanal obtivemos valores de Exatidão, Bias, RMSE e R^2 descritos na Tabela 2.

Tabela 2: Valores dos índices estatísticos de validação matemáticas dos modelos primários às curvas de crescimento microbiano no processamento de fermentação.

Modelo	Fator Bias	Fator Exatidão	RMSE	R^2
Weibull	0,999	1,007	0,206	0,77

Analisando os dados pode-se verificar que o modelo de Weibull apresentou melhor ajuste dos dados do crescimento microbiano e que a exatidão e o fator Bias se ajustaram muito bem (valores próximos a 1), o que pode validar o modelo ao produto elaborado. Podemos concluir que o iogurte atingiu valores do crescimento de BAL dentro do esperado para iogurte probiótico e o modelo matemático Weibull foi satisfatório.

Keywords: *:* Iogurte probiótico, Modelagem microbiana, Modelo de Weibull

Modeling the responses of *salmonella enterica* Typhimurium exposed to an osmotic stress condition

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Salmonella spp. are responsible for bacterial foodborne diseases all over the world, resulting in problems that affecting public health and economic development. One way to control the growth of *Salmonella* spp. in food is the addition of sodium chloride (NaCl) to decrease water activity (a_w) and, consequently, inhibit bacterial growth. However, when exposed to osmotic stress conditions, responses different in bacterial behavior can be found. The aim of this study was to model the behavior of *Salmonella enterica* Typhimurium under condition of low water activity (a_w). To investigate the effect of the osmotic stress on the behavior of *S*. Typhimurium a solution with 7% NaCl was prepared, reaching a_w of 0.95. The solution was inoculated with the microbial suspension of S. Typhimurium (around 10^4 CFU/L^{-1}), incubated at 25 °C and bacterial concentrations were measured by viable counts. The primary Baranyi and Roberts model was adjusted to the data. The fitted was performed the nonlinear regression, using Microsoft Excel with the aid of the solver supplement. The results showed that *S*. Typhimurium bacterial cells were resistance to osmotic stress, able to adapt and grow in low a_w environments. The viable count curve showed an initial decrease, followed by a period in which the cells appear to adapt to the new environment and, thereafter, exponential growth ensues. Baranyi and Roberts model was adapted based on the assumption that the log count curve of the total population was the sum of a dying and a surviving-then-growing subpopulation. The growth parameters obtained were the maximum specific growth rate (μ_g), the maximum specific death rate (μ_d), the maximum population growth (y_{maxg} (CFU/mL)), the maximum dying population (y_{maxd} (CFU/mL)) and the lag phase duration (λ (h)). The predictive ability of the model was assessed through statistical indexes, with good results (bias factor 1.016; accuracy factor 1.178, RMSE 0.288 and R^2 0.973), showing predictions were safe. The findings show that during exposure at a condition of low a_w, two subpopulations, one surviving-then-growing and one dying, are presently leading to a microbial behavior known as Phoenix phenomenon. This phenomenon shows the different cellular responses and the complexity in the behavior of microbial populations in conditions close to the boundary of growth. In conclusion, the study and interpretation of the adaptation to osmotic stress (a_w = 0.95) of foodborne bacteria was well described by Baranyi and Roberts model. These results are important in order of maintaining food safety standards.

Keywords: Low water activity, Bacterial surviving, Phoenix phenomenon

Thermodynamic properties of *Spondias tuberosa* Arruda Camara (umbuzeiro) fruit during drying

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Umbu (*Spondias tuberosa* Arruda Camara) fruit has an exotic flavor and aroma and contains phenolic antioxidants, polyphenols and vitamin C. These properties make it of great importance to rural populations of the semiarid Brazilian Northeast, especially in years of drought because bumper crops become an important source of food. Umbu is sold by small farmers for fresh consumption or as pulp, juice, candy, liqueur and in other forms. The acidic flavor makes the fruit a good option for producing raisins or dried fruit. The thermodynamics of drying based on the degree of hydration (α_H) and a structural transition model were examined in *Spondias tuberosa* (umbuzeiro) fruit. Umbu fruit was dried in a continuous tray dryer operated at 50, 60, 70 and 80 °C. In addition, we describe the steps used in the model to generate surface and contour plots of these parameters. These results provide the first analysis of specific heat of water release (ΔCpw). The region of energy optimization for the degree of hydration α_H = 0.1 should be obtained at 67 °C and 128 min drying condition point that corresponds the minimum ΔCpw (-720 J/mol/K). On the other hand, the results also show that the condition of ΔCpw = 0 can be reached using 63 °C and drying time of 153 min, and with lower drying time (125 min) in a higher temperature (71 °C).

Keywords: Drying kinetics, Spondias tuberosa Arruda Camara, Specific heat of water release, Structural transition model

A phenomenological based model to predict the water holding capacity in the mixing process of processed meats

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Maximum potential of water holding capacity (WHC) can be achieved in the mixer since it is the only process where water molecules from external fonts could be incorporated to interact with meat proteins. This study proposes a phenomenological based semi-physical model (PBSM) for the mixing process that explains proteins denaturation and their interaction with water molecules when salts and phosphates are present. A reaction scheme is proposed based on the literature review and the consolidation of individual experiments elaborated at pilot and industrial scale. The scheme consists of three irreversible denaturing reactions that govern the development of WHC. All of them involve structural changes of two protein fractions, sarcoplasmic and myofibrillar, which after unfolding are able to hold water in their structures. Additionally, phosphate is considered to be working in synergy with salts to improve WHC. This model provides a tool to predict the potential contribution of the protein fractions to WHC based on their native and denatured state and their interaction with the ingredients with major impact in the mixing process.
The reactions were simulated via numerical integration of the differential equations of the species involved in the reaction scheme, the rate constants were parameterized with Arrhenius expression. The pre-exponential factors ($1.10 \times 10^{18} min^{-1}$, $0.61 \times 10^{18} min^{-1}$ and $1.15 \times 10^{7} kmol^{-1} min^{-1}$) and the activation energies ($9.23 \times 10^{4}\ kJ kmol^{-1}$, $8.83 \times 10^{4}\ kJ kmol^{-1}$ and $8.8 \times 10^{3}\ kJ kmol^{-1}$) are the values optimized for simulation. The model was applied to a batch of mortadella performed at industrial scale. The results show that the model is able to predict the WHC at standard formulation and operational conditions with an error of 21%.

Keywords: Water holding capacity, Protein denaturation, Mixing process, Phenomenological based model

Quality parameters assessment in vegetables pulps during pasteurization. Modelling and optimization of the thermal process

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Consumers are demonstrating an increased awareness regarding the importance of a balanced, convenient and healthy diet. According to this trend, the fruit and vegetable industry is undergoing changes in order to develop novel products, such as fruit and vegetable (F&V) pulps, as a response to the challenge brought by the consumers. In this sense, the transformation of seasonable F&V (or production surplus) into added-value storable products with increased shelf-life is a strong and growing interest topic to industry players.
Fruit and vegetable pulps are nutritionally balanced products with bioactive value that can be enhanced by the rational combination of fruits and vegetables according to a particular formulation. However, F&V pulp quality is rapidly loss due to enzymatic reactions and excessive microbial growth. Due to the added value attributed to these products, efforts to preserve quality are being developed through the optimization of different preservation technologies toward pulp production. Also due to the demand of "chemical-free" products, this is taken as a premise to develop the preservation strategy.
The strategy investigated in this study explores de use of heat (pasteurization) to reduce spoilage microbiota and to enzymatic inactivation. Two F&V pulps were studied in this research, one with a mix of pear and pineapple (50:50, p:p; P_Amarela / yellow) and one with a mix of pear, strawberry, beetroot and lemon juice (66:30:4:0.15, p:p:p:v; P_Vermelha / red). Pulp pasteurization was optimized by the development of degradation kinetics (80 °C to 98 °C in time intervals of 0.5 to 25 min) and evaluating the respective effects on the pulps quality. The evaluated quality parameters included the determination of peroxidase activity (POD), pH, soluble solids content (SSC), rheological parameters, total phenolic content (TPC), sensory evaluation (colour, taste and aroma) and reduction of microbial counts. Regarding the pasteurization optimization, it was concluded that heat treatments applied under the high-temperature-short-time concept were more effective to inactivate POD, to significantly reduce the initial microbial load and to maximize colour retention and TPC levels. As an example, from the degradation kinetic models, it was possible to conclude that POD followed a 1^{st} order kinetic, where the temperature effect was well fitted to the Arrhenius equation. From these results it was possible to optimize the thermal intensities for both pulps and the selected time-temperature binomials were of 90 °C/5 min and 90 °C/4 min for the P_Amarela and P_Vermelha, respectively.

Keywords: Vegetables pulps, Pasteurization, Kinetics, Optimization, Quality parameters

The effect of UV-C and electrolyzed water on yeasts on fresh-cut apple at 4 °C

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The aim of the present study was to evaluate the growing ability, of a cocktail of yeasts (at 4 °C) obtained from fresh-cut apple: *Candida sake, Hanseniaspora uvarum, Pichia fermentans, Metschnikowia pulcherrima*. Additionally, the efficacy of Ultraviolet-C (UV-C), acidic electrolyzed water (AEW) and neutral electrolyzed water (NEW), as well as sodium hypochlorite (SH), in the reduction of the yeasts on fresh-cut apple was also studied. Apple portions were inoculated and incubated at 4 °C for 9 days. Contaminated apples were disinfected with UV-C (2.5-10 kJ/m^2), AEW, NEW and SH (100 ppm) and the yeasts was counted. The yeasts inoculated at 5.97 log cfu/g, grew on the apples portions at 4 °C, reaching values of 7.42 log cfu/g, in 6 days. The inverse hyperbola model was used to explain the microbial reductions caused by UV-C irradiation (physical), AEW, NEW, SH and DW (chemical) treatments during the storage. The initial microbial decline and the half-life time values estimated by the model varied from 1.72 to 1.81 log cfu/g and 6.52 to 11.70 days or 0.91 to 1.96 log cfu/g and 0.68 to 4.38 days, for physical or chemical disinfections, respectively. All of these disinfections presented higher microbial reductions and half-life time values than SH (0.92 log cfu/g and 2.96 days). The treatments with the highest values of model parameters were AEW or NEW and UV7.5 or UV10. The UV-C was more effective than the chemical disinfections, as it resulted in superior microbial decreases and could be a substitute of the hypochlorite.

Keywords: Fresh-cut apple, Yeasts, Ultraviolet-C, Electrolyzed water

Potencial de óleos essenciais de Lamiaceae como agentes antimicrobianos na preservação de alimentos

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Óleos essenciais (OE) de muitas plantas têm sido utilizados como agentes aromatizantes. Contudo a sua utilização potencial na preservação e segurança de alimentos e suas embalagens tem vindo a ser estudada. Neste trabalho, a atividade antimicrobiana de óleos essenciais de *Salvia officinalis* (L.), *Lavandula angustifolia* (Mill.), *Mentha piperita* L. e *Melissa officinalis* L. foi avaliada utilizando microorganismos contaminantes de alimentos e respetivas embalagens, nomeadamente *Escherichia coli*, *Bacillus subtilis*, *Helicobacter pylori*, *Candida albicans*, *Saccharomyces cerevisae*, *Yarrowia lipolytica*, *Dekkera anomala*, *Torulaspora delbrueckii*, *Zygosaccharomyces bailii* and *Pichia membranifciens* tendo em vista a sua utilização na preservação de alimentos e embalagens. Os OE foram obtidos por hidrodestilação em Clevenger. Os respetivos constituintes foram identificados e quantificados por GC-MS e GC-FID respetivamente. A sensibilidade das estirpes microbianas aos OE foi avaliada pela técnica de crescimento radial de suspensões microbianas (DO_{640} 0,5-0,6) espalhadas sobre meios de cultura (YEPD) solidificados com 2% de agar, em placas de Petri contendo discos de papel embebidos com 8 µl de OE puro. Os raios dos halos de inibição foram medidos após um período de incubação de dois dias a 25ºC. As concentrações mínimas inibitórias (MIC) e concentrações mínimas letais (MLC) foram determinadas através de ensaios em meio YEPD líquido mantido sob agitação á temperatura de 25ºC e suplementados com diferentes concentrações de OE (10 a 2.000 µg/ml). Partindo de inóculos de (OD_{640} = 0,1) o crescimento microbiano foi monitorado ao longo do tempo por leituras da OD a 640 nm. O parâmetro MIC foi considerado como sendo a concentração mínima de OE ou seu constituinte que determinada um ΔOD_{640} = 0 ao fim do 5º dia. A cicloheximida foi utilizada como controlo positivo. Dos quatros óleos essenciais testados o de *Melissa officinalis* seguido pelo de *Mentha piperita* foram o que foi o que proporcionaram resultados mais promissores contra *H. pylori*, *C. albicans* e *S. cerevisae*. A MIC do OE de *M. officinalis* foi de 500 e 1000 ppm para *C. albicans* e *S. cerevisae*, respetivamente e o do OE de *M. piperita* foi de 1000 ppm para ambos microorganismos. O OE de *M. officinalis* foi também o mais eficaz na inibição total do crescimento dos restantes microorganismos de contaminação alimentar com um MLC de 500 ppm.

Keywords: Microorganismos de contaminação alimentar, Óleos essenciais, Atividade antimicrobiana, Preservação de alimentos

Modelos cinéticos de degradación de color y polifenoles en extractos liofilizados y encapsulados de subproductos de pepino

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En la obtención de derivados de zumos de frutas y hortalizas, se obtienen subproductos que contienen compuestos bioactivos con propiedades beneficiosas para la salud, cuya vida útil puede alargarse mediante liofilización y/o encapsulación. En este trabajo se compararon los efectos de la liofilización y de esta seguida de encapsulación de extractos obtenidos de subproductos de pepino sobre el color y el contenido en polifenoles totales (PT) a diferentes temperaturas de almacenamiento, según sus cinéticas de extracción y/o degradación.

Los extractos de subproductos de pepino fueron liofilizados (EPL), encapsulados por atomización con maltodextrina (EPE) y almacenados a temperaturas diferentes (4, 25, 37 y 50ºC) durante 30 días. Se determinó la evolución del color mediante los parámetros CIEL*a*b* y se calculó la diferencia de color (ΔE^*). Además, se obtuvo el contenido en polifenoles totales (PT) espectrofotométricamente mediante el método basado en la reducción del reactivo Folin-Ciocalteu.

En los EPL, se observó que, para todas las temperaturas, existía un descenso en L*, un aumento de a* y una disminución leve de b*. La evolución de ΔE^* con el tiempo de almacenamiento se ajustó a un modelo cinético de pseudo-primer orden en dos etapas: una de aparición (orden cero) y otra de desaparición (primer orden) del color, siendo del tipo: $\Delta E^* = K[1-\exp(-kt)]$, donde K es la relación entre las constantes cinéticas de ambas etapas. Sus valores fueron 27.6 ± 3.8, 28.0 ± 3.6, 29.3 ± 2.6 y 35.8 ± 3.1 (u.a.), para 4, 25, 37 y 50ºC, respectivamente, lo que indica que la etapa formadora de color fue la predominante. En el caso de los EPE, los parámetros colorimétricos apenas variaron, lo que se asoció al efecto protector que la maltodextrina ejerce sobre los compuestos encapsulados. Con respecto a los PT, se aplicó el modelo exponencial del tipo $C_R = C_{R\infty} + (1-C_{R\infty})\exp(-kt)$, siendo las constantes cinéticas de degradación 0.063 ± 0.020, 0.119 ± 0.048, 0.120 ± 0.020 y 0.137 ± 0.050 h^{-1} para EPL y 0.236 ± 0.132, 0.070 ± 0.019, 0.057 ± 0.016 y 0.039 ± 0.010 h^{-1} para EPE, a las temperaturas de 4, 25, 37 y 50ºC, respectivamente.

Los modelos cinéticos propuestos describen de forma adecuada la evolución de ΔE^* y la degradación del contenido en PT. La ΔE^* y la degradación de PT es menor en los EPE que en los EPL, como consecuencia de la protección ejercida por la maltodextrina, y a bajas temperaturas en ambos casos.

Keywords: Modelos cinéticos, Color, Polifenoles, Pepino

Food Processing Technologies

Food Physicochemical Properties

Oral Communications

Cualificación de azúcar de sacarosa mediante nuevo método no destructivo de microscopia de fuerza atómica

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La sacarosa es el carbohidrato edulcorante cristalino de mayor comercialización a nivel mundial, sin embargo, para determinar su calidad solo existen métodos colorimétricos o de tamizado centrados en principios subjetivos, o métodos químicos destructivos y costosos. Esto hace necesario la búsqueda de alternativas para obtener estándares de cualificación de su calidad que además sean replicables. De esta forma, se planteó la medición nanotecnológica mediante microscopía de fuerza atómica (AFM) en cristales de azúcar, empleando un microscopio NaioAFM acoplado con una punta Budget Sensor ContactAI-G, en áreas de muestreo de 50x50 nm^2, valores nominales de frecuencia de resonancia de 190 Khz y constante elástica de 0,2 N/m para las caras de los cristales evaluados de sacarosa. Inicialmente se analizaron muestras de azúcar cristalizada en el laboratorio bajo diferentes condiciones y velocidades de cristalización, junto a la presencia de diferentes niveles de adición de minerales de caña (característicos de azúcar morena); posteriormente se evaluaron cristales de azúcar de tres marcas comerciales disponibles en el mercado en diferentes tipos y presentaciones existentes (azúcar blanca 500 g, azúcar morena 500 g, sachet 5 g). Así mismo, los resultados se compararon mediante pruebas químicas de cuantificación del ácido 3,5 dinitro salicílico (DNS) y de 9,10-dihidro-9-oxoantraceno (Antrona) como mecanismo de corroboración. Como resultado se encontró que el método propuesto por AFM si permitió observar y diferenciar características intrínsecas a la velocidad de cristalización, la conformación y la estabilidad estructural del cristal, y la interacción con los minerales procedentes del jugo de caña; parámetros que pueden ser definidas como estándares de cualificación. Específicamente mayor cantidad de irregularidades estructurales en la superficie y en las secciones del cristal de azúcar blanco se relacionó inversamente proporcional con el tamaño de cristal final en cualquiera de sus presentaciones; además se encontró que la presencia de minerales adheridos en el azúcar morena no afecta la cristalización o la estabilidad estructural del cristal en concentraciones inferiores a 7.5%, mientras que en concentraciones entre 7.5 a 12.5% reduce la velocidad de conformación del cristal hasta un 60% respecto al control sin minerales. En conclusión, los resultados encontrados mediante el método propuesto de AFM pueden incorporar una herramienta novedosa para el control de la calidad en la etapa de la cristalización del azúcar de caña a nivel industrial o del producto a nivel comercial de forma rápida, precisa y replicable sin la necesidad de emplear reactivos químicos o destruir la muestra.

Keywords: Nanotecnología, Cualificación, Conformación estructural, Cristalización

Control de la actividad proteolítica endógena en un sistema modelo de enzimas de trucha arcoíris (*Oncorhynchus mykiss*) y trucha de mar (*Salmo trutta*) con inhibidores enzimáticos de leguminosas

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Las proteasas es el nombre genérico de enzimas que hidrolizan las proteínas. En la tecnología de alimentos la proteólisis es empleada para modificar propiedades funcionales y nutricionales de los alimentos, y en algunos casos esta proteólisis puede provocar el deterioro del alimento. En general los alimentos de origen acuático como la trucha arcoíris y la trucha de mar tienen un acelerado proceso de descomposición una vez que se ha realizado su captura, debido a diversos factores como la actividad enzimática endógena que puede provocar la pérdida de estructura, forma y firmeza, además de la liberación de aminoácidos precursores de aminas biogénicas. Algunos estudios sugieren el empleo de inhibidores de proteasas de leguminosas y otras semillas como las oleaginosas y pseudocereales como reguladores biológicos de la actividad proteolítica. Los inhibidores enzimáticos son cualquier sustancia que reduce la velocidad de una reacción catalizada por una enzima. El objetivo de este estudio fue evaluar *in vitro* la reducción de la actividad proteolítica de extractos de enzimas endógenas de trucha arcoíris (*Oncorhynchus mykiss*) y trucha de mar (*Salmo trutta*) con inhibidores de proteasas obtenidos de las harinas de chía (*Salvia hispánica*), amaranto (*Amaranthus sp.*), garbanzo (*Cicer arietinum*), haba (*Vicia faba*) y soya (*Glycine max*). Se evaluaron diferentes proporciones de extractos enzimáticos de trucha arcoíris (75%, 50% y 25%) en combinación con extractos de inhibidores enzimáticos (25%, 50% y 75%) de chía, amaranto, garbanzo, haba y soya utilizando como sustratos para la fracción de enzimas ácidas la hemoglobina y para las básicas la caseína. Se utilizó la técnica de Kunitz para evaluar la actividad proteolítica especifica (APE) en los tratamientos evaluados. Se observó una diferencia significativa ($P \leq 0.05$) con la prueba de Duncan al comparar la actividad proteolítica específica de la fracción de enzimas básicas y ácidas en la trucha arcoíris. Los inhibidores de chía fueron los mejores en las condiciones experimentales evaluadas para reducir la actividad proteolítica específica (APE) de la fracción de enzimas básicas de la trucha arcoíris. Con los inhibidores de haba no se observó un efecto significativo sobre la APE en ninguno de los tratamientos evaluados. En el estudio con la trucha de mar los inhibidores de amaranto, garbanzo, haba, chía y soya tuvieron un efecto significativo ($P \leq 0.05$) sobre la reducción de la APE. Este efecto se observó sobre la fracción de enzimas ácidas al comparar el control y los tratamientos en todas las harinas evaluadas.

Keywords: Inhibidores enzimáticos, Proteínas, Proteólisis

Characterization of the antioxidant capacity of peptide fractions from cod blood and sardine cooking water, attained through membrane processing

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Several research groups have focused on the identification and extraction of natural bioactive compounds from fish by-products with bioactive representing an interesting group of compounds given their numerous physiological functions and their potential use as sources of nitrogen and amino acids (Harnedy, 2012). The potential for providing bioactive proteins and peptides makes fish by-products relevant for human nutrition and health management (Khora, 2013). Considering the arguments above, the present work aimed to characterize the antioxidant potential of peptide fractions attained from Sardine cooking wastewater (from the canning industry) and codfish blood (from the cod salting industry). The peptide enriched fractions were obtained using a molecular weight cut-off (MWCO) between 10 and 50kDa for cod blood and a molecular weight cut-off (MWCO) of 2.5kDa for sardine cooking wastewater. Fast protein liquid chromatography (FPLC) characterization of each fraction allowed the definition of the most interesting fractions to be targeted for functional properties. The final permeates from fishery by-products (sardine cooking wastewater and codfish blood) were characterized in terms of their antioxidant capacity using two methods: 2,2'-azino-bis 3-ethylbenzothiazoline-6-sulphonic acid (ABTS) and Oxygen Radical Absorbance Capacity (ORAC). The cod blood permeates, exhibited an antioxidant capacity 438.37, 354.87 and 419.10 µmol Trolox equivalent /mg of lyophilized powder by ORAC and 14.68, 11.63 and 17.34 mg of Ascorbic equivalents/g by ABTS methods in UP010, MW and PW membranes respectively. Cooking wastewater exhibited an antioxidant capacity of 63.42 µmol Trolox Equivalent /mg by using ORAC and 4.33 mg of ascorbic equivalents/g by ABTS methods in GH membrane.

Keywords: Fish byproducts, Bioactive peptides, Antioxidant activity

Food Processing Technologies

Food Physicochemical Properties

Poster Communications

Influence of the harvest time on the bioproduction of phenolic compounds of *Pereskia aculeata* Mill.

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The *Pereskia aculeata* Mill. belongs to the cactaceae family, is mainly consumed in the old mining regions of the state of Minas Gerais, Brazil, where it is well known as ora-pro-nobis, lobrobo and carne-de-negro. It is considered a native vegetable of high nutritional value, besides being a potential source of bioactive substances and possessing high protein value, similar to caruru (*Amaranthus viridis*), cabbage (*Brassica oleracea* L) and spinach (*Spinacia oleracea*). They are considered a nutraceutical species. The content of secondary metabolites can be affected by several factors, one of the main factors being the time the plant is collected, since the quantity and even the nature of the active constituents are not constant during the year. *Pereskia aculeata* Mill. leaves were harvested at January and September 2017 (respectively summer and spring seasons at South Hemisphere) at the Nontraditional Vegetables Bank, EPAMIG Prudente de Morais-MG (19° 28' 42" S, 44° 9' 27" W). The statistical design was completely randomized and the evaluations were done with six replicates and in triplicate. The total phenolic compounds content was determined by the Folin-Ciocalteau spectrophotometric method. The data were submitted to the t test at 5% probability. There was a significant difference between the two seasons ($p < 0.05$). The mean content of phenolic compounds was higher in spring (19.52 g GAE.100g^{-1} on dry matter) than in summer (11,08 g GAE.100g^{-1} on dry matter). This may have occurred due to a higher amount of rain in the summer and near the date of leaf collection, which decreased the production of the phenolic compounds, since the light incidence was lower. It is concluded that the harvesting time affects the content of phenolic compounds for *P. aculeata.*

Keywords: Bioactive compounds, Brazilian Nontraditional Vegetables, Ora-pronobis

Comparação da composição química de presuntos crus comercializados no Brasil

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Presunto cru é um produto cárneo curado típico de países europeus mediterrâneos. As características sensoriais do produto dependem principalmente das condições da matéria-prima e do processamento. Este trabalho avaliou a composição química e o teor de sódio de cinco marcas de presunto cru comercializadas no Brasil. Presuntos crus de cinco marcas (M1, M2, M3, M4 e M5) foram adquiridas em supermercado na cidade de São José do Rio Preto, Estado de São Paulo, Brasil. Para cada marca, cinco diferentes lotes foram adquiridos. Cada amostra foi triturada e homogeneizada para as análises. A composição centesimal de cada lote foi realizada em triplicata para umidade, gordura, proteína e cinzas, e o teor de sódio foi feito por digestão via seca. Todas as marcas diferiram entre si ($P < 0.05$) para o teor de gordura, que variou de 8.94 a 21.13%. As marcas variaram de 50.34 a 43.93% para teor de umidade e apenas M4 e M5 não diferiram entre si. Para proteína, as marcas variaram de 32.65 a 24.96% e apenas M2 e M4 não diferiram entre si. Estes resultados evidenciam uma heterogeneidade na composição de presuntos crus comercializados no mercado brasileiro. A legislação brasileira preconiza valores para o mínimo de proteína (27%) e máximo de gordura (20%) para este produto e, todas as marcas analisadas estão em conformidade, porém não existe limites fixados para o sódio. O teor de sódio apresentou variação de 2393 a 1645 mg Na/100g, mostrando grande variação entre as marcas, apenas as amostras M2 e M4 não diferiram entre si. A obrigatoriedade da comunicação visual por meio da rotulagem frontal de “esquema de advertência” e “semáforo” no qual os consumidores possam identificar os alimentos que contenham excesso de sódio ou algum outro nutriente estão sendo estudadas como estratégia para a escolha de produtos mais saudáveis pelos consumidores e órgãos reguladores, podendo ser uma alternativa para o aumento da produção e consumo de presuntos crus com menores teores de sódio em detrimento aos com teores mais elevados.

Keywords: Presunto cru, Sódio, Gordura, Rotulagem

Evaluación de Ocratoxina A (OTA) y propiedades fisicoquímicas en café de alto consumo en Colombia

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OBJETIVO: Cuantificar la OCRATOXINA A (OTA) y su relación con propiedades fisicoquímicas en cafés colombianos de diferente calidad y de alto consumo. METODOLOGÍA: Tres tipos de café tostado y molido del comercio de Medellín, café orgánico(A), excelso Premium(B) y estándar(C), fueron evaluados en las propiedades colorimétricas con método HunterLAB, densidad libre DL y compactada (DCP), porosidad estimada, tamaño de partícula (TP) y contenido de humedad, según Normas Técnicas Colombianas(NTC) 2441y 2558. Igualmente, actividad acuosa-aw por punto de roció con analizador-aw, pH según Chemists Association of Official Analytical. AOAC943.02, sólidos solubles (%SS) y extracción (%Ext) según NTC4602-1. Recuento de mohos y levaduras según AOAC 997.02 y cuantificación de OTA con metodología ELISA (Enzyme-Linked Inmunosorbent Assay), con método estandarizado de literatura científica revisada. Se aplicó análisis componentes principales con software Statgraphics Centurion-XVII. RESULTADOS: El contenido de OTA encontrado, fue de 0.87 0.00, 1.10 0.01 y 6.34 0.17 ppb para cafés A, B y C, respectivamente, siendo la muestra C, la de menor calidad, que en Colombia permite la presencia de granos defectuosos, mostrando un valor superior a los límites normativos colombianos, hasta 5ppb. Las muestras de café orgánico y excelso, están en el rango de seguridad según OTA. Según los componentes 1 y 2, que explican el 85.721% de la variabilidad, la variable OTA presentó correlaciones cercanas a 0,5 con TP y D, de 0.57con aw, lo que se podría asociarse con proliferación fúngica y disponibilidad de agua, en etapas tempranas del proceso, sin embargo, es importante mencionar que todas las muestras mostraron valores inferiores a 10UFC/g de mohos y levaduras en el producto envasado. Se observó correlación fuerte entre TP, DCP, %H, %SS, porosidad y %Ext. Los parámetros colorimétricos, L* a* y b*, mostraron altas correlaciones (0.74 a 0.78) y observó que los bajos valores de L*, (tostión alta-baja luminosidad) los mostró la muestra C, que puede considerarse de riesgo de inocuidad respecto a la presencia de OTA y contenido de compuestos de reacciones térmicas. Considerando la relación del nivel de calidad del café y la ingesta diaria tolerable de esta toxina, según los parámetros definidos por el Comité Mixto FAO/OMS de Expertos en Aditivos Alimentarios JECFA (14 ng/kg peso corporal/día), según el consumo de café en Medellín, se está exponiendo al consumidor a un riesgo en los niveles de OTA ingeridos. Los resultados reflejan la necesidad de continuar este tipo de estudios, que relacionen la calidad, el consumo de café y su inocuidad.

Keywords: Café, OTA, Propiedades fisicoquímicas, metodología ELISA

Aditivo antioxidante natural en polvo basado en extractos de yerba mate (*Ilex paraguariensis)*: estabilidad oxidativa sobre una matriz alimentaria real (mayonesa)

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Los polifenoles obtenidos por extracción etanólica a partir de yerba mate (*Ilex paraguariensis*) poseen importantes propiedades antioxidantes, útiles para la conservación de alimentos. Sin embargo, debido a su sensibilidad a factores ambientales y de proceso, es necesaria su encapsulación para incorporarlo como aditivo en polvo en matrices alimentarias. El objetivo de este trabajo fue evaluar la estabilidad oxidativa de una matriz alimentaria real (mayonesa) por la incorporación de un aditivo natural en polvo (liofilizado o secado por aspersión), obtenido a partir de extractos de yerba mate encapsulados.

Las hojas molidas de yerba mate (20 g) fueron sometidas a extracciones etanólicas (150mL) asistidas por ultrasonido a partir de yerba mate (YM) canchada estacionada (Misiones, Argentina), las cuales fueron mezcladas con maltodextrina en proporción 1:2 y posteriormente secadas por aspersión o liofilización. Se realizó una caracterización física de los polvos obtenidos (FTIR, SEM), química por contenido de fenoles totales (Folin-Ciocalteu) y estabilidad oxidativa (relación 1:1) en una matriz alimentaria real (mayonesa casera sin aditivos). La estabilidad oxidativa se definió como la diferencia en el tiempo que tarda la matriz alimentaria en disminuir un 10% la presión de oxígeno (700mPa y 120°C) comparada al control mayonesa sin aditivos.

Los resultados muestran que la banda de absorción típica de la YM (1044cm^{-1} asociado a -COH primario) no fue detectada por FTIR en presencia de maltodextrina-secado por aspersión, mientras que esta señal disminuye en las muestras maltodextrina-liofilización, evidenciando un mayor efecto protector al secar por aspersión. Esto fue corroborado por SEM, donde la estructura superficial es crucial para su funcionalidad; observándose una superficie homogénea semiesferica por aspersión y superficies no homogéneas, rugosas y porosas al liofilizar, independientemente de la presencia de maltodextrina. Por otro lado, se correlacionó el mayor contenido de polifenoles (mgGAE/g extracto puro) con la mayor estabilidad oxidativa (min) en la matriz alimentaria ($P_{Pearson}$=1) para ambos tipos de secado. El mayor efecto antioxidante en la matriz real fue obtenido con el aditivo YM-maltodextrina secado por aspersión (135±5mgGAE/g-304min) comparado con el aditivo encapsulado liofilizado (88±2mgGAE/g-157min) o el aditivo sin encapsular (51±2mgGAE/g-80min). En conclusión, el tipo de secado, así como la presencia del agente encapsulante (maltodextrina) son fundamentales para la incorporación de un aditivo natural antioxidante en polvo, el cual fue desarrollado a partir de la encapsulación de un extracto polifenólico a base de yerba mate y maltodextrina secado por aspersión para aumentar la estabilidad oxidativa de una matriz alimentaria real (mayonesa).

Keywords: Yerba mate, Estabilidad oxidativa, Matriz real, Liofilización y Secado por aspersión

Changes in physical properties of cow milk by the addition of cheese liquid whey and reconstituted powder whey

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The effect of the addition of cheese whey in the cow's milk is evaluated, liquid whey and the one reconstituted form the powder. Three physical properties were considered (density, freezing point, and refractive index), with the purpose of finding new alternatives to control this fraud. Samples of raw milk and milk with two types of whey added at five concentrations were prepared and analyzed at different temperatures between 5° at 40°C.

Proximal composition data show the dilution effect of the solids components of milk for the addition of whey. This is explain for the major content of water in whey (93%) with relation at in milk (88%).

Density are not appropriate indicator to identify or quantify the whey in milk, the changes are minimal and variable.

The freezing point is an adequate alternative for an early alarm of possible adulteration either with water or with whey. Is relevant to detach the linear relation and the high determination coefficient between whey added in volume percentage (W) and the freezing point (PC). The equation for the case of added liquid whey, is:

$(PC) = 0.0018\ W - 0.53$ $(R^2 = 0.995)$

With reconstituted powder whey:

$(PC) = 0.0016\ W - 0.53$ $(R^2 = 0.998)$

The inverse linear relationship between the refraction index and the quantity of added whey leads to the calculation of the specific refraction or Lorenz-Lorentz index, indicator that serves for the whey quantification as a milk adulterant up to 50% or more in volume, in independent form to origin or type of whey. The equation to calculate the percentage in volume of added whey is:

$n_s = -3.40\ (10^{-8})\ W + 2.091\ (10^{-4})$ $(R^2 = 0.968)$

In the equation (n_s) is the calculated value of specific refraction, based in data of refractive index at 40°C, and density values at the same temperature.

The methods used for the evaluation and control of whey in milk are little known and applied because they required expert people and specialized laboratories. It is expected that the proposed alternative will conduce to the normalization and the development of easy and fast methods to control the fraudulent action of mixing milk with cheese whey.

Keywords: Physical properties, Adulteration, Milk, Whey, Temperature, Specific refraction

Avaliação da solubilidade de sacarose, frutose e glicose em misturas de etanol e água, a 25 °C

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Uma alternativa para o reaproveitamento de bananas que seriam descartadas devido ao estágio de maturação avançado, é isolar os polissacarídeos não amiláceos (PNAs) com potencial uso como ingrediente funcional. Entretanto, para a sua obtenção é necessária a remoção dos açúcares solúveis, presentes em quantidades apreciáveis na fruta (aproximadamente 20 g/100 g de banana). Neste sentido, a extração sólido-líquido utilizando etanol hidratado como solvente pode ser interessante, pois apresenta baixa toxidade e extensiva produção no Brasil. O objetivo deste trabalho foi avaliar a solubilidade de sacarose, frutose e glicose em misturas de etanol e água, a 25 °C, obtendo informações sobre a transferência de massa destes compostos. Soluções modelo contendo sacarose, glicose ou frutose em excesso e solvente etanol e água nas proporções de 0, 5, 10, 15 e 20 g/100 g foram preparadas e mantidas a 25 °C. Para os sistemas contendo apenas etanol absoluto (99,5 g/100 g) como solvente, amostras foram coletadas por até 13 dias para a determinação do tempo para o estabelecimento do equilíbrio. Posteriormente, com base neste tempo, procedeu-se o estudo da solubilidade em função do teor de água no etanol. Em todos os ensaios, a massa de soluto dissolvido no sobrenadante foi determinada por secagem em estufa a 105 °C e 101 kPa. Através da análise estatística (teste de Tukey, $p>0,05$) dos sistemas contendo soluto e etanol absoluto, determinou-se que, em 24 h, o equilíbrio de fases foi alcançado, para todos os açúcares estudados. Independente do teor de água no solvente, a frutose apresentou a maior solubilidade, seguida pela sacarose e glicose. Maiores teores de água no solvente estão associados ao aumento da massa de soluto dissolvida no sobrenadante. Em números, a solubilidade de frutose, sacarose e glicose em etanol absoluto foi, respectivamente, igual a (1,42±0,05; 0,083±0,005 e 0,15±0,04) g/100 g de solução. Para o etanol contendo fração mássica igual a 0,2, os valores obtidos foram (27,6±0,1; 4,51±0,09 e 3,6±0,1) g/100 g de solução, respectivamente para frutose, sacarose e glicose. A adição de água no solvente aumenta a polaridade do mesmo e, consequentemente, a afinidade entre os açúcares e o etanol. Entretanto, neste estudo, elevados teores de água podem não ser interessantes ao processo, pois podem solubilizar também os PNAs. Desta forma, a utilização de etanol contendo frações mássicas de água próximas a 0,20 pode garantir a maior extração de açúcares sem perda apreciáveis de PNAs.

Keywords: Monossacarídeos, Dissacarídeos, Açúcar, Equilíbrio sólido-líquido

Caracterização de marcas comerciais de salame tipo italiano produzidas no Brasil

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O salame tipo italiano é um produto cárneo fermentado de considerável consumo no Brasil. Embora seja considerado fonte de proteína, este tipo de produto cárneo apresenta, tradicionalmente, alto teor de sódio. O objetivo deste trabalho foi determinar a composição centesimal de cinco marcas (A, B, C, D e E) de salames tipo italiano produzidas no Brasil e comercializadas na região de São José do Rio Preto – SP. As análises realizadas foram: umidade, proteína, gordura, cinzas e teor de sódio. Em relação aos resultados encontrados para umidade, somente a marca D ultrapassou o limite recomendado pela legislação brasileira (máximo de 35%). Em relação ao teor de gordura, somente a marca A apresentou valor médio maior que o limite legal (35%) e todas as marcas apresentaram valor mínimo de proteína (25%). Para teor de cinzas, os valores obtidos ficaram entre 5,26 a 6,56%. Para teor de sódio os resultados das médias foram 900,6; 808,6; 670,4; 629,0 e 947,4 mg de Na/100g de amostra para as marcas A, B, C, D e E, respectivamente, mostrando que há necessidade de um melhor entendimento da adição deste mineral, frente às diretrizes para redução de sódio de produtos cárneos, já que a maior média encontrada (947,4 mg de Na / 100g amostra) é 50% maior que a menor média obtida (629 mg Na / 100g amostra). Os resultados mostraram que houveram diferença significativa entre as marcas para composição centesimal. Mostrando que as marcas A e D necessitaria de ajuste de formulação e / ou processo para melhor enquadramento no regulamento técnico de salame tipo italiano.

Keywords: Produto fermentado, Composição centesimal, Teor de sódio

Development of quality index method (QIM) for whole meagre (*Argyrosomus regius*)

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Seafood are highly valuable sources of protein in terms of their nutritional values. However, due to the nutritional composition, quality losses occur rapidly during the storage. The spoilage of seafood can be assessed through the growth of spoilage bacteria (*Pseudomonas* spp., *Photobacterium phosphoreum*, lactic acid bacteria, etc.), the formation of chemical compounds (total volatile basic nitrogen (TVBN), thiobarbutiric acid reactive substances (TBARS)) and sensory changes. Many studies focused on rapid determination of the freshness of seafood often thru sensory analysis. The quality index method (QIM) is a simple and accurate method for the evaluation of sensory changes of marketed seafood. The development of QIM schemes comprises the determination of the quality attributes (e.g. appearance of eyes, color of skin, odor and color of gills) that change during (ice) storage. Consequently, a QI score is obtained as the sum of attributes' scores. In this study, a QIM scheme was developed for whole meagre during ice storage. Whole meagre was obtained from EPPO-IPMA and transferred to the laboratory at DEA-ISE UAlg in Styrofoam® boxes in ice. During transfer and later storage trial, temperatures in boxes and storage room were recorded using data logger. Initial observations regarding the changes in sensory attributes of whole meagre were performed by experts. Following the development of the draft scheme another set of specimens was used for training the panelists and test the draft scheme. For this, whole meagre was stored under constant (+4 °C) temperature. The final QIM scheme was thus obtained after testing the draft scheme under constant temperatures. For validation of the QIM, whole meagre were then stored under fluctuating temperatures. Of the 14 attributes that were considered in the draft QIM scheme, namely skin color, mucus clarity, muscle elasticity, belly firmness, odor of flesh, eyes appearance and shape, gills color-odor and mucus, peritoneum integrity, organs integrity and odor and finally fins appearance, three were excluded (peritoneum integrity and organs entireness and odor), thence 11 attributes were retained in the final scheme. The scores obtained using the final QIM scheme, tested under fluctuating temperatures, were linearly related to storage time (PLS-Regression, R^2=0.98). The shelf-life of whole meagre determined using the developed QIM was found to be 17-18 days under constant temperature and 13-14 days under fluctuating temperatures.

Keywords: Quality index method, Sensory scheme, Meagre, *Argyrosomus regius*

Análise físico-química e antioxidante do inhame (Dioscorea sp.) sob diferentes condições de processamento

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O inhame (*Dioscorea sp*.) é bastante cultivado para o consumo direto, sendo de grande importância socioeconômica no Brasil e cultivado em regiões de clima tropical e subtropical. A forma de consumo usada pela população é usando o processo de cocção. O presente trabalho objetivou ampliar o conhecimento físico-químico de *Dioscorea sp.,* verificando sua composição nutricional e ação antioxidante, a fim de se obter indicações de seu potencial nutricional para contribuir com a qualidade de vida da população. Também objetivou-se averiguar se o processo de cocção interferia nas características físico-químicas. Foram realizadas analises físico-químicas através de metodologias oficiais preconizadas na literatura, considerando-se o processo de cocção em diferentes intervalos de tempo (15 e 30 minutos): determinação de potencial hidrogeniônico (pH) foi feita com o pHmetro, acidez total por titulação, umidade por secagem em estufa e pesagem da matéria seca, análise de açúcar redutor pelo método de Eynon Lane, de proteínas qualitativas pelo método de Biureto, de ácido ascórbico pelo método de Tillmans, os solídos solúveis por ºBrix e os lipidios pelo método de Bligh e Dyer. A atividade antioxidante foi realizada através do método DPPH 0,1mM (1,1-difenil-2-picrilhidrazila). Observou-se que o processo de cocção não influenciou significativamente as analises de umidade, acidez titulável e pH. Porém, o processo de cocção afetou o teor de sólidos solúveis (*in natura* = 7,5 ºBrix, 15 e 30 minutos = 15 ºBrix) e o de açúcar redutor (*in natura* = 0,42 ± 0,01, 15 minutos de cocção = 0,69 ± 0,01 e 30 minutos 0,57 ± 0,01). Em relação ao teor de lipídeos e ácido ascórbico observou-se que quanto maior foi tempo de cocção menor foi o teor de lipídeos presente. Também verificou-se a presença de proteína em todas as amostras analisadas e foi observado um potencial antioxidante significativo tanto pela amostra *in natura* quanto a amostra submetida ao processo de cocção por 15 minutos, em todas as concentrações analisadas (1000, 100 e 10 μg/mL). Para a amostra *in natura* não houve diferença significativa na ação antioxidante em relação à concentração, enquanto que na amostra submetida à cocção por 15 minutos houve variação, isto é, 95,2% (1000 μg/mL), 90,5% (100 μg/mL) e 78,6% (1000 μg/mL). Conclui-se que o processo de cocção interfere nas características físico-químicas do inhame, mas mesmo assim o inhame pode ser considerado como fonte natural de compostos antioxidantes e nutrientes, os quais podem auxiliar na prevenção de doenças e proporcionar uma dieta balanceada.

Keywords: Cocção, *Dioscorea sp.*, Dpph, Dieta

Atividade Antioxidante de Hortaliças Convencionais Comercializadas em Campos dos Goytacazes/ RJ/ Brasil

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No corpo humano, a atividade metabólica normal produz constantemente radicais livres. Essas moléculas podem promover danos que contribuem para o envelhecimento e a instalação de doenças degenerativas, como câncer, aterosclerose, artrite reumatóide, dentre outras. Evidências epidemiológicas mostram, que existe uma inversa e forte correlação entre o consumo regular de frutas, hortaliças e a prevalência de algumas doenças degenerativas. A descoberta que as plantas possuem substâncias biologicamente ativas, que trazem benefícios para a saúde ou efeitos fisiológicos desejáveis, incentivou estudos sobre as propriedades antioxidantes. O presente trabalho tem como objetivo avaliar a capacidade antioxidante de três espécies de hortaliças convencionais: salsa (*Petroselinum crispum)*, hortelã *(Mentha lamiaceae*) e alfavaca (*Ocimum basilicum Lamiaceae*) comercializadas na cidade de Campos dos Goytacazes-RJ pelo método da redução do radical livre DPPH (1,1-difenil-2-picrilhidrazil) utilizando o Hidroxibutiltolueno (BHT) como padrão de antioxidante sintético. A análise da atividade antioxidante pelo método de DPPH consiste na adição do extrato em concentrações que variam de 0,1 - 1000 µg/mL, a uma solução metanólica de DPPH (0,1 mM), sendo a reação processada em 1h à temperatura ambiente. Imediatamente, a absorção do DPPH é verificada em 515 nm em um espectrofotômetro ultravioleta. Para a preparação das amostras, uma porção em torno de 2g de cada vegetal foi mantida, por 20 minutos, sob agitação permanente, em 100 mL de metanol à temperatura ambiente (28+- C) e, em seguida, filtrada. O resíduo foi novamente submetido ao processo de extração, acima explicitado, por mais dois períodos de 20 minutos, totalizando um tempo de extração de 60 min. Os filtrados resultantes foram combinados, evaporados e concentrados naturalmente. Após foi analisada a atividade antioxidante das amostras. Todas as amostras apresentaram atividade antioxidante, sendo que a hortaliça que apresentou maior capacidade de sequestro do radical DPPH foi a hortelã, que na maior concentração (1 mg/mL) exibiu um percentual de 61,8% de ação antioxidante, seguida da salsa (56,3%) e por último a alfavaca (53,2%). Porém, o percentual de ação antioxidante das amostras ainda é inferior ao antioxidante sintético BHT, o qual é amplamente empregado na indústria de alimentos. Conclui-se que as hortaliças convencionais podem ser consideradas como fontes naturais promissoras de compostos antioxidantes e o cultivo e consumo destas deveriam ser estimulados no comercio local, visto que os compostos antioxidantes fornecem benefícios à saúde. Ressalta-se que é necessário estudos mais aprofundados para identificar quais os compostos bioativos presentes nas amostras.

Keywords: *Petroselinum crispum*, *Mentha lamiaceae, Ocimum basilicum Lamiaceae*, Dpph, BHT

Influência da copigmentação de antocianinas com uso de ácido gálico no extrato de repolho roxo

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O mercado volta-se nesse momento para a elaboração de novos produtos que atendam às necessidades nutricionais e satisfaça o consumidor que está em busca de produtos específicos a sua dieta. A busca por produtos naturais, ricos em vitaminas e antioxidantes é uma das principais linhas de pesquisa e por isso o repolho roxo é apresentado como uma fonte natural rica em antioxidantes e que ainda pode oferecer subprodutos como o corante a base de antocianinas. Objetivou-se com essa pesquisa estudar a estabilidade das antocianinas e parâmetros colorimétricos dos extratos de repolho roxo formulados com ácido gálico em 4 concentrações (0,4, 0,6, 0,8 e 1 %) por um período de armazenamento de 15 dias, sendo as análises realizadas em triplicata a cada 3 dias (0, 3, 6, 9, 12 e 15 dias). Para obtenção dos extratos utilizou-se o método descrito por Nazaré et al. (2002), na proporção de uma parte de repolho roxo para duas partes de solvente. Para a formulação dos extratos submetidos à copigmentação, adicionou-se o ácido gálico em diferentes proporções e uma amostra pura. Desde o início do armazenamento (tempo zero) e a cada 72 h foi feito o acompanhamento da estabilidade dos extratos através da determinação de antocianinas totais e cor. A determinação de antocianinas foi realizada de acordo com o método descrito por Francis (1982), as leituras foram realizadas em espectrofotômetro a um comprimento de onda de 535 nm para absorbância. As características de cor foram avaliadas através de um espectrofotômetro portátil com obtenção dos parâmetros luminosidade (L*), intensidade de vermelho (+a*) e intensidade de amarelo (+b*). Os dados obtidos foram submetidos à análise de variância (ANOVA), teste de comparação de média de acordo com o teste de Tukey a 5% de probabilidade. Observou-se que os parâmetros de luminosidade e intensidade de amarelo apresentaram queda nos resultados no tempo final de armazenamento quando comparados ao tempo inicial. A intensidade de vermelho aumentou, especialmente na formulação 1% de ácido gálico, apresentando 42,38 no T0 e 46,06 no T15, um aumento de 7,99%. A concentração de antocianinas diminuiu ao longo do armazenamento. A formulação menos afetada foi a 1% de ácido gálico, onde no T0 apresentou 19,46 mg/100g e no T15 16,72 mg/100g, uma redução de 14,08%. Apesar da perda, as melhores concentrações na formulação foi em 1%. É válido dizer que, quanto maior a acidez da amostra, menor é o seu pH, favorecendo a intensificação da coloração e maior proteção dos compostos contra a degradação, o que explica maior percentual de aumento na intensidade de vermelho e menor perda na concentração de antocianinas na formulação com maior percentual de ácido gálico.

Keywords: Cor, Degradação, Antioxidantes, Bioativos

Physicochemical characterization of cocoa *(Theobroma cacao L)* during infrared roasting process

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In this study, the effect of the roasting process at different temperatures (100, 150 and 200 ° C) for high-quality cocoa was performed evaluating the water activity, moisture content, analysis by MDSC, TGA, GC -MS, FTIR, and BET. The samples were cryogenically groundTwo thermal phenomena were evidenced by MDSC: (i) fusion of fat (35 °C) and (ii) solvation (water and volatile compounds), this endothermic peak < 100 ° C for pan with hole and well above at 100° C in hermetic lid; as result of the effect of internal pressure, six times higher in hermetic conditions.

TGA showed that during the heating of the cocoa particles there is an evident loss of mass at different temperatures that, by means of the deconvolution of the signal of the curve -dm / dT, it was possible to determine 7 peaks, which correspond to different groups of chemical components present and generated during roasting. By means of FTIR, two high-intensity bands stand out in 2934 and 2852 cm^{-1}, corresponding to asymmetric and symmetric vibrations of the C-H group given by modifications in the alkenes, lipids and olefins caused by roasting, showing that the applied thermal process generated chemical reactions, water loss and volatile components that resulted in changes important in terms of the chemical composition of cocoa.

The initial total sugar content of the unroasted sample was 2.71% and decreased to 0.64% in the roasted sample at 200 ° C, in the same way that the content of reducing sugars also decreased with roasting, which shows the consumption of these components during the process, where the highest rate of loss of these was around 130 ° C, this is because the Maillard reaction between reducing sugars and amino acids is carried out by thermal action and are generating compounds Volatile intermediates such as pyrazines, furfurals, furans, aldehydes, ketones, melanoidins, etc.

By SPME and GC-MS, it was possible to identify volatile components, including acids, alcohols, aldehydes, and pyrazines. The heat treatment caused the generation of pyrazines, whose number increased in seven different isomers (200 ° C), which gives it a sweet taste and a chocolate aroma. Tetramethylpyrazine is the most relevant, which presents its highest concentration when roasted at 150 ° C, that is if 200 ° C is used it is probably volatilizing with higher speed due to the high temperature, therefore, when analyzing the material roasted solid was found a smaller amount.

Keywords: Infrared heating, Pyrazines formation, Thermal analysis, Chemical analysis

Thermal properties of the exopolysaccharide produced by *Mesorhizobium* sp. with different carbon sources

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Diazotrophic bacteria of the genus *Rhizobium* and *Mesorhizobium* present great potential to produce extracellular polysaccharides called exopolysaccharides (EPS). These polymers of high molecular weight are diverse in terms of their chemical structures and therefore have great industrial importance in the production of gels, emulsions and biofilms. The understanding of its thermal properties allows the detection of the temperature limits which the EPS can be submitted without its properties being compromised. The main goal of this work is to characterize the thermal properties of the EPS produced by *Mesorhizobium* sp. SEMIA 816 using different carbon sources (xylose, arabinose and glucose) in the cultivation medium. Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) were performed in order to verify the thermal behavior. From the analysis of the TGA curves it was possible to observe the variation of the sample mass during the temperature rise process. The DSC technique measures the energy difference delivered to the substance as a function of the temperature transition. A similar behaviour for the three samples was observed, where the exothermic degradation occurred in a single step and had its midpoint at temperatures of 290 °C for xylose, 275 °C for glucose and 290 °C for arabinose. The mass loss was 74, 70 and 64% for the EPS obtained from xylose, glucose and arabinose, respectively. These differences can be explained by the difference of molecular weight, structure and presence of different substituents in each EPS, considering that the carbon source can affect the biosynthesis. In relation to DSC analysis, an endothermic peak in the temperature of approximately 70 °C was observed for the three different carbon sources. This early peak can be attributed to the breaking of hydrogen bonds and the change of conformation of the double helices of the polysaccharide, while it happens the fusion of aggregates and the breakage of the network. Thus, the use of different carbon sources in the cultivation did not cause expressive differences in thermal properties. Both methods allowed the determination of thermal parameters that are important for the potential industrial applications of these polysaccharides.

Keywords: Bacterial polysaccharides, Differential Scanning Calorimetry, Thermogravimetric Analysis

Determinação de sódio e oxidação lipídica em bacon comercial

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O processamento do bacon envolve operações de adição dos ingredientes, homogeneização, cura e cozimento com defumação onde cada uma dessas etapas introduz características na matéria prima, exercendo forte influência sobre a qualidade final do produto. O bacon é um produto muito aceito pelos consumidores ao redor do mundo e suas vendas crescem 10% ao ano. Tal produto possui bastante gordura quando comparado a outros produtos cárneos, correspondendo aproximadamente a 56,31%. Em países industrializados, cerca de 80% do sal consumido é proveniente de alimentos processados. Dentro da categoria de alimentos processados, os produtos cárneos fazem parte daqueles alimentos que mais contribuem para o teor de sódio na dieta. Este estudo teve como objetivo comparar o teor de sódio e a oxidação lipídica (0 e 40 dias) em cinco marcas de bacon comercial tipo especial. As amostras comerciais de bacon foram adquiridas em supermercado local na cidade de São José do Rio Preto, São Paulo, Brasil e demarcadas como Amostra A, B, C, D e E. O teor de NaCl foi determinado por titulação em nitrato de prata, utilizando como marcador cromato de potássio (método de Mohr), e os resultados expressos em mg Na/100g de amostra. A oxidação lipídica foi avaliada a partir da análise de substâncias reativas ao ácido tiobarbitúrico (TBARS), e os resultados expressos em mg malonaldeído/kg de amostra. Foram encontradas diferenças significativas entre as marcas quanto ao teor de sódio, variando de 564 mg/100g a 1,984 mg/100g de amostra. A diferença foi de 1,420 mg/100g entre a marca com o maior valor para a de menor valor. No resultado inicial de oxidação lipídica (0 dia) todas as marcas obtiveram valores semelhantes entre 0,094 e 0,098 mg de malonaldeído/kg de amostra. Já para as análises após 40 dias, os resultados oscilaram de 0,190 a 0,229 mg de malonaldeído/kg de amostra. Constatou-se que as amostras com maior teor de sal apresentaram menor oxidação lipídica, evidenciando que as tentativas de redução no teor de sódio em bacon devem ser melhor estudadas pois o produto tem uma alta quantidade de gordura.

Keywords: Bacon, Teor de sódio, Oxidação lipídica

Caracterização do óleo de sacha inchi (*Plukenetia volubilis l.*) Quanto a composição em acidos graxos, índice de peróxidos e de iodo, acidez e capacidade antioxidante (frap, abts e dpph).

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Plukenetia volubilis L., Sacha Inchi, é uma planta da família da Euphorbiaceae que é encontrada normalmente em estado silvestre, originária da Amazônia brasileira e também da Amazônia peruana, alastrou-se pela américa central e Colômbia. É conhecida entre os nativos como amendoim da montanha, amendoim dos incas, ou simplesmente Sacha Inchi. Sua semente apresenta grande quantidade de ácidos graxos insaturados, sendo rica em ácido linolênico (C18:3), ou ômega 3. A carência de ácidos graxos ômega-3 em uma dieta alimentar cotidiana está associada a uma grande incidência de doenças, como processo inflamatórios, distúrbios cardiovasculares, infecções virais, distúrbios relacionados a imunidade e alguns tipos de câncer. Compostos como o ômega-3 também são chamados de compostos bioativos O objetivo deste trabalho foi analisar o azeite obtido da semente de Sacha Inchi, fazer sua caracterização e avaliar sua atividade antioxidante. Para a análise da atividade anti-oxidante foi utilizado os métodos de captura de radicais livres – ABTS e DPPH, e o método de poder de redução de metais FRAP. Para a caracterização do azeite foi determinada sua composição por cromatografia gasosa capilar (CGC Agilent 6850 Series GC System, Santa Clara, CA, USA), sendo as amostras preparadas na forma de ésteres metílicos de ácidos graxos de acordo com AOCS Ce 1f96 (1997), sendo estas separadas em coluna DB-23 Agilent Capilar. Foi determinado ainda o índice de iodo (Wijs) observando a metodologia proposta pela American Oil Chemists' Society - (AOCS), 1995. A determinação do índice de peróxido foi realizada observando a metodologia proposta pela American Oil Chemists' Society - (AOCS), 1990, conforme procedimento Instituo Adolfo Lutz, (2005), bem como a determinação do índice de acidez. A cromatrografia mostrou a presença de 45,51 ± 0,01 % de ácido linolênico (C18:3), 35,13 ± 0,02 % de ácido linoleico (C18:2), apresentando um total de 17 compostos lipídicos. O azeite apresentou índice de acidez, índice de peróxido e índice de iodo de 6,50 ± 0,14 (mg KOHg-1), 47,96 ± 2,22 e 1,73 ± 0,28 (meq, O2Kg-1) respectivamente. O FRAP, ABTS e DPPH apresentaram valores de 668,214 ± 0,122 ± 0,006, 164,444 ± 0,033 e 211,292 ± 0,067 respectivamente, todos expressos em µM Trolox por grama de azeite. O azeite apresentou grande quantidade de lipídios poli-insaturados, rico em ômega-3, e apresentou boa atividade antioxidante, o que o qualifica como produto ótimo para o consumo humano.

Keywords: Atividade antioxidante, Sacha Inchi, ômega-3, Ácidos graxos insaturados

Caracterização físico química de leite UHT zero lactose comercializado em aracaju, SE, Brasil

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Leite UHT é definido como o leite homogeneizado que foi submetido, durante 2 a 4 segundos, a uma temperatura entre 130 ºC a 150 ºC, diante de um processo térmico de fluxo contínuo, resfriado a uma temperatura inferior a 32 ºC e envasado sob condições assépticas. A intolerância à lactose é o termo habitualmente usado para descrever os sintomas expostos por pessoas que apresentam má digestão da lactose após ingerirem leite e derivados. O leite UHT com baixo teor de lactose é indicado às pessoas intolerantes a lactose, para que possam usufruir dos outros nutrientes presentes no leite. O objetivo deste trabalho foi avaliar as características físico-químicas de leite UHT zero lactose comercializados em Aracaju, SE, Brasil. Para isso, seis amostras de diferentes marcas foram adquiridas no comércio local e transportadas em suas embalagens originais até o laboratório Multifuncional do IFS, Glória para realização, em triplicata, das análises físico-químicas. Os resultados revelaram valores para análise de acidez titulável variando de 16 ºD a 18 ºD, valores de pH entre 6,6 a 6,8, considerados normais. Todas as amostras, apresentaram resultados satisfatórios em relação a estabilidade ao etanol de 68 °GL até 80 °GL, bem como para o de extrato seco desengordurado (ESD). Em relação a análise de crioscopia, verificou-se variações de -0,550 a -0,577 °H para as amostras de leite UHT zero lactose. Apesar do Regulamento Técnico de Identidade e Qualidade do Leite UHT não preconizar valores para densidade e proteínas, constatou que as amostras analisadas apresentaram-se dentro dos padrões estabelecidos pela legislação vigente de leite cru. Em relação ao teor de gordura, verificou que as amostras de leite UHT zero lactose apresentaram valores variando de 0,0 % a 2,1 %, sendo que a marca L4 não apresentou percentual de gordura. Contudo, todos os resultados apresentaram dentro dos padrões legais vigente, pois a rotulagem da marca L4 declarava que o leite era desnatado, enquanto as demais amostras declaravam que o leite era semidesnatado. Todas as amostras analisadas apresentaram ausência do teor de lactose conforme o método utilizado (Cloramina T). Conclui que todas as amostras de leite UHT avaliadas, apresentaram resultados satisfatórios em relação as análises físico-químicas realizadas e que esse monitoramento deste produto é de suma importância, principalmente em relação ao teor de lactose, pois a única garantia que o consumidor intolerante a lactose tem de que o leite está delactosado é a informação declarada pelo fabricante na embalagem.

Keywords: Qualidade, Tratamento térmico, Leite delactosado

Structure and physicochemical properties of octenyl succinic anhydride modified cañihua starch at different pH and reaction temperature conditions

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Cañihua grains (*Chenopodium pallidicaule*) represent an important starch source, with little known characteristics and properties. The objective of the project was to chemically modify native cañihua starch at two pH ranges (7.5-8.0 and 8.5-9.0) and three reaction temperatures (20, 30 and 40°C). Cañihua starch was esterified with octenyl succinic anhydride (OSA), at 3g/100g starch, in aqueous slurry systems. The following structural characteristics were evaluated after modification: degree of substitution (DS), morphology by scanning electron microscopy (SEM), X-ray diffraction and infrared spectroscopy (FTIR). Solubility index (SI) and swelling power (SP) at different temperatures (50, 70 and 90 °C) were also evaluated. The maximum degree of substitution, for each pH range (7.5-8.0; 8.5-9.0) at 40°C, were 0.0136 and 0.0187 with reaction efficiency of 60.07% ±1.76 and 80.68% ±2.84, respectively. Similar aggregates were observed in the micrographs for both modified and native starches. X-ray results suggested that OSA modification did not alter starch crystallinity index (26.2% ±3.3) or diffraction pattern (type A) and esterification occurred primarily in the amorphous regions. Two new absorption bands, 1570 and 1750 cm^{-1}, were found in OSA starches, evidencing incorporation of carboxyl groups in the starch chains. This incorporation altered the solubility index behavior and swelling power when compared to native starch. The swelling power values, for each pH range (7.5-8.0; 8.5-9.0) at 40°C, were 27.06 (g/g) ±2.26 and 25.01 (g/g) ±2.26 at a heating temperature of 90°C. The solubility index, for treatments with different pH range at 40°C, reached 60.07% ±3.06 and 36.37% ±1.15 respectively, at a heating temperature of 90°C. Better understanding on how modification conditions affect starch properties can lead to products with targeted macromolecular structures.

Keywords: Cañihua, Starch modified, Octenyl succinic anhydride, Degree substitution

Thermal analysis of gluten-free breads

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The staling phenomenon in gluten-free breads is still more pronounced than in breads made from wheat flour, and causes losses for both the industry and the consumer. The challenge is to find a formulation that minimizes the effects of this phenomenon and yields gluten-free breads with greater shelf-life. Differential Scanning Calorimetry (DSC) has been of great importance in the study of the loss of crystalline order during gelatinization and recrystallization of starch during bread staling. The enthalpy of dissociation can report the degree of crystallinity and estimate the intensity of starch retrogradation, a parameter directly related to the staling of bread. The objective of this study was to evaluate the potential of additives (monoglyceride emulsifier, guar and xanthan gums) and processing aid (maltogenic amylase enzyme) in reducing the staling of gluten-free breads. The breads were produced from a formulation based on rice flour, manioc starch and acidified and dehydrated albumin. From the previous optimization of the formulation, samples containing 0.25% monoglyceride (MG25), 0.25% guar gum:xanthan gum (GGX25), 200 ppm maltogenic amylase (AM200), an amylase-gum blend (GGXAM) and an amylase-gum-emulsifier blend (GGXMGAM) were produced and the evolution of starch retrogradation and the moisture contents of the crumb and crust were analyzed and related to the staling of the breads stored for 1, 5 and 10 days. As expected, migration of moisture from the crumb to the crust occurred in all the breads, but samples AM200 and GGXAM presented higher values of moisture in the crumb (43%) until the fifth day of storage. The retrogradation enthalpy changes of the crumb of the samples MG25, GGX25 and GGXMGAM were statistically higher than the control bread (3.38 J/g) during the storage period, reaching values close to 4 J/g. Meanwhile, the GGXAM sample presented the lowest enthalpy change value (3 J/g), followed by the AM200 formulation. Thus, the results show that amylase and gums were responsible for reducing starch retrogradation. The action of amylase is on the gelatinized starch granules during the baking stage, partially hydrolyzing starch; while gums retain water, contributing to greater moisture content in the crumb. A greater reduction in the trend of retrogradation was observed when 200 ppm of maltogenic amylase and 0.25% guar gum:xanthan gum were used.

Keywords: Gums, Enzyme, Emulsifier

Quantification of vitamin D3 in chitosan based suspensions using Raman analysis

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Vitamin D3 quantification is mainly performed via extraction and analysis in the High Performance Liquid Chromatography (HPLC). Raman microspectroscopy is a promising technique to evaluate the stability of this active compound over time without sample preparation. Therefore, this is an exploratory with the aim of evaluating the potential of Raman microspectroscopy to distinguish and quantify vitamin D3 in chitosan/vitamin D3 matrices. First, chitosan suspensions (2 mg.mL-1) with different vitamin D3 concentrations were prepared from 0.5 to 10.0 mg.mL-1. Vitamin dosage was performed by the conventional method (HPLC) and Raman spectra (3 spectra/sample in triplicate using RAMII, Bruker, excitation light 1064 nm, from 400 to 3500 cm-1, with the resolution of 5 a 9 cm-1) were collected in the freeze-dried sample pellets. Partial Least Squares (PLS) were used to correlate biochemical and spectral data (600-1800 cm-1) using the software OMNICTM e Turbo Quant Analyst™ v. 8.5.21 (ThermoFicher Scientific, Waltham, Massachusetts, EUA). A linear relationship is observed between HPLC and Raman results for vitamin D3 concentration. First analyses showed that Raman seems to correctly quantify vitamin D3 in chitosan suspensions (R2=0.97, Root Mean Square Error of Calibration - RMSEC = 0.18 and Root Mean Square Error of Prediction - RMSEP = 0.17) and the cross-validation coefficient was 0,92. Raman spectroscopy was used to evaluate the degradation of the vitamin as a function of temperature (60 min at 98oC) in encapsulated systems of liposomes coated with chitosan by ionic gelation using sodium tripolyphosphate as cross-linker (TPP-chitossomes). Vitamin-loaded TPP-chitossomes did not present degradation, compared to the control (non-encapsulated vitamins), confirming the potential of these particles in the encapsulation of vitamin D3, as indicated by Raman spectroscopy results. Since vitamins are lipophilic, they may bind to the apolar chain of phospholipids during vesicle formation, prior to coating with chitosan-TPP.

Keywords: *Salix* extracts, Metabolic inhibition, Membrane damage, Cell proliferation

Homemade versus industrial strawberry jam processing

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Homemade processed food has been more preferable than industrial food due to nutritional, environmental and social aspects. However, this statement is generalist and the evaluation of homemade processes is usually not considered. Strawberry jam is the best-selling in Brazil, so this study aimed to compare both, homemade and industrial process, according to process utilities, waste generation and quality aspects. It was evaluated the water consumption during strawberry cleaning and washing steps, and the energy used during concentration. Besides that, the anthocyanin, ascorbic acid and color were also evaluated. Homemade jams were prepared in different ways, using some fruit/sugar ratios, and different stove burner potencies. Pilot scale jams were made in our laboratory and industrial jam was acquired from industry (both with 50% of fruit), being all of them evaluated after process and during storage. The strawberry residues were 7.86±1.05% in September (season) and 11.61±1.69% in January (off season) for the homemade process, and 15% in the industry according to company information. The water consumption (liters/kg of strawberry) in household washing carried out by running water ranged from 9.5 to 20 depending on manipulator awareness, while the water consumption by simple immersion was 1.65±0.12; and the industrial process consumes 1.5. The energy consumption (kcal) per kg of evaporated water in the homemade jam was 2028±714 and it was 708±57 for the pilot plant and industrial process. In the conditions of 25°C and darkness both anthocyanin (k=0.0153 day-1) and ascorbic acid (k=0.0164 day-1) degradation followed a first-order degradation model for the industrial and laboratorial jams. The highest anthocyanins (97,65%) and ascorbic acid (83%) retention as well as the highest difference of color (30,14±4,42) in relation the raw material occurred in the jam with higher amount of sugar (50%) and shorter exposure to heat (20 minutes). The smaller anthocyanins (59,07%) retention occurred in the homemade jam with higher amount of sugar (50%) and highest exposure to heat (60 minutes) and it was significantly equal (p>5%) to the industrial simulated jam made in our laboratory. The best quality jam can be obtained by both, industrial and homemade processes, depending mainly on the heat exposure time. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

Keywords: Food processing, Quality, Energy

Caraterização físico-química de variedades exóticas de arroz

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O arroz (*Oryza sativa* L.) é um alimento base para grande parte da população mundial. Apesar de o rendimento ser um fator prioritário para os agricultores, as caraterísticas de qualidade do grão são da maior importância para o consumidor; estas são avaliadas tendo em vista não só o comportamento industrial mas também as suas propriedades nutricionais, organolépticas e culinárias. Nesse sentido, a qualidade do arroz comercial é aferida através de análises à sua composição química (proteína, gordura, cinza, amilose) e ao seu comportamento reológico (viscosidade das farinhas). A avaliação destes parâmetros, bem como a quantificação de compostos bioativos de relevância nutricional, é de particular importância para a monitorização das caraterísticas de qualidade do arroz e comunicação com e para o consumidor; por outro lado esta caraterização é um incentivo ao melhoramento e inovação do produto. O projeto Arroz-BIG, procura explorar a variabilidade destas caraterísticas, tendo em conta que estas variam de acordo com as variedades, condições edafoclimáticas e o processamento industrial.

Foi avaliada a variabilidade das propriedades físico-químicas de 6 variedades exóticas de arroz de diferentes origens, fornecidas pelo Banco de Germoplasma Internacional (IRRI) e selecionadas de acordo com a cor do pericarpo do grão. Na farinha de arroz branqueado caraterizaram-se os perfis de viscosidade pelo método AACC61-02.01; a quantificação do teor de amilose pelo método colorimétrico EN ISO 6647-2:2007 e a análise de proteína, gordura, fibra, humidade e amido total por espetroscopia de infravermelho próximo (NIR, Bruker). Foram ainda analisados os teores de γ-orizanol e ácido fítico por cromatografia líquida de alta resolução (HPLC) em farinhas de arroz integral.

O teor de amilose é um dos grandes diferenciadores entre variedades ($p<0,05$). As variedades Arabon e Ballatinao são do tipo 'waxy' (ceroso), com amilose próxima 2%, tendo as restantes variedades valores de 20% a 23%. Esta caraterística reflete-se, como esperado, nos valores obtidos para os perfis de viscosidade, também eles fonte de diferenciação ($p<0,05$). Na caraterização de composição, os valores mais relevantes, proteína e amido, apresentaram diferenças entre variedades ($p<0,05$), tendo a variedade Bora apresentado o menor valor de proteína (5,46g/100g) e o maior valor de amido (79,56g/100g). Relativamente aos compostos bioativos, não se encontraram diferenças significativas entre variedades ($p<0,05$) para o conteúdo de ácido fítico (0,15-0,72g/100g) enquanto que para os valores de γ-orizanol foram encontradas diferenças significativas ($p<0,05$). As variedades com maior teor de orizanol foram as de pericarpo púrpura (Ballatinao), com 34,32mg/100g e laranja (Dinorado) com 26,97g/100g.

Keywords: Arroz, Amilose, Viscosidade, Gama-orizanol, Ácido fítico

Efecto de la incorporación de pulpa de fresa en las propiedades fisicoquímicas, sensoriales y capacidad antioxidante de bebidas vegetales a base de horchata

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En la actualidad, se comercializan distintas bebidas vegetales a base de soja, arroz, almendra, etc. En la comunidad valenciana se elabora una bebida vegetal tradicional denominada horchata la cual se obtiene a partir de la chufa. Usando la horchata como base se han formulado bebidas vegetales con pulpas de frutas las cuales, permiten ofrecer una alternativa al consumo de este tipo de producto aportando nuevas propiedades a la horchata y haciéndola aún más nutritiva y saludable. En el presente estudio se pretende evaluar el efecto de la incorporación de pulpa de fresa en las propiedades fisicoquímicas, reológicas y sensoriales de bebidas vegetales elaboradas a base de horchata. Se han formulado y analizado tres bebidas vegetales a base de horchata con pulpa de fresa a distintas concentraciones, empleándose como muestra control la horchata. Todas las bebidas fueron caracterizadas mediante el análisis de pH, °Brix, color, reología y sensorial. Se determinó además la capacidad antioxidante mediante el método de DPPH con objeto de conocer sus propiedades como alimento funcional. El estudio ha permitido conocer la aportación de la fruta a la horchata en cuanto a su descenso de pH (desde 7.33±0.05 para la horchata a valores de 5.12±0.01), menor contenido en sólidos solubles (desde 18.43±0.06 hasta 14.63±0.06) y el aumento de su capacidad antioxidante (de 36±2 mg E Trolox/100mL en la horchata hasta 98±2 mg E Trolox/100mL). La pulpa de fresa incorporada, en los niveles de concentración ensayados, aporta a la horchata su color y aroma característicos. El análisis sensorial realizado mostró una muy buena aceptación del producto por parte del consumidor.

Keywords: Horchata, Capacidad antioxidante, Sensorial

Influencia de la zona de cultivo de Theobroma cacao L., variedad ccn-51, en las propiedades químicas del grano y reológicas del licor

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La región de San Martín, en Perú, se ha convertido en una región productora de cacao; las áreas cultivadas, específicamente de la variedad CCN-51, se están incrementado, por ser una variedad de maduración rápida, cualidad apreciada por el agricultor. El conocimiento de la influencia de la zona de cultivo (altitud, tipo de suelo) en las características químicas del grano y reológicas de licor de cacao favorecerá el desarrollo de la industrialización de este insumo. Los objetivos del presente trabajo fueron: 1) Determinar la influencia de cuatro zonas de cultivo (Mariscal Cáceres, San Martín, Lamas y Huallaga) en la composición proximal del grano de cacao, variedad CCN-51 y 2) Determinar la influencia de la zona de cultivo y la temperatura (60, 70 y 80 °C) en las propiedades reológicas de licor de cacao, variedad CCN-51. Las muestras fueron recolectadas, fermentadas, secadas y tostadas (análisis proximal); luego fueron descascaradas y fue obtenido el licor (pruebas reológicas). Se plantearon dos diseños experimentales: un diseño de Bloques Completo al Azar (DBCA) (4 x 3), considerando cuatro pisos ecológicos o zonas y tres áreas de muestreo (bloques), cada ensayo fue realizado por triplicado, totalizando 36 ensayos. Para el análisis reológico el diseño experimental utilizado fue un DCA con arreglo factorial, 4 x 3 x 3, (4 zonas de cultivo, 3 áreas de muestreo y 3 temperaturas), cada experimento se realizó por triplicado, totalizando 108 ensayos. Para el estudio reológico, los datos de esfuerzo de corte) versus velocidad de corte ($\dot{\gamma}$) fueron obtenidos con un viscosímetro BROOKFIELD, RVDV-III ultra, spindle SC–18 y fueron ajustados a la ecuación de Herschel-Bulkley. El análisis de varianza (ANVA) indicó que el contenido de cenizas y de proteínas en el grano de cacao fue influenciado en forma significativa ($p < 0.05$) por la zona de cultivo; por otro lado, la zona de cultivo y el lugar de muestreo influenciaron significativamente ($p < 0.05$) en el contenido de grasa bruta en granos de cacao. Así mismo, el análisis de varianza para los parámetros de la ecuación de Herschel-Bulkley indicó influencia significativa ($p < 0.05$) de las zonas de cultivo en el esfuerzo umbral (τ_0) e índice de consistencia (K), empero, el índice de flujo (n) fue influenciado significativamente ($p < 0.05$) por la zona de cultivo y el lugar de muestreo. Este resultado fue correlacionado con el análisis de suelo y la altitud de la zona de cultivo.

Keywords: Licor de cacao, Ecuación de Herschel-Bulkley, Análisis proximal de grano de cacao

Desarrollo de horchatas de chufa con sabor a cacao: caracterización de las propiedades fisicoquímicas y sensoriales

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La horchata de chufa es una bebida vegetal tradicional en la Comunidad Valenciana que se caracteriza por ser nutritiva y energética. A diferencia de otras bebidas vegetales y/o batidos donde existe una gran variedad de sabores a café, chocolate o fruta, la horchata sigue consumiéndose en su sabor original. El objetivo de este trabajo es desarrollar nuevos productos tipo batido con sabor a chocolate utilizando horchata como base. Se formularon 20 bebidas distintas añadiendo a la horchata cacaos en polvo (natural y alcalinos) a diferentes concentraciones (0.5 – 3%). Todas las bebidas se caracterizaron en cuanto a sus propiedades fisicoquímicas y sensoriales. Los resultados del estudio muestran que la adición de cacao aporta sólidos solubles, modifica el color y el pH, incrementa ligeramente la viscosidad, pero no modifica el comportamiento reológico de las muestras. La horchata tiene un pH de 7.27±0.02. Este valor es intermedio entre el del cacao natural (N) (5.45±0.05) y el del cacao alcalino super fuerte (ASF) (7.86±0.0). Tras elaborar horchata con los diferentes cacaos al 3% el valor de pH de la horchata disminuyó cuando se usó cacao natural (6.64±0.02) y aumentó al añadir cacao alcalino super fuerte (7.973±0.006). De la misma manera, la adición de cacao aportó sólidos solubles pasando éstos de 18.7±0.1 ºBrix en la horchata a 20.2±0.1 en horchatas con cacao al 3%. El color también se modificó, según el tipo de cacao y la concentración del mismo. De esta manera, mientras que los valores de L* y C* descendieron desde L=68.9±0.2a hasta L=17.5±0.3 (ASF 3%), y desde h*=84.1±0.1 hasta h*=41.2±0.6 (ASF-3%), los valores de C* se incrementaron desde 11.8±0.2 hasta 19.83±0.07 (N 3%). Los valores de viscosidad de la horchata (0.0035 ± 0.0002 Pa.s) fueron similares a los de la horchata con un 0.5% de cacao. La adición de porcentajes mayores de cacao en polvo provocó un aumento estadísticamente significativo ($p<0.05$) de la viscosidad del fluido, alcanzando un valor de 0,0048 ± 0,0003 en AS (3%), pero no modificó el comportamiento reológico de las muestras. A su vez, la introducción de cacao incrementó significativamente el poder antioxidante de las muestras, pasando de 36.7 mg E Trolox/100mL en la horchata a 342.0±5.3 mg Trolox/100mL en horchata con 3% de cacao natural y contribuyendo a mejorar su perfil funcional. A nivel sensorial, los productos son aceptables (puntuación de 5±1.5 en una escala 1-7), siendo las formulaciones mejor valoradas aquellas preparadas con un 3% de cacao natural.

Keywords: Horchata, Cacao, Propiedades fisicoquímicas, Reología, Capacidad antioxidante, Sensorial

Características nutricionales de una hamburguesa de carne y verduras con cocción al vacío

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Se desarrolló una hamburguesa de carne y vegetales envasada y cocinada al vacío, con el fin de obtener un producto de características nutricionales mejoradas. El producto desarrollado presenta un menor contenido graso y de sodio con un aporte importante de fibra comparada con una hamburguesa comercial.

Introducción

Las frutas y las verduras son componentes esenciales de una dieta saludable, y un consumo diario suficiente podría contribuir a la prevención de enfermedades importantes, como las cardiovasculares y algunos cánceres. Actualmente se ha visto que la población busca alimentos saludables y prontos para consumo, es por este motivo que se planteó desarrollar una hamburguesa de carne y vegetales envasada y cocida al vacío, lista para ser consumida. La principal ventaja de la cocción al vacío es la extensión de la vida útil, mientras que la incorporación de verduras proporcionaría un aporte importante de fibra y otros nutrientes.

Materiales y métodos

Se elaboró una hamburguesa de carne vacuna, zanahoria, manzana, cebolla, avena, chía, orégano y sal. Se mezcló la materia prima hasta obtener una pasta homogénea. La mezcla se moldeo con un tamaño de 10 mm de espesor 105 mm de diámetro y se selló en una plancha a 250ºC durante 1 minuto de cada lado. Se envasó al vacío y se realizó la cocción en baño de agua a 60ºC durante 90 minutos. Se enfrió rápidamente y se llevó a refrigeración durante 24 horas hasta realizar los ensayos fisicoquímicos. Se analizó en simultaneo una hamburguesa de carne vacuna preparada con cocción tradicional en plancha, con una temperatura de 250 ºC durante 8 minutos de cada lado, tiempo para alcanzar una temperatura interna de 73ºC, para asegurar la inocuidad microbiológica.

Resultados

Parámetros nutricionales	Hamburguesa de carne y verduras	Hamburguesa comercial
Lípidos	5,9%	14,8%
Proteínas	25,5%	23,5%
Carbohidratos	2,9%	0%
Fibra	5,9%	0%
Sodio	2349 ppm	5251 ppm

Conclusiones

Se desarrolló una hamburguesa con menor contenido de grasa y sodio y mayor contenido de fibra que una hamburguesa comercial de carne preparada con cocción tradicional.

Keywords: Hamburguesa, Vegetales, Nutrición

Elaboração e caracterização físico química de bebida gaseificada a base de soro lácteo, sabor uva

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Com o aumento da produção de queijos no Brasil, alternativas que reduzem os impactos causados pelo soro tornam-se necessárias. Por outro lado, o refrigerante destaca-se como um dos alimentos líquidos mais aceitos pelos consumidores apesar de causar efeitos indesejáveis à saúde humana. Entretanto, verifica-se que o hábito alimentar da população e a busca por produtos saudáveis, inovadores, seguros e práticos tem aumentado. O objetivo deste trabalho foi elaborar e avaliar as características físico-químicas de bebida gaseificada, sabor uva. Para isso, o soro lácteo obtido da fabricação de queijo coalho nas concentrações de 35%, 50%, 65% e 80% foram adicionados de 7% de açúcar, 7% de polpa da uva concentrada e água mineral necessária para completar 100%. Em seguida, as formulações foram submetidas ao tratamento térmico (80 ^{o}C/ 10 min) e resfriadas a 10 ^{o}C por 12 horas. Posteriormente, realizou o processo de gaseificação (Sodastream), envase e armazenamento até a realização das análises. ANOVA e teste de Tukey ($p \leq 0,05$) foram realizados. Os resultados obtidos demonstraram que as amostras não apresentaram diferenças estatísticas para análise de pH na qual variaram de 8,28 a 8,30. Em relação, aos sólidos solúveis, somente a amostra elaborada com 50% de soro diferiu significativamente ($p \leq 0,05$) das demais amostras revelando o menor valor (15,40 ^{o}Brix), sendo que o maior valor obtido foi de 18,00 ^{o}Brix. Igualmente, constatou-se que a amostra elaborada com 50% de soro diferiu estatisticamente das demais amostras apresentando o menor valor para análise de resíduo seco (16,50 mL/100mL), permanecendo o maior resultado com valor médio de 18,99 mL/100mL. A análise de acidez titulável foi a que apresentou maior variabilidade entre as amostras, na qual a amostra elaborada com 80% de soro de lácteo apresentou o maior índice de acidez (0,59 g de ácido tartárico/100mL) diferindo significativamente das demais concentrações. Entretanto, a amostra elaborada com 50% de soro de leite foi a que apresentou estatisticamente o menor valor para acidez (0,48 g de ácido tartárico/100mL), não diferindo da amostra de 35% de concentração (0,49 g de ácido tartárico/100mL). A amostra elaborada com 65% de soro lácteo, apresentou acidez titulável de 0,50 g de ácido tartárico/100mL, não diferindo estatisticamente também da amostra elaborada com 35% de soro. Conclui-se que todos os resultados obtidos nas análises físico-químicos apresentaram dentro dos padrões estabelecidos pela legislação vigente e que a bebida gaseificada de soro de leite, sabor uva, apresenta potencial de comercialização e diversificação nos derivados lácteos com baixo impacto ambiental.

Keywords: Soro de leite, Novo produto, Gaseificação

Elaboração e caracterização de doce dos frutos da gabiroba (camponesa cambodia) com substituição da pectina comercial por albedo de maracujá

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Frutos como a gabiroba (*Camponesia cambessedeana*) são catalogados como fonte de compostos com propriedades funcionais que geram benefícios à saúde, estimulando seu uso pela indústria e exigindo pesquisas acerca de sua caracterização, processamento e viabilidade de inserção na alimentação humana através do desenvolvimento de novos produtos. O objetivo deste trabalho foi o aproveitamento do fruto gabiroba na forma de doce com substituição da pectina comercial por albedo de maracujá, bem como a caracterização físico-química tanto do fruto *in natura* quanto do produto processado. Os frutos foram obtidos do cerrado brasileiro, na cidade de Goiânia-GO, e selecionadas de acordo com o estado de maturação e conservação. Para a caracterização dos frutos coletados foram realizadas as seguintes análises: composição centesimal, pH e acidez total titulável. Para o processamento do doce foi utilizado com planejamento fatorial completo 2^3, que tem por finalidade avaliar a influência de três fatores como a concentração de ácido cítrico, a razão polpa/açúcar e a concentração do albedo. Os doces produzidos foram avaliados em relação ao seu teor de açúcares redutores e totais, rendimento, sólidos solúveis, pH e acidez. O valor médio de umidade da polpa de gabiroba foi de 79,83%; o teor de lipídeos encontrado foi de 1,09%; 1,29% de proteínas; 4,09% de fibras totais; 0,47% de cinzas e 13, 23% de carboidratos. Já os valores de pH e acidez titulável foram de 3,47 e 0,183% respectivamente. Verificou-se que a polpa de gabiroba tem um valor de pH elevado para a obtenção de doces. O pH ótimo para a formação de gel é de 3,0 a 3,2 e, quando o pH do suco de frutas é elevado, é necessária a adição de ácido, para a obtenção de geleia. Todos os doces de gabiroba produzidos obtiveram o teor de sólido solúveis de acordo com os padrões exigidos pela legislação para doce de corte, 74ºBrix. Dentre as onze formulações, a que teve o maior teor de açucares redutores foi a com 1% de ácido cítrico, razão polpa/açúcar 40/60 e 3% de albedo com 26,27% de açúcares redutores. A formulação com 1% de ácido cítrico e razão polpa/açúcar 40/60 se destacou com 70,90% de açúcares totais e rendimento de 71,50% na sua produção. O pH dos doces variaram entre 4,2 e 5,4 e a acidez titulável entre 3,15 e 15,19% v/m. A gabiroba apresentou-se adequada para o seu aproveitamento na produção de doces, sendo que estes tem características físico-químicas desejáveis.

Keywords: Doce, Gabiroba, Caracterização

Caracterização físico-química do abacaxi pérola (*Ananás comosus*) e da pimenta dedo-de moça (*Capsicum baccatum* var. pendulum) para a elaboração de um condimento alimentício picante

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O Abacaxi Pérola (Ananás comosus) fruto típico do Brasil, conhecido por suas características sensoriais peculiares e marcantes, rico em vitaminas, sais minerais e bromelina que o torna um fruto com grande potencial alimentício e farmacológico sendo utilizado de diversas formas tanto para consumo in natura quanto na industrialização. As pimentas do gênero Capsicum estão dominando o comércio de especiarias picantes no mundo, aproximadamente um quarto da população mundial consome este tipo de pimentas nas formas in natura ou processadas, excelente fonte de antioxidantes naturais, capsianoides carotenoides e compostos fenólicos. A importância das especiarias na vida humana é grande, elas não apenas enriquecem o sabor dos alimentos como podem influenciar na fisiologia e bioquímica humana. Neste contexto, o objetivo deste trabalho foi à caracterização físico-química do abacaxi (Ananás Comosus) e da pimenta dedo-de-moça (Capsicum baccatum) para a formulação de um condimento alimentício picante. Os frutos foram adquiridos nos mercados da cidade de Palmas/TO, e encaminhados ao Laboratório de Cinética e Modelagem de Processos da UFT. As avaliações físico-químicas seguiram as metodologias preconizadas pela AOAC, seguindo um planejamento experimental de sete repetições em triplicata. Os frutos foram submetidos a determinação de pH onde o abacaxi apresentou uma maior acidez (4,61) a pimenta apresentou-se mais neutra (5,82), acidez titulável de 7,8 e 7,9 respectivamente, teor de sólidos solúveis totais (13,75 e 9,9°Brix). O abacaxi e a pimenta apresentaram teor de umidade semelhante (83%), os valores de lipídios, fibras e cinzas para o abacaxi foram 0,46%, 3,9%, 63%, para a pimenta estes valores ficaram em 1,64%, 24, 58%, 57%. Os valores encontrados de vitamina C foram 35,85% no abacaxi e 42,61% na pimenta. Para determinação da atividade antioxidante utilizou-se o método DPPH e o valor encontrado foi 0,051mg/ml e 0,072mg/ml para o abacaxi e pimenta respectivamente. No parâmetro cor para o abacaxi, L* foi de 51,23 e (*H) 106,11 considerada alta, tendendo para o amarelo, para a pimenta L* (25,41) e *H (51,80) tendendo para o vermelho. A qualidade do perfil fotoquímico e físico-químico, dos vegetais e frutos em particular, varia em função do tipo, variedade e grau de maturação da fruta, bem como das condições climáticas e eficácia do cultivo.

Keywords: Condimento, *Ananás comosus*, *Capsicum baccatum*

Avaliação optica de emulsões na produção de micropartículas de óleo de pequi

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O pequi é um fruto muito rico em óleo, proteínas, vitamina A e carotenóides. O óleo é considerado de excelente qualidade, pois em sua maior parte está constituído por ácidos graxos insaturados. Entretanto, a exposição dos carotenóides ao calor, ao oxigênio, à luz, ar e umidade pode causar mudanças estruturais, reduzindo assim sua atividade como vitamina e antioxidante. Diante disso o processo de microencapsulção é uma alternativa de proteção para estes compostos sensíveis a oxidação. Assim, o objetivo deste trabalho foi verificar o efeito da temperatura sobre a medida quantitativa da absorção da luz da emulsão formulada com maltodextrina, amido modificado e goma arábica, para a produção de microcápsulas de óleo de pequi. O óleo de pequi foi adquirido no mercado central de Belo Horizonte. A emulsão com total de sólidos de 10 % p/p foi preparada com o óleo de pequi (10 % dos sólidos) e material de parede (90 % dos sólidos) que se constitui de uma mistura de polímeros contendo as seguintes proporções: 25 % de goma arábica, 50 % de amido modificado e 25 % de maltodextrina. A medida quantitativa da absorção da luz da emulsão foi avaliada através de espectrofotômetro com UV-visível (SHIMADZU), e as medidas foram feitas ao longo do tempo obtendo-se as absorbâncias a cada 15 minutos sob uma temperatura fixa de 25 °C. As leituras foram feitas em um comprimento de onda de 600 nm, sendo o branco a água destilada. Mediante análise de espectrofotometria, foram encontradas as seguintes absorbâncias: no tempo zero obteve-se uma absorbância igual a 3,0; Após 15 minutos a absorbância permaneceu constante; no decorrer de 30 minutos, a absorbância começou a apresentar um decréscimo mínimo (abs=2,921); corridos 45 minutos obteve-se uma absorbância igual à 2,886, e após uma hora encontrou-se valor de 2,854. O declínio da absorbância em função do tempo pode ser explanado à separação das partículas contidas na emulsão. Porém, pode-se inferir que a emulsão se apresentou estável, uma vez que nos primeiros quinze minutos não houve variação na absorbância e, a partir de então obteve um declínio desprezível e a emulsão avaliada se apresentou favorável ao encapsulamento.

Keywords: *Caryocar brasiliense*, Spray-dryer, Absorbância

Contenido de cadmio en suelos, frutos, granos fermentados, licor de cacao y chocolate en zonas productoras de la región San Martín

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La presencia de metales pesados en cacao es un serio problema para cacaoteros de varias regiones del país, entre ellas San Martín. En el presente trabajo fue evaluado el contenido de cadmio en suelos, hojas, almendras frescas (testa y embrión), almendras fermentadas secas, licor de cacao y tabletas de chocolate con 70% de cacao, de dos (02) provincias (Bellavista y Huallaga) y 5 localidades (3 en Bellavista y 2 en Huallaga) de la Región San Martín. El contenido de cadmio se determinó con espectrofotómetro de absorción atómica, utilizando muestra filtrada obtenida de 0,5 g de muestra seca y 5 ml de solución nítrica perclórica, previa digestión; ensayos realizados en laboratorios de la UNSM-T. Los valores máximos obtenidos para contenido de cadmio (ppm) fueron: en suelos, 0,960; en hojas 0,780; en testa y cotiledón 0,098; en almendras fermentadas y secas 0,075; en licor de cacao, 0,210; en tabletas de chocolate al 70% de cacao 0,625. El coeficiente de correlación (R^2) para almendras fermentadas y secas, indica que no existe diferencia significativa entre zonas, mientras que en licor de cacao la muestra de Tingo de Saposoa fue estadísticamente diferente ($p<0,05$), estando todos los valores por debajo del máximo permisible. El incremento del contenido de cadmio en chocolate, respecto al licor de cacao, puede deberse a los ingredientes complementarios (leche, panela) o al equipo de procesamiento utilizado.

Keywords: Cadmio, Cacao, Espectrofotometría absorción atómica

Consumers' perception toward rice and rice with low glycemic index: inputs for the development of a new rice product

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Current consumption trends, especially those dictated by health and well-being, have been influencing the consumption of rice. Portugal has the largest rice consumption rate in Europe, with 21.3 kg/capita/year and the highest prevalence of diabetes in Europe. Thus, under the scope of the research project ArrozBIG and with the objective of developing a rice product with a low glycemic index (GI), this qualitative study aims to evaluate the consumers' associations with rice and rice products with low GI, through the application of a projective free word association methodology. To evaluate this conceptualization, two stimulus words, "rice" and " rice with low GI" were used. A total of 256 individuals (64% female), aged 18-73 years (40 ±12.8), residing in the Great Porto area were surveyed. The response words were screened and categorized following triangulation. The frequency of the words/categories was counted, and chi-square test of independence was used to determine if there is a significant relationship between the emergent categories and the sociodemographic characteristics. Nutrition and health categories were common to all stimuli, evidencing practical perception of the satisfaction of biological needs. A sensory related category was also built for all stimuli showing how important these attributes are even for foods with a major functional character. "Rice" and "rice with low GI" differed in the "convenience" evoked only in the first stimulus, and in the "naturalness" and "lack of knowledge" found in the second one. The "naturalness" category may be seen as a desired requirement in the product. Sex, age, and education influenced the association's nature, with income and household size less expressive. "Rice with low GI" is seen as innovative and interesting, associating hedonic and acceptance terms. These results are important to assist in the planning and design of this new product, enclosing consumer's perception.

Keywords: Consumer conceptualization, New product development, Rice, Rice with low glycemic index, Word association

Impact of the application of vegetable proteins and yeast extract in the chemical and aromatic profile of red wine

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Fining wines are used to ensure the physicochemical stability and prevent the formation of hazes and deposits. Several fining agents (gelatin, isinglass, bentonite, etc.) are used by winemakers. These products are animal proteins or of mineral origin. However, some strict vegetarians do not accept any beverage treated with products of animal origin. Consumers requirements have given origin to new alternatives to these products, such as proteins of plant origin and yeast extracts.

This work aimed to evaluate the effect of four fining agents, two vegetable proteins [pea protein and patatin, a protein extract from potatoes (*Solanum tuberosum*)], one yeast extract and one gelatin, on phenolic composition, volatile composition and sensory profile. The fining agents were used at the minimum (D1) and maximum dosages (D2) suggested by the respective technical sheet. Unfined wine was used as a control (D0). The red wine 2015, was produced in the Escola Superior Agrária de Santarém winery, in Tejo region. The wine is a blend of Tinta Roriz, Syrah and Alicante Bouschet.

Total phenolic Index (IPT), total anthocyanins (Ant) and total tannins (Tan), colour intensity (CI) and hue were determined according the International Organization of Vine and Wine (OIV). The turbidity was also evaluated. The analysis of the volatile compounds was done by GC-MS and the sensorial analysis was performed by five expert panellists, members of the 'Comissão Vitivinícola Regional of Tejo (CVRTejo)'. The attributes of the wine, corresponding to the visual (limpidity and colour), nose (typicity, intensity and quality) and taste senses (typicity, intensity, persistence and quality, as well as the harmony (overall judgment).

According the results obtained, the vegetable proteins and the yeast extract used did not influence the wine phenolic composition: IPT (60,04±2,735), Ant (443,96±22,32 mg/L), Tan (3034,33±189,89 mg/L), CI (10,54±0,47), Hue (0,711±0,017). However, the tannin content decreased in fining wines (untreated wine 3178,47±36,24 mg/L; D1: 2980,59±238,73 mg/L; D2 2943,96±154,27 mg/L).

The turbidity decreased significantly in fining wines (untreated wine 2,53±0,00; D1 1,68±0,61; D2 1,12±0,47); the gelatin was the less efficient in the decrease of turbidity (2,10±0,46).

The results indicate that the fining agents did not significantly remove isobutyl alcohol, isoamyl alcohols, acetoin, ethyl lactate, diethyl succinate, 2,3-butanediol-*meso* and 2,3-butanediol-*levo*, 1-hexanol, γ-butyrolactone, octanoic acid, 2-metil-propanoic acid, diethyl succinate, 2-phenylethanol and ethyl vanilate. As with regards to the hexanoic acid, the ethyl 3-hydroxybutyrate and the ethyl 3-methylbutyl succinate, these decreased when the treatment was carried out with patatin, pea protein or yeast extract.

These results are in agreement with those obtained in the sensory analysis, in which the tasters did not detect significant differences between the wines treated with different fining agents.

Keywords: Fining, Vegetable proteins, Yeast extract, Gelatin, Wine

Avaliação da atividade antioxidante de extratos do bagaço de acerola em diferentes sistemas e na estabilidade oxidativa em óleo de soja refinado

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A oxidação lipídica é uma das principais reações de deterioração em alimentos, provocando perdas de qualidade e valor nutricional. Para minimizar esse problema a indústria de alimentos usa aditivos capazes de retarda tais reações, os antioxidantes. Os antioxidantes mais utilizados pela indústria de alimentos são os artificiais, entretanto nos últimos anos têm-se questionado a inocuidade destes à saúde do consumidor, isso aliado a constatação que muitos vegetais, como as frutas, possuem quantidades apreciáveis de substâncias com propriedades bioativas, impulsionado a utilização de antioxidante natural na indústria. Atrelado a este fato, tais compostos não estão presentes só na polpa, mas também na casca e sementes assim, a utilização destes resíduos, gerados durante o beneficiamento de frutas, poderá baratear a produção de compostos antioxidantes e contribuir na redução do impacto que esses resíduos podem causar ao meio ambiente. Dessa forma, esse trabalho teve como objetivo determinar o sistema de solvente mais eficiente para a extração desses fitoquímicos, a partir de bagaço de acerola, avaliar o potencial antioxidante de seus extratos e a eficiência dos mesmos no controle do processo oxidativo do óleo de soja refinado. Quanto ao teor de compostos fenólicos, os solventes hidroalcoólicos com concentração de 40% (2.064 mg EAG/100g) e 60% (1.860 mg EAG/100g) apresentaram um número significativamente maior que os demais sistemas (água, etanol 20% e 80%), evidenciando serem sistemas de extração mais eficiente. O extrato hidroalcoólico de 40% apresentou o melhor potencial de captura do radical DPPH, com EC50 de 71,27 µg/mL de extrato. Em relação a avaliação da estabilidade oxidativa do óleo de soja adicionado dos extratos hidroalcoólicos de maior teor de fenólicos (40% e 60%), foi observado uma menor degradação, isto é, um menor teor de peróxidos no óleo, até o sexto dia de incubação da amostra a 60 °C, mantendo o índice de peróxido dentro dos padrões da legislação (< 10 mEq/kg), em comparação com a amostra controle (sem agente antioxidante). Com isso, os resultados obtidos permitem evidenciar o resíduo de acerola como uma fonte de antioxidante natural, bem como impulsionar as pesquisas na busca de produtos mais naturais em benéficos a saúde do consumidor.

Keywords: Capacidade antioxidante, Resíduo de acerola, Oxidação lipídica, Óleo vegetal

Caracterização instrumental de manteiga de garrafa comercializada em Aracaju, SE, Brasil

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A manteiga de garrafa ou a manteiga da terra ou mesmo a manteiga do sertão é um produto oleoso nos estados líquido e pastoso, obtido do creme quase eliminando a água por um processo tecnologicamente apropriado. Adicionalmente, as alterações de cor medidas pela colorimetria podem ser usadas para predizer mudanças químicas e de qualidade. Devido ao alto consumo da manteiga de garrafa no nordeste do Brasil, o objetivo deste trabalho foi caracterizar a cor instrumental de diferentes marcas de manteiga de garrafa comercializadas no mercado municipal de Albano Franco, localizado na cidade de Aracaju, Sergipe, Brasil. Para isso, uma pesquisa prévia foi realizada para verificar as marcas comercializadas e três marcas foram encontradas. As amostras foram coletadas e transportadas para o Laboratório do IFS, Glória, em temperatura ambiente, para caracterização da cor utilizando colorímetro da marca *Hunterlab Miniscan Spectrophotometer Plus*, iluminante D65, ângulo de observação de 10°, sendo os resultados expressos pelo sistema *L**, *a**, *b** de Cielab. As leituras foram realizadas em 50 mL da manteiga homogeneizada, utilizando uma Cubeta de cristal de volume definido acoplada em um Copo Opaco Preto. Foram realizadas leituras em posições rotacionais da cubeta no sentido horário a cada 45º, até atingir 360º de rotação, totalizando 8 leituras por amostra, sendo o resultado representado pela média dessas leituras de cor para cada repetição. Os dados foram analisados por ANOVA e teste de Tukey ($p \leq 0,05$). Os resultados revelaram que as diferentes marcas de manteiga de garrafa apresentaram diferenças significativas ($p \leq 0,05$) entre as três amostras analisadas nos parâmetros *L**, *a**, *b**. Em relação ao parâmetro *L**, constatou que a amostra B apresentou a maior luminosidade (56,98), enquanto que a amostra A, demonstrou a menor luminosidade (31,31) entre as amostras analisadas. Para o parâmetro *a**, verificou-se que todas as amostras apresentaram baixa intensidade da cor vermelha, sendo que a amostra C apresentou o maior valor (9,68), enquanto que a amostra A apresentou o menor valor para este parâmetro (4,85). Os valores positivos obtidos para o parâmetro *b**, caracterizaram as amostras de cor amarela variando de 17,16 (amostra A) a 29,77 (amostra B), na qual a amostra C apresentou valores médios de 26,83. Conclui-se que a manteiga de garrafa ainda é um produto artesanal fabricado no Nordeste, muito utilizado na elaboração de comidas típicas da região, que ainda precisa ser adaptada e padronizada em seu processo de fabricação devido as diferenças significativas apresentadas nos parâmetros instrumentais de cor.

Keywords: Qualidade, Colorimetria, Laticínios

Avaliação físico-química e rendimento de labneh elaborado com farinha da casca de maracujá (*Passiflora edulis*) e polpa de mangaba (*Hancornia speciosa Gomes*)

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O Labneh é considerado um intermediário entre leites fermentados e os queijos com alta umidade. É produzido a partir do iogurte, ou de outro tipo de leite fermentado como o kefir, com remoção parcial do soro. Estudos têm mostrado que a farinha de casca do maracujá apresenta alto teor de fibras, tornando-se um ingrediente promissor para o enriquecimento de formulações de alimentos, além de agregar valor por ser um produto de um resíduo da indústria e ser sustentável ao meio ambiente. A mangaba apresenta ótimas características sensoriais e nutricionais. O objetivo deste trabalho consistiu na elaboração de Labneh enriquecido com farinha da casca de maracujá e polpa de mangaba. Os experimentos foram realizados no Instituto Federal de Sergipe, Campus Glória. Utilizou-se para elaboração do Labneh diferentes concentrações de farinha da casca de maracujá (A: 0%, B: 0,5%, C: 1,0%, D: 1,5%) e 3% de polpa de mangaba pasteurizada. As amostras foram submetidas às análises físico-químicas do teor de umidade (%), teor de Extrato Seco Total/EST (%), índice de pH e acidez total titulável (% ácido lático). Os resultados de índice de pH e acidez não apresentaram diferença significativa entre as formulações. O índice de acidez aumentou à medida em que obteve aumento na concentração da farinha da casca do maracujá. Já o teor de umidade diminuiu com o aumento da concentração da farinha da casca de maracujá, havendo um aumento do índice de extrato seco total, apresentando diferença significativa entre todas as amostras analisadas. Em relação ao rendimento, os resultados obtidos apresentaram variações de 32,14% a 34,56%, valores próximos ao encontrado na literatura. Conclui-se que a elaboração de Labneh pode ser uma alternativa para maior diversificação de produtos lácteos na região do alto sertão sergipano. Estudos posteriores serão realizados a fim de avaliar as características microbiológicas e sensoriais do Labneh produzido.

Keywords: Resíduos agroindustriais, Fibra, Aspectos sensoriais, Inovação

Caracterização físico-química de queijos coalho produzido com leite de diferentes animais

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O queijo de coalho possui origem brasileira, e é de grande aceitação principalmente na região Nordeste do Brasil, possuindo grande importância econômica. O mesmo se destaca entre os principais queijos artesanais de fabricação e consumo incorporados à cultura regional de tradição secular; sendo habitualmente consumido assado na brasa ou frito. O objetivo deste trabalho foi realizar a caracterização físico-química de queijos coalho produzidos com leite de diferentes animais. Três amostras dos queijos coalho (A: caprino; B: bubalino e C: bovino) foram adquiridas no mercado local do município de Aracaju, Sergipe, Brasil. As amostras coletadas permaneceram em suas embalagens originais de comercialização, armazenadas e transportadas, em caixas térmicas, para o Laboratório Multifuncional de Laticínios do IFS, Campus Glória e mantidas sob refrigeração a 10ºC até o momento das análises. Foram avaliadas as características físico-químicas de acidez titulável em percentual de ácido lático (%), pH utilizando-se pHmetro (AK88, AKSO), % umidade (ID-200), (%) gordura. A determinação do teor de gordura no extrato seco foi realizada de modo indireto, por meio da diferença entre o teor de gordura e o teor de extrato seco total do queijo. Todas as análises foram realizadas conforme metodologias descritas na legislação vigente, em triplicata. De acordo com os resultados obtidos nas análises físico-química observou-se que o pH (A: 6,35; B: 6,25 e C: 6,20), extrato seco total (A: 45,10%; B: 39,13% e C: 41,30%) e umidade (A: 54,90%; B: 60,87% e C: 58,70%) das amostras de queijos avaliadas não apresentaram diferenças entre si. Entretanto, em relação ao índice de acidez (A: 0,36%; B: 0,25% e C: 0,08%) e percentual de gordura (A: 38,62%; B: 71,55% e C: 58,11%) as amostras apresentaram diferenças significativas entre si. Variações na concentração de ácido lático podem ser encontradas nos queijos decorrente dos diferentes processos adotados nas queijarias, isso devido tamanho dos grãos de coalhada cortados, quantidade de sal e o método de salga, tempo e temperatura dos queijos prensados, atividades dos cultivos lácticos presentes no leite. Variações nos teores de gordura de queijos devem-se a individualidade do leite de cada espécie. Conclui-se que variações nas características físico-químicas constatadas entre as amostras dos queijos coalho das três espécies, notou-se diferenças significativas e marcantes no teor de gordura e acidez titulável, demonstrando a influência da composição de cada animal no produto final.

Keywords: Qualidade, Queijos, Animais

Potencial nutracéutico de extractos obtenidos a partir de subproducto o desecho de campo de tomate secados en horno de convección forzada

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Introducción. El tomate es la segunda hortaliza más consumida en el mundo, en México, en 2018 se produjeron 2,600,000 ton, siendo el estado de Sinaloa el principal productor (900,000 ton). Se ha reportado, tanto el fruto en fresco, los productos de su industrialización y los subproductos industriales generados, como fuente de compuestos con potencial nutracéutico: carotenoides, compuestos fenólicos, vitaminas, etc. En el estado de Sinaloa se reportan pérdidas en campo de hasta 30 ton/ha y generación de 3,000 ton de subproductos industriales, que no se aprovechan para generar productos con valor agregado. El objetivo de este trabajo es establecer un método de secado que permita preservar el potencial nutracéutico de subproductos y desechos de tomate, y mantener una a_w entre 0.4-0.6; además de obtener extractos y evaluar su potencial nutracéutico. **Métodos.** Se colectó subproducto industrial de tomate y desecho de campo (piel y semillas fueron separadas de la pulpa), el material fue prensado para eliminar agua. El secado se realizó en un horno de convección forzada, probando tres temperaturas: 45, 50 y 55 °C, durante 140 min; realizando un monitoreo de actividad de agua (a_w) y evaluación de carotenoides totales (espectrofotométrico) con muestra tomada cada 20 min. Se hizo un análisis de correlación entre la a_w y carotenoides totales. Como referencia se liofilizó subproducto industrial. El material seco se molió y se realizaron extracciones polares (etanol al 80%) y no polares (etil acetato grado alimenticio). La cuantificación de fenólicos y carotenoides se realizó mediante HPLC y se evaluó actividad antioxidante por el método de protección a mioglobina. **Resultados**. Se establecieron como mejores condiciones de secado: 55 ºC y 120 min, preservando un total de carotenoides de 9.58 µg/mg de extracto seco, los valores de a_w registrados bajo esta condición oscilaron entre 4.3-5.4. Se obtuvo un coeficiente de correlación entre ambos parámetros de -0.8784. Los mayores contenidos de licopeno y compuestos fenólicos por HPLC (11.26 µg y 162.82 µg/mg de extracto seco, respectivamente), y actividad antioxidante (61.87% de protección a mioglobina, frente al ion hipoclorito/500 µg de extracto seco), se observaron en la muestra de desecho de campo, seguida por el subproducto liofilizado.
Conclusiones. El desecho de campo y subproducto industrial de tomate secados en horno de convección forzada, conservan concentraciones atractivas de carotenoides (licopeno y β-caroteno) y de compuestos fenólicos, éstos podrían ser usados para obtener extractos que posteriormente se empleen como aditivos o ingredientes en la industria alimentaria.

Keywords: Tomate, Secado, Actividad de agua, Carotenoides, Compuestos fenólicos

Physical chemical, microbiological and sensory evaluation of pepper jelly with different concentrations

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Jelly is a type of dessert that can be made with sour sugar and pectin. For the purpose of harnessing the fruits of pepper and pineapple it is necessary to develop products that meet the needs of consumers. The peppers are cultivated throughout the national territory, having great representativity to small farmers, since they foment the integration with the agroindustries, adding value to the manufacture of jellies. The objective of this work was to evaluate the physicochemical, microbiological and sensory properties of "Bode" peppers (*Capsicum chinenses* L.) with different concentrations. For the manufacture of pepper jelly, the fruits were harvested in the Horticulture Sector of the Federal Institute Goiano-Campus Ceres, and they went through the sanitization process in 150 $mg.L^{-1}$ chlorine solution. After this process were made four forumulations of pepper jelly. Physicochemical and microbiological analyzes were carried out in the instrumental and microbiological laboratory, verifying the qualitative and contamination level (total coliform and thermotolerant coliform). Sensory analysis was performed with 50 untrained panelists in order to evaluate the acceptability index. The treatments were (T1- 0,2, T20,4, T3-0,6, T4-0,8) grams of "Bode" pepper, in each jelly formulation. The results were analyzed by the Tukey test at the 5% probability level. The all samples evaluated did not present contamination for total coliform and thermotolerant coliform. The results of the physical-chemical analyzes shown that the jelly is according to Brazilian legislation and when compared to other scientific works. Sensory analysis confirmed that the acceptability index was greater than 70%, with values ranging from 80% to 90%. The treatments (T1-0,2, T4-0,8) with smaller and higher concentration peppers were the ones that had better preference.

Keywords: Capsaicin, Commercialization, Flavor, Hygiene

Cereal bars coated with edible coatings of whey protein isolate or alginate incorporated with *Bifidobacterium animalis* subsp. *lactis* BB-12 and inulin

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Currently, consumption of ready to eat products, namely snacks, has increased widely due to changes in people's lifestyles. Among the different types of snacks available, cereal bars are gaining interest globally because of their nutritionally balanced and convenient nature. One healthy strategy is to add probiotics to cereals bars, to make them a functional food product. In this study, a cereal bar functionalized with edible coatings of whey protein isolate (WPI) or alginate (ALG) incorporated with *Bifidobacterium animalis* subsp. *lactis* BB-12 and inulin was developed and evaluated for its physicochemical and microbiological properties, throughout 90 days of storage at 23 °C under vacuum. The cereal bars were developed with food grade and local ingredients. Coating formulation was developed based on WPI (10%, w/v) or ALG (1,2% w/v), glycerol (5%, w/w) and with incorporation 5% (w/w) of B*ifidobacterium animalis* subsp. *lactis* BB-12 and 2% of inulin (w/v). Cereal bars were coated by immersion of bar for 2 min in the film forming-solutions.

WPI-coated cereal bars were shown to be the solution that better maintained the level of incorporated probiotic strain when compared to the ones coated with ALG, although both were able to maintain values above 10^6 log CFU/g throughout storage and throughout *in vitro* gastrointestinal digestion. The physicochemical properties of the bars, namely a_w, moisture content, color and texture were not altered over storage time. However, the coated bars exhibited higher a_w (0.555 ± 0.013) and moisture (9.54 ± 0.10 %) content values in comparison to the control bars. Color and texture were not affected upon addition of the coating.

Keywords: Edible coatings, Whey protein isolate, Alginate, Cereal bars, Inulin, Bifidobacterium

Evaluation of the sulforaphane content in broccoli (*Brassica oleracea* L. var. italica) as a result of fermentation with native microbiota and commercial starter culture

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Among food processing and conservation technologies, fermentation by the use of lactic acid bacteria (LAB) allows to increase shelf life, develop sensory characteristics and improve the bioavailability of food components as a result of biochemical transformation of the initial material. The preventive effects of cancer by cruciferous vegetables are related with its particular content of glucosinolates, within this group, broccoli is the main natural source of sulforaphane, its precursor glucoraphanin constitutes 50 to 80% of total glucosinolates present in this vegetable. The aim of the present study was to evaluate 1) the role of the native microbiota and 2) commercial culture of lactic bacteria, on the content of sulforaphane during the lactic fermentation of different parts of broccoli (florets and stalks). The fermentation conditions included initial blanching, 2% NaCl solution, temperature of 28-30° C and a period of 120 hours. During the process, the values of pH, total titratable acidity (ATT) and the chemical composition of the fermented were determined at 6,12,24,48,72,96 and 120 h. Sample preparation for the quantification of sulforaphane included the conversion of glucoraphanin to sulforaphane, extraction with dichloromethane, purification of the extract, and detection by HPLC were as follows: column, ZORBAX Extend-C18 (4.6 x 100 mm), 3.5 µm; column temperature, 36°C; mobile phase, a 30:70 (v/v) mixture of acetonitrile:water; flow rate, 0.6 mL/min. The detection wavelength was UV 202 and 254 nm. During the fermentation process the pH decreased from 6.5 to 3.8, the ATT was increased from 0.45 to 4.99%. The concentration of sulforaphane is in the range of 54.66 to 482 µg / g of dry matter in the samples analyzed.

Keywords: Sulforaphane, Broccoli, Fermentation process

Estudo comparativo de biscoitos tipo cracker, pela adição de farinhas de linhaça (*Linum Usitatissimum*), amaranto (*Amaranthus* spp) e trigo sarraceno (*Fagopyrum Esculentum*) em substituição parcial à farinha de trigo

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O desenvolvimento de novos produtos é uma necessidade da indústria de alimentos, que têm buscado desenvolver alimentos mais saudáveis, por meio da incorporação de ingredientes que favoreçam suas qualidades nutricionais e com ações benéficas para a prevenção de doenças. O presente trabalho teve como objetivo realizar um estudo comparativo de massas de biscoitos tipo cracker, pela adição de linhaça (*Linum usitatissimum,* L.), amaranto (*Amaranthus cruentus*) e trigo sarraceno (*Fagopyrum esculentum*) e avaliar os efeitos dessa substituição na qualidade de biscoitos salgados tipo cracker quanto à cor, textura, comprimento, largura e o volume, a partir da substituição parcial da farinha de trigo. Foi utilizado o desenvolvimento casualizado na substituição parcial da farinha de trigo aos níveis de 10 e 20%. As análises de umidade, proteína, cinzas, propriedades da massa e alveográficas, *Falling Number* foram realizadas conforme AACC, 2000. A análise de cor através do colorímetro digital Minolta modelo CR300, a de textura pelo texturômetro. Na produção dos biscoitos utilizou-se o método esponja e massa. Na caraterização da farinha obtiveram-se umidade 13,65%, proteína 10,49%, cinzas 0,67% em base seca, cor (L) 92,20, cor (b) 10,05, glúten úmido 24,30% e glúten seco 8,43%. Em relação à farinografia, obteve-se 57,22% para absorção d´agua, 10 minutos para o tempo de desenvolvimento da massa e 19,30 minutos para a estabilidade da massa. Na alveografia, obteve-se para o trabalho (W) - 245,28 x 10^{-4}.J, P (tenacidade)/L (extensibilidade) - 1,68 e *Falling Number* - 350,23 s. O biscoito com proporção de 20% de farinha de trigo sarraceno foi o mais resistente em relação à quebra, a presença das farinhas sucedâneas elevaram a força de quebra em relação à formulação controle. Os biscoitos apresentaram cores entre o vermelho e o amarelo, devido às cores das farinhas utilizadas, as reações de caramelização de açúcares e de Maillard. A luminosidade do biscoito com linhaça foi estatisticamente inferior aos demais. As análises de espessura, largura, comprimento e volume específico dos biscoitos apresentaram diferença estatística com o biscoito controle. Os biscoitos com 10 e 20% de farinhas de amaranto, linhaça e trigo sarraceno e sem adição de protease comercial são aceitáveis quanto à cor, textura e medidas dimensionais, assemelhando-se, aos biscoitos com farinha de trigo. Tais resultados propiciam o incentivo à comercialização desses produtos, os quais se mostraram tecnologicamente adequados e saudáveis, por apresentarem pseudocereais ricos em substâncias bioativas.

Keywords: Biscoito tipo cracker. Pseudocereais. Farinhas mistas

Efecto del tratamiento con plasma frio sobre emulsiones con proteína cárnica

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OBJETIVO: Estudiar el efecto del tiempo de tratamiento (0-2 y 5 min) con plasma frío (10000V) bajo atmosfera de Helio (0,3 bar) sobre las propiedades físico químicas (Color, pH, digestibilidad enzimática y microestructura) y funcionales (Capacidad de retención de agua-CRA, Estabilidad) de emulsiones a base de proteína cárnica de bovino (86.4% de carne de Res (80/20), 8% grasa de cerdo, 1.67% NaCl y 0.019% Nitritos y 0.313% Polifosfatos).
METODOLOGÍA: Para el tratamiento con plasma frio se utilizó un prototipo desarrollado en la Unipamplona. Los análisis fisicoquímicos se realizaron siguiendo la metodología de la AOAC (2016). El Color se determinó en la escala CIELab, la digestibilidad se realizó por método enzimático y la microestructura se analizó con el software Motic-plus.
RESULTADOS: Se observó que el tratamiento disminuyó la Luminosidad (***L***) de las muestras tratadas durante 2 min de 28 a 17 unidades en el primer día y se mantuvo en el tiempo de observación; mientras que en las muestras tratadas durante 4 min no hubo alteraciones con el tratamiento, pero disminuyó con el tiempo de almacenamiento en 2 undades. La coordeanda ***a*** aumentó dos unidades en el primer día en las muestras tratadas durante 5 min y disminuyó 11 unidades con el tiempo de almacenamiento. Por su parte la coordenada ***b*** disminuyó con el tiempo de tratamiento alcanzando en el último día un valor de 12 en las muestras tratadas durante 5 min. El tratamiento y el tiempo de almacenamiento no tuvieron influencia significativa ($P>0,05$) en el pH y la estabilidad. La digestibilidad aumenta con el tratamiento y el tiempo de almacenamiento en 3,2%. La CRA se ve disminuida con el tratamiento y el tiempo de almacenamiento alcanzando valores de 30% y 28% en el último día de análisis para los tratamientos de 2 y 5 min respectivamente. Por efecto del tratamiento y el tiempo de almacenamiento el promedio del tamaño del glóbulo de grasa aumento de 0.1 mm a 1.4 mm.
CONCLUSIONES: El tratamiento afecta el color de las emulsiones estudiadas observandose mayores cambios a mayores tiempos de exposición. El tratamiento disminuye la CRA pero aumenta la digestibilidad proteíca y el tamaño de los glóbulos de grasa.

Keywords: Carne de bovino, plasma frío, propiedades fisicoquímicas, proteínas cárnicas

Effect of ultrasound pretrating in convective drying kinetics of la uchuva (Physalis peruviana)

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Ultrasound (US) is a novel technique used in the food industry. In this work, the effect of pretreatment with US (40 KHz / 130W / 30 ° C / 10, 20 and 30 min) in the convective drying at 60 ° C / 2m / s of the cape gooseberry (Physalis peruviana) was evaluated. A diffusional model was used to describe the drying kinetics and to quantify the influence of the US on the effective diffusivity of water. Noting that the US significantly increased (p> 0.05) the drying rate in all the treated samples with an average reduction of 38% in the drying time with respect to the control treatment; reaching a weight loss of 78% with respect to the initial weight (4.21 to 0.93g.). The Logarithmic model is the most adequate to predict the experimental curves of drying of cape gooseberry and showed that the application of US increased both the effective diffusivity and the mass transfer coefficient, and corroborate the values of the percentage of variance explained from 97.3 to 99.5 %.

Keywords: Water diffusivity, physalis peruviana, Drying, Cape gooseberry ultrasound

Physical characterization of high pressure induced gelatinization of arrowroot (*Marantha arundinacea*) starch

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The objective of this work was to evaluate the effect of high pressure processing (HPP) on morphological and technological properties of commercial arrowroot starch. Starch water suspensions were prepared at 25% concentration (w/w) and processed using an Isostatic High Pressure (HPP) equipment. HPP was carried out at 400 to 650MPa, 25 and 50°C, for 15 and 25 min. After processing, all samples were lyophilized and stored until analysis. Native and processed arrowroot starches were analysed by scanning electron microscopy (SEM) and the pasting properties were measured using a Rapid Visco Analyser (RVA). Starches resultant from RVA were stored at 4°C and the strength of the resultant gel was determined using a TA-XT2i Texture Analyzer. Native arrowroot starch (NAS) granules presented heterogeneous size (2–16µm) and circular shape, with some truncated granules occurrence and smooth surface. The SEM micrographs of NAS granules processed (PS) at 400MPa (25°C; 15 and 25 min) have no observable differences when compared to the native one. Images showed that 650MPa PS were entirely disintegrated and agglomerate, independently of temperature and time processing. Generally, the pasting parameters of NAS were modified by HPP. However, the sample processed at 400MPa (25°C, 15 min) has shown pasting behavior similar to NAS. Viscosity curves of the PS at the same pressure showed a similar profile among them. Peak viscosity was maximum at 500MPa (25°C) and at 400MPa (50°C). The same trend was observed for the maximum gel strength. It implies that the temperature (50°C) has intensified the changes throughout the 400 and 500MPa PS, as also observed from the micrographs. Among the pasting parameters, both cold viscosity and setback were significantly improved as the pressure improved (25°C). The processing at 650MPa was crucial on leading to extreme changes on NAS which were independent of temperature and time. The observations reported can be elucidated by pressure effect (temperature combination) on molecular orientation and structural order of the starch granule. When undergoing to critical conditions a total granule disruption and disorder is followed in a phenomenal named gelatinization. In conclusion, the special technological changes provided by HPP, without use of chemical reagents, on ANS could figure an interesting input on modifying and spreading the root starches for industrial use.

Keywords: Modified starch, High pressure processing, Arrowroot

Inulin-based emulsion gel as animal fat replacer in reduced-salt low cost Bologna sausages

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Meat products like Bologna sausage containing high fat and sodium content require strategies aiming their reformulation to become healthier. The use of emulsion gel presents an alternative with great potential for application in meat products, mainly because it can be formed by dfferent vegetable oil and functional compounds, such fibers. This study aimed to use a high-fiber emulsion gel (EG) containing inulin, soy protein isolate, and soybean oil as animal fat replacer to substitute pork back fat (50 and 100%) in Bologna sausage with 50% NaCl reducing when compared to controls. Treatments were formulated with 50% of mechanically deboned chicken meat to obtain low cost products. Technological properties were evaluated during 60 days of chilled storage at 4 °C, and sensorial analysis was performed at day 7. A reduction of 21% and 39% of total fat and sodium were achieved in sausages, respectively. EG addition allowed samples to reach the claims as good source of fiber and high content of unsaturated lipids. A reduction of 47 and 25% of SFA and an increase of 87 and 42% of PUFA was reached for EG and EG+pork back fat added bolognas sausages, respectively. A softer more elastic, cohesive and resilient samples with a higher intensity of lipid oxidation were observed in sausages reformulated which ranged from 0.04 to 0.89 mg MDA/kg sample. The matrix of EG added treatments loses some of its spongy appearance, showing a more continuous and compact structure. Results from time domain NMR analysis show that occurs an increase in spaces that hold water with the reduction of fat and salt simultaneously in bologna sausages. However, with EG addition the values of time were recovered to near the standards probably due the fibers of the emulsion make in parts the function of the fat. Sensory evaluation showed that the incorporation of the emulsion gels resulted in acceptable scores and the strategy to replace partially animal fat by EG in reduced salt sausage is suitable to make them healthier.

Keywords: Functional fiber, Fat substitute, Lipid reformulation, RMN analysis, Low sodium

Polyphenols, from anti-nutrients to nutraceuticals: the case study of table olives

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Olive orchards shape mediterranean landscape and their products are not limited to olive oil, which is a main pillar of the Mediterranean Diet. An increasing diversity of industrial products can also be obtained from the olive tree, encompassing cosmetic and nutraceutical ingredients, and most particularly table olives (TO). TO are an ancient healthy food, typical of mediterranean countries, and generally obtained from cultivars less suitable for olive oil production. TO is herein presented as a case-study of a traditional Mediterranean industry urging revitalization. Data from autochthonous and introduced cvs from Algarve-Portugal and Tunisia are presented and discussed: Pomological characteristics, quantification of total phenols and *in vitro* anti-oxidant capacity, as well as the discrimination of phenolic and fatty acid (FA) profiles. Despite fruit composition depends on the cv, region, climate etc., high levels of total phenols (within the range of 20 000 mg/kg), predominance of mono-unsaturated fatty acids (MUFA), and important levels of linoleic acid are consistently registered, highlighting the nutritional value of TO, generally much richer in polyphenols than olive oil. Polyphenols once viewed as less desirable (e.g. for their bitterness or for their ability to precipitate proteins), are now appreciated for their health-beneficial properties, not limited to their potent anti-oxidant action. As plant secondary metabolites, a multitude of compounds can be found. While some of which are conserved at species' level, others are specific to the cv and region. Despite its nutritional value and its relevance to the Mediterranean Diet, TO consumption is declining, namely in Portugal, and many *O. europea* cvs risk disappearing. According to IOOC statistics, in 1990, TO consumption was 11000 Mt in Tunisia, and 20 000 Mt in Portugal. Since years 2000, Tunisia shows an increasing trend in consumption, while in Portugal a sharp decline in TO consumption is observed. In 2009, the registered figures were 20 000 Mt in Tunisia and 7 Mt in Portugal.

Our results emphasize the importance of paying more attention to TO, namely for their content in potent anti-oxidant polyphenols, its potential for the development of novel foods, as well as the urgency in safeguarding autochthone cvs, which are more robust and resilient to extreme weather events than introduced cvs. The revitalization of TO industries, and the diversification of products can have very positive outcomes on local economies, on the environment, and on population's health, both in Portugal and in Tunisia.

Keywords: Table-olives, Polyphenols, Fatty acid profile, Mediterranean Diet, Biodiversity

Food Processing Technologies

Freezing and Refrigeration

Oral Communications

Avaliação do congelamento a vácuo como alternativa aos métodos convencionais de conge lamento utilizados na etapa inicial da liofilização de extrato de café

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A secagem é a etapa mais importante no processamento de café solúvel e métodos que utilizam baixas temperaturas, como a liofilização, são preferíveis por preservarem o sabor e o aroma. O congelamento é a etapa inicial da liofilização e tem grande importância, uma vez que o espaço ocupado pelos cristais de gelo se torna a principal passagem para o transporte de vapor durante a etapa de sublimação. Desta forma, novos métodos de congelamento vêm sendo estudados e dentre eles destaca-se o congelamento a vácuo (CV). O CV baseia-se na remoção de calor do produto através da evaporação da sua água livre e da sublimação do gelo formado a baixas pressões. A evaporação e a sublimação durante a formação da fase congelada podem contribuir para o aumento da porosidade da matriz e para a redução da carga energética na etapa subsequente de secagem. Diante disso, o objetivo deste estudo foi avaliar o CV como alternativa aos processos convencionais de congelamento por ar frio (C_{ar}) e por contato com superfície fria (C_c). Para tal, extrato de café em diferentes concentrações (10 e 40 °Brix) e camada de 6 mm foi submetido ao CV, C_{ar} e C_c. O monitoramento da temperatura das amostras foi realizado através de termopares inseridos no centro geométrico da camada de extrato. Para as condições experimentais avaliadas, o tempo para a redução da temperatura das amostras de aproximadamente 20 °C até -15 °C foi em média 3,6 vezes maior para o método C_c e 8 vezes maior para C_{ar} em comparação com CV. Esse comportamento era esperado, visto que os mecanismos de transferência de calor envolvidos no congelamento a vácuo diferem dos métodos convencionais. Enquanto o CV depende principalmente da evaporação de água livre do produto sob baixa pressão, o Car e Cc se baseiam na transferência de calor por convecção, condução e radiação. Comparativamente aos métodos convencionais, o CV alcançou taxas de congelamento até 60 vezes superiores e a perda de massa das amotras foi até 17 vezes maior. A menor taxa de congelamento e o período maior na zona crítica (0 a 5 °C) observados para o C_{ar} e C_c resultaram na formação de cristais de gelo grandes e irregulares. Por outro lado, o CV gerou uma microestrutura extremamente porosa que poderá auxiliar na dinâmica de secagem. Assim, os resultados obtidos mostram que o CV pode ser integrado à liofilização, reduzindo o tempo da etapa de congelamento.

Keywords: Congelamento por ar frio, Congelamento por contato, Café solúvel

Numerical and experimental investigation of food freezing using hydrofluidisation method

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The novel method of Hydrofluidisation Freezing is based on submerging food products inside a tank filled with appropriate water solution, which is pumped through arrays of orifices located at the tank bottom towards the group of food products in order to create highly turbulent fluid flow. Due to that, this method allows to obtain significantly higher heat transfer coefficients resulting in freezing time reduction comparing with commonly used technologies. As a result of rapid freezing, the quality of products is significantly improved. This method is beneficial mostly for freezing of small products like fruits and vegetables.
Despite of clear advantages, literature describing this method is scarce meaning that this technique it is not developed yet. The aim of presented study is to investigate parameters affecting the fluid flow within the Hydrofluidsation Freezing system and the freezing process of food products, i.e. orifices diameter and arrangement, food products size and the distance between the product and the orifice.
Laboratory scale HF food freezing unit has been designed and built for experimental investigation of this method. The Particle Image Velocimetry (PIV) system was used to capture the coolant flow around the artificial spherical sample. In addition, the temperature of the sample surface as well as the centre were measured during the freezing process. Numerical model of this process has been developed using Computational Fluid Dynamics (CFD) to predict the fluid flow around the products with high accuracy and to simulate phenomena occurring during the food freezing process like heat and mass transfer which are crucial in terms of the process and final quality of the products.
The velocity field has been studied for various operating conditions using CFD results confirmed by PIV validation measurements. That system arrangement consisted of a single orifice with the diameter of 2-5 mm and single sphere positioned 20-80 mm above the orifice. Different sphere diameters of 5-30 mm corresponded to a variety of food products. The Reynolds number range was 1,700-93,000 for all cases. The coolant used was aqueous solution of ethanol with the mass concentration of 5%. The obtained results include velocity profiles along the jet axis and around the sphere, the angle of boundary layer separation and heat transfer coefficient distribution.
In the end, a set of key parameters describing the process were identified to be applied for freezing of wide variety of food products.

Keywords: Hydrofluidisation, Food Freezing, Freezing Methods, Computational Fluid Dynamics (CFD), Particle Image Velocimetry (PIV)

Propriedades tecnológicas de extratos de cardo (*Cynara cardunculus* L.) para utilização em queijaria: efeito da conservação e da formulação

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A flor de cardo (*Cynara cardunculus*) é utilizada desde há muito como coagulante no fabrico de queijos tradicionais, alguns dos quais beneficiam de Designação de Origem Protegida (DOP). O modo de uso tradicional foi recentemente objeto de um pedido de inscrição na lista europeia de enzimas alimentares, passo essencial para a respetiva utilização regulamentar. A carência de material vegetal e heterogeneidade inerente não possibilita uma contribuição para a qualidade dos produtos para os quais tem sido considerado como fator fundamental. A utilização da flor não é sujeita a um controlo de utilização adequado ao importante papel que os coagulantes representam para as características do queijo. Mantém-se a preparação diária a partir da flor, não existindo a apresentação de soluções tituladas e garantidas como se verifica para outros coagulantes.

Este trabalho pretendeu avaliar o efeito da conservação nas propriedades tecnológicas dos extratos de flor de cardo - preparações tradicionais e formulações obtidas com diferentes soluções extratantes - NaCl 5%, NaCl 20%, tampão acetato pH 5,5 e tampão citrato pH 3. Os extratos obtidos a partir de populações dispersas pela região do Alentejo e de um lote de flor de cardo recolhido no *campus* do INIAV, em Oeiras, foram avaliados, até 6 meses de conservação sob refrigeração (6ºC), relativamente à atividade coagulante e à evolução da coagulação, e também no que se refere à componente microbiana, através da avaliação das contagens de microrganismos mesófilos, psicrotróficos, *Enterobacteriaceae* e bolores e leveduras.

Os extratos tradicionais mostraram perdas acentuadas de atividade coagulante, em média, de cerca de 20 % e de 50% ao fim de dois e quatro meses, respetivamente. Os extratos obtidos com tampão citrato apresentaram comportamento mais estável, a nível tecnológico e microbiológico, praticamente sem contaminação. Os extratos preparados com NaCl (solução 5%) mostraram-se como os mais adequados quer para a extração, quer a nível da conservação; apresentaram propriedades tecnológicas superiores, com uma consistência do gel superior às restantes soluções, fruto de uma maior velocidade de agregação micelar. O desempenho a nível microbiano foi ligeiramente inferior ao do extrato com tampão citrato mas os níveis microbianos registados estiveram muito aquém dos que integram as fichas técnicas da maioria das soluções coagulantes do mercado. As formulações com base em solução de NaCl 20% foram as que induziram maiores perdas de atividade coagulante, proporcionando ainda pior desempenho no evoluir da coagulação.

Keywords: Conservação de extratos de cardo, Formulação de coagulantes, Propriedades tecnológicas, *Cynara cardunculus* L., Fabrico de queijo

Food Processing Technologies

Freezing and Refrigeration

Poster Communications

Influência de diferentes variáveis de processo na cinética de congelamento a vácuo de extrato de café

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O congelamento a vácuo (CV) tem como princípio a remoção de calor do produto através da evaporação da sua água livre e da sublimação do gelo, ambas a baixas pressões. O processo inicia-se quando a pressão no interior de uma câmara atinge a pressão de saturação correspondente à temperatura inicial do produto, ocasionando a evaporação da água. Nesta etapa, o calor latente para a evaporação é fornecido pelo próprio produto que se resfria. O resfriamento se estende até a amostra atingir a temperatura de nucleação. Quando a pressão é reduzida a partir desse ponto, a fase congelada aumenta à medida que a água evapora e, posteriormente, a temperatura da amostra é reduzida à medida que o gelo formado sublima. Há poucos estudos na literatura considerando o CV como alternativa à etapa inicial da liofilização. No entanto, considerando que a morfologia da matriz congelada influencia a cinética de secagem, o CV desponta como uma alternativa capaz de formar uma estrutura extremamente porosa devido à geração de vapor no interior do produto. Diante do exposto, o objetivo deste trabalho foi avaliar o efeito da concentração (10 e 40 °Brix), da espessura da camada (4 e 6 mm), da taxa de queda de pressão (0,57 e 0,37 kPa s^{-1}) e da temperatura inicial (0 e 20 °C) do extrato de café na cinética de CV. Para tal, foi utilizado um liofilizador de bancada adaptado para a aquisição *on-line* das variações de temperatura e pressão. A concentração do extrato não afetou o tempo para as amostras alcançarem -15 °C, o qual foi de aproximadamente 2 minutos após as amostras atingirem a temperatura de congelamento. No entanto, o tempo de processo foi 50 % maior para as amostras dispostas em camada de 6 mm. A redução na taxa de queda de pressão provocou um aumento de até 5 vezes no tempo de congelamento. A temperatura inicial do extrato teve um efeito significativo no congelamento das amostras de 10 °Brix, proporcionando uma camada congelada uniforme em virtude da temperatura inicial estar próxima da temperatura de congelamento da solução. As micrografias revelaram uma microestrutura extremamente porosa, a qual deverá favorecer a transferência de massa durante a liofilização. As amostras congeladas a vácuo apresentaram uma perda de massa de até 43 %. Isto pode se um fator vantajoso quando analisado sob a ótica da integração do CV com a liofilização, visto que o objetivo é desidratar uma solução.

Keywords: Café solúvel, Liofilização, Microestrutura

Efeito dos extratos de alecrim e de acerola na estabilidade oxidativa de hambúrguer de frango congelado

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O hambúrguer é um produto cárneo processado que tem feito parte do hábito alimentar da população brasileira. Com foco na preocupação pelos consumidores da presença de conservantes sintéticos, pesquisas estão sendo realizadas para encontrar substâncias naturais que possam estender a vida útil e/ou melhorar a segurança desses alimentos. O objetivo deste estudo foi avaliar o efeito dos extratos de alecrim e de acerola sobre as características físico-químicas e de oxidação lipídica em hambúrguer de frango durante armazenamento congelado. As formulações foram elaboradas com a mesma quantidade de ingredientes, variando somente os antioxidantes. Foram produzidas 4 formulações, C1 (controle – sem antioxidante), F1 (adição de 0,2% de eritorbato de sódio), F2 (adição de 0,2% de extrato de acerola), F3 (adição de 0,2% de extrato de alecrim). Avaliou-se a composição centesimal (umidade, lipídeos, proteínas e cinzas), pH (0 e 30 dias) e índice de TBARS (0 e 30 dias). Os teores de umidade, cinzas, proteínas e lipídeos não diferiram entre os tratamentos, provavelmente devido à mesma quantidade de matéria-prima. O pH variou entre 5,95 e 6,37, e não diferiu entre os tratamentos no mesmo período de armazenamento. O índice de TBARS variou entre 0,47 e 0,94 mg de TBARS/kg de amostra, e no tempo 0 de armazenamento não houve diferença entre os tratamentos. Após 30 dias, F3 apresentou menor valor para TBARS, demonstrando efeito antioxidante para o extrato de alecrim. O extrato de alecrim mostrou ser uma alternativa de antioxidante natural em hambúrguer de frango por até 30 dias sob armazenamento congelado.

Keywords: Oxidação lipídica, Antioxidantes, Aditivos naturais, Conservação

Capacidad antioxidante y antimicrobiana de subproductos de cítricos y su aplicación en el control de *Listeria monocytogenes* NCTC 11994

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Algunas cáscaras de cítricos tienen antioxidantes y se ha observado que compuestos de naturaleza fenólica pueden tener actividad antimicrobiana sobre bacterias gram (+) y gram (-), *e.g.* se ha encontrado un efecto bactericida sobre *Escherichia coli*. El objetivo de este estudio fue evaluar la concentración de fenoles totales de cáscara de toronja (*Citrus paradisi*), naranja (*Citrus sinensi*) y limón persa (*Citrus latifolia*) en extractos metanólicos, etanólicos y acuosos (EM, EE y EA). Además, se evaluó la actividad antimicrobiana *in vitro* sobre *Listeria monocytogenes* NCTC 11994. Los resultados experimentales se sometieron a un análisis estadístico con una prueba de ANOVA y Duncan (SAS System, WindowsTM Versión 6.12, USA). Las muestras de extractos metanólicos, etanólicos y acuosos de cáscaras de toronja (*Citrus paradisi*) (CT), naranja (*Citrus sinensis*) (CN) y limón persa (*Citrus limón*) (CL) se le determinaron fenoles totales utilizando el reactivo de Folin-Ciocalteau. En el estudio microbiológico se empleó el diseño estadístico de punto central y las combinaciones/repeticiones se obtuvieron del programa Design-Expert. Los valores de las variables fijas analizadas fueron: pH 4,6 y 8, concentración de CT, CN o CL de 0 g/mL, 0.05 g/mL y 0.1 g/mL y la temperatura de -15°C, -5°C y 5°C. Las cuentas microbianas se realizaron a los tiempos de 0 d y 10 d. El análisis estadístico mostró que los resultados experimentales se ajustaron a un modelo lineal, para el efecto de las variables fijas; solvente (metanol, etanol y agua), tipo de cáscara (toronja, naranja o limón persa) y concentración de cáscara (0.0, 0.005, 0.01, 0.02 y 0.04 g/mL) sobre la variable respuesta (Fenoles totales, µg de ácido gálico/mL). Se observó un efecto altamente significativo ($P<0.0001$) del solvente (A), tipo de cáscara (B) y concentración de la cáscara (C) en los tratamientos evaluados, así como en todas las interacciones de estudio. El coeficiente de determinación para el modelo lineal propuesto indica que < 1% de la variación total en la respuesta no puede ser explicado por el modelo desarrollado. El análisis estadístico para el estudio microbiológico muestra que los resultados experimentales se ajustaron a un modelo cuadrático, al tiempo de almacenamiento de 0 d y 10 d respectivamente. La temperatura de -15°C y el pH a los 10 días de almacenamiento provocaron la inhibición microbiana mayor. Este comportamiento puede ser explicado posiblemente a que *Listeria monocytogenes* NCTCT 11994 puede sufrir daño subletal (a -15°C), condición que provoca mayor sensibilidad a compuestos con actividad antimicrobiana.

Keywords: Actividad antioxidante, FRutos citricos, Fenoles totales

Bioelectrical impedance and color of blueberry: a behavior study during freezing

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The behavior of bioelectrical impedance and the color of freeze-thawed blueberries were investigated. Blueberry fruits were divided into 15 groups, each group with 4 fruits were placed within polyethylene containers. The blueberries were subjected to freezing at -18 ° C for 135 minutes, during this process each container was removed every 9 minutes, and stored at 4 ° C until further analysis. The characteristics of bioelectrical impedance; intracellular resistance (Ri), extracellular resistance (Re), capacitance of the cell membrane (Cm) and the color characteristics both of the skin (L*s, a*s, b*s) and the flesh (L*f, a*f, b*f) of blueberries were measured and after analyzed by computational algorithms implemented in MatLab. The results show progressive loss of the cellular structure of blueberry during freezing, this behavior was associated with the decrease of Re and Cm. The values of these parameters at the beginning and at the end of the freezing process went from 43471.97±13343.12 Ohm to 1876.85±282.75 Ohm and from 2.55±0.47 nF to 1.27±0.32 nF, for Re and Cm respectively, while Ri showed a slight increase going from 894.93±100.73 Ohm to 1103.77±165.30 Ohm. The blueberries cells damage also influenced in color changes, these changes were mainly observed in the blueberries flesh, where coordinates values of the color at the beginning and at the end of the freezing process went from 27.28 ±7.72 to 9.44±4.68 for L*f, from 10.24±7.83 to 22.74±5.73 for a*f and, -5.65±4.31 to -23.47±7.39 for b*f, suggesting diffusion of pigments from the skin to the flesh of blueberry. In conclusion, bioelectrical impedance is a powerful tool for evaluating cell damage in blueberries caused by freezing, which can be complemented with the evaluation of the color by computational algorithms.

Keywords: Electrical impedance spectroscopy, Computational vision, Modeling and fit, Blueberry properties

Food Processing Technologies

Fermentation

Oral Communications

Produção e armazenamento refrigerado de bebida láctica fermentada de castanha do Brasil

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Bebidas lácticas fermentadas tem grande aceitação em diferentes públicos consumidores e também podem ser utilizadas como veículos para micro-organismos probióticos, que promovem melhora da microbiota intestinal e benefícios à saúde humana. Com intuito de atender as demandas do mercado consumidor vem sendo amplamente estudado a produção de novas bebidas fermentadas com características funcionais e/ou para atender públicos específicos. Tradicionalmente estas bebidas são produzidas com leite, porém tem crescido o interesse por matérias-primas de origem vegetal, como cereais, frutas, nozes, grãos e legumes. Estas matérias-primas tem como vantagens a ausência de lactose, proteínas alergênicas do leite e colesterol, além de atender aos consumidores veganos. O presente estudo teve como objetivo avaliar a produção de uma bebida láctica fermentada utilizando extrato de castanha do Brasil (*Bertholletia excelsa*), espécie endêmica na floresta Amazônica, rica em proteínas e gorduras mono e polininsaturadas. Para preparação do extrato, as castanhas foram hidratadas por 12 h, em seguida, descascadas, lavadas, trituradas com água mineral (proporção 1:10 m/m castanha:água) a 37 °C, por 5 minutos em liquidificador e filtrada em pano de algodão. O extrato foi inoculado com fermento láctico (contendo *Bifidobacterium, Lactobacillus acidophilus* e *Streptococcus thermophilus*) e a fermentação conduzida por 12 h, a 37 °C, sem agitação. A bebida obtida foi estocada a 5 °C, por 28 dias. A fermentação e a estocagem foram avaliadas por análises físico-químicas (pH, acidez e concentração de sólidos solúveis (SS)) e microbiológicas (contagem de bactérias lácticas em ágar MRS – Man, Rogosa e Shap). Durante a fermentação houve acidificação do substrato (redução média do pH de 7,09 para 4,71 e aumento da acidez de 0,06 para 0,30 g/100 g de ácido láctico) enquanto SS manteve-se estável em 1,0°Brix. A bebida obtida apresentou contagem total de bactérias lácticas de 10,77 log UFC/mL, valor maior que o mínimo (6,0 log UFC/mL) exigido pela legislação brasileira para classificar o produto como bebida láctica fermentada. Ao longo do armazenamento refrigerado verificou-se redução de pH para 4,43 e da contagem de bactérias lácticas para 8,38 log UFC/mL; aumento da acidez para 0,32 g/100g de ácido láctico e manutenção do SS em 1,0 °Brix. Os resultados obtidos indicam que o extrato de castanha do Brasil é um substrato eficiente para a produção de bebida láctica fermentada, podendo ser empregado como matéria-prima alternativa ao leite. Além disso, a bebida mostrou ser estável ao armazenamento refrigerado pelo período analisado (28 dias).

Keywords: Extrato vegetal, Castanha, Fermentação láctica, Vida de prateleira

Production of carotenoids in batch and fed -batch process

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Carotenoids are pigments which have an increasing demand for a wide range of market applications, being commercialized as food colors, cosmetics products and nutritional supplements. The biotechnological production is an alternative to obtain natural carotenoids, but the cost is relatively high, the use of agroindustrial co-products as a source of nutrients is an alternative for bioproduction to become economically viable. Therefore, the aim of this work was the carotenoids production in batch and fed-batch process, using corn steep liquor (CSL) and sugar cane molasses (SCM) in the culture medium, by the yeast *Rhodotorula mucilaginosa* CCT 7668. The culture was accomplished in erlenmyers containing 225 mL and added with 10% of the inoculum, incubated at 25 °C, 180 rpm. Two agro-industrial means were tested: M1 (70 g L^{-1} of SCM and 3.4 g L^{-1} of CSL) and M2 (30 g L^{-1} of SCM and 6.5 g L^{-1} of CSL) in batch and fed-batch process (feed being carried out with 10% of the initial volume of the culture with the medium 10 times concentrated). Biomass and carotenoids were determined. The recovered biomass was dried at 35°C for 48 h, macerated and standardized (mesh 125). Cellular disruption was performed with dimethyl sulfoxide and quantification of carotenoids by spectrophotometry (448 nm). The maximum production of carotenoids 3726.7 µg L^{-1} (118.2 µg g^{-1}) and biomass (16.1 g L^{-1}) was in medium M2 in fed-batch process whit feeding at 96 h. The mean M1 in fed-batch carotenoid production of 2228.7µg L^{-1} (139.4 µg g^{-1}) and biomass of 13.7 g L^{-1} feeding in 168 h. Process in batch the medium M1 carotenoid production of 1404 µg L^{-1} (173 µg g^{-1}) and a biomass of 8.1 g L^{-1} and M2 a total carotenoid production of 740.3 µg L^{-1} (122.8 µg g^{-1}) and a biomass of 6.0 g L^{-1}. It can be observed an increase of 158% and 500% in carotenoids production when comparing the processes between mediums M1 and M2, correspondingly. This increase was also substantiated in biomass production, 169% and 268% for M1 and M2, respectively. It can be observed that the batch process feed induced an increase in the cellular concentration and consequently in the production of volumetric carotenoids. Thus, it can be concluded that this strain of yeast *R. mucilaginosa* indicates potential for the carotenoids production in agro-industrial environment, both in the batch and fed-batch process.

Keywords: *Rhodotorula mucilaginosa*, Bioproduction, Agroindustrial

Screening of lactic acid bacteria and yeast strains suitable for unripe tomato fermentation

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In Portugal, tomato industry is focused on obtaining a single high value product – tomato paste, where only completely mature red tomato enters process plant. The non-use of high volumes of unripe fruits (ca 112 M ton/year), left in the fields along with tomato fruits discharged by the industry, represents huge losses in food, water and energy. However, there is a great potential for this biomass, considering its use as reliable source for added-value marketable products. The valorisation opportunity of these fruits is aligned with the growing interest in innovative processes and technologies for recovering value-added materials compliant with the "circular economy" principles. Lactic acid fermentation is considered as a simple and valuable biotechnology to keep and/or enhance the safety, nutritional, sensory and shelf-life properties of vegetables and fruits. Then, the implementation of controlled fermentation processes and the selection of starter cultures has been a current strategy to increase the consumption of fresh-like vegetables and fruits. Tomato has a very interesting nutritional value, besides having prominent antioxidant, anti-inflammatory and anticancer activities. However, unripe tomato is generally scarce in nutrients and holds higher tomatine levels, a mildly toxic glycoalkaloid. These facts can compromise the tolerance and fermentation performance of the fermenting organisms where the overall yields and productivities largely depend on the choice of the fermenting strain. The purpose of this study was the selection of lactic acid bacteria (LAB) and yeasts strains to be used as starter cultures in unripe tomato foreseeing the development of fermented products that will serve as the basis for highly nutritious sauces and dressing products. The screening of pure strains (35 LAB and 28 Yeasts, from INIAV's strains cultures collection), was undertaken on homogenised unripe tomato, tested *in vitro* (batch fermentations; 72h), for their ability to grow and remain viable. This preliminary selection was based on acidifying ability (ΔpH), sugar consumption (Δ soluble solids content (SSC)) and viable cell counts achieved during the fermentation. While the majority of LAB strains tested showed ability to promote pH and SSC changes, the best performing ones belong to the genus *Lactobacillus* (*plantarum*, *pentosus* and *paracasei*). Only one yeast strain, *Pichia membranaefaciens*, was able to reduce significantly pH and SSC. Nevertheless, the maintenance of yeast flora on future fermentation tests (LAB/yeast combination starters) relies also on their potential contribution to sensorial characteristics of the fermented products.

Keywords: Unripe tomato, Fermented products, Lactic acid bacteria and yeasts, Starter cultures

Estudo da atividade antioxidante em vinhos de açaí elaborados por diferentes processos

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O açaí, fruto nativo da Amazônia, tem recebido grande interesse internacional devido os benefícios à saúde associados a concentração de compostos antioxidantes. Em trabalhos anteriores foi estabelecida a tecnologia para a elaboração de vinho de açaí utilizando dois processos diferentes: maceração do caroço (MC) e polpa de açaí (PA). O objetivo deste trabalho foi determinar a atividade antioxidante nos vinhos obtidos com a utilização dos dois processos de produção. O açaí foi proveniente de Anori e Codajás no estado do Amazonas. No processo PA, a atividade antioxidante foi determinada no mosto antes e após a filtração em terra e no vinho, já para o processo MC foi determinada somente no vinho. A atividade antioxidante foi determinada através da capacidade de sequesto dos radicais $DPPH^{\cdot}$ e $ABTS^{\cdot+}$, redução de ferro – FRAP e quantificação de fenois totais - FT. As análises foram realizadas em triplicata e os resultados expressos em µMET para DPPH e ABTS, µM de Equivalentes de Fe (II) para o FRAP e $mEAG.L^{-1}$ para fenóis totais. Para o açaí coletado em Anori, os valores médios obtidos para o mosto não filtrado nos ensaios DPPH, ABTS, FRAP e FT foram respectivamente: 769,3 ± 3,8; 1356,0 ± 8,4; 1715,0 ± 5,8 e 341,0 ± 0,4; no mosto filtrado foi 1116,8 ± 3,8; 1717,6 ± 7,7; 1965,9 ± 2,5 e 603,8 ± 0,9; no vinho elaborado pelo processo PA foi 1140,0 ± 19,9; 1807,0 ± 33,7; 1526,0 ± 9,6 e 451,0 ± 16,0; no vinho elaborado pelo processo MC foi 1080,0 ± 95,5; 1711,0 ± 109,1; 1937,0 ± 38,0 e 589,0 ± 17,7. A operação de filtração promoveu um aumento nos valores da atividade antioxidante do mosto e do vinho elaborado pelo processo PA. Quando comparada a atividade antioxidante nos vinhos, os maiores valores foram observados no processo PA quando a atividade antioxidante foi determinada através de DPPH e ABTS e no processo MC através de FRAP e FT. Para o açaí coletado em Codajás, os valores obtidos para DPPH, ABTS, FRAP e FT no vinho elaborado pelo processo PA foi de 1090,0 ± 96,0; 1686,0 ± 124,5; 2209,0 ± 391,3 e 572,0 ± 71,8 e no vinho elaborado pelo processo MC foi 889,0 ± 3,8; 1459,0 ± 6,7; 1913,0 ± 5.1 e 583,0 ± 0,5, respectivamente. Comparando os dois processos, os resultados da atividade antioxidante nos vinhos produzidos pelo processo PA foram maiores do que nos produzidos pelo processo MC.

Keywords: *Euterpe precatoria*, Capacidade antioxidante, Processamento, Vinho

Processo simultâneo de sacarificação e fermentação alcoólica de polpa de tamarindo (*Tamarindus indica* L.) para posterior acetificação

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O tamarindo (*Tamarindus indica L*) é um fruto de sabor único muito comum do norte e nordeste brasileiro, rico em fibras. Devido às características sensoriais do produto, sabor ácido e azedo pronunciados, a produção de um fermentado acético deste fruto pode ser uma alternativa interessante. Assim, o objetivo desse trabalho foi avaliar a influência dos parâmetros de processo: temperatura (25, 35 e 38 ^{0}C), concentração de leveduras (1,0, 1,5 e 2% g de levedura seca/g de polpa) e mix de enzimas (Viscozyme® e Pectinex® Ultra tropical – 250, 500 e 750µL/g) sobre o processo fermentativo da polpa de tamarindo diluída. Para este estudo, aplicou-se um planejamento experimental 3^3, com três repetições do ponto central. A sacarificação e fermentação simultâneas foi realizada em erlenmeyers incubadas em shaker a 137 rpm, com controle de temperatura. Para cada tratamento, pesou-se inicialmente 400 g de polpa de tamarindo (16^{o}Brix) e condicionou-se a temperatura do mosto para 37^{o}C. Adicionou-se o mix de enzimas, homogeneizou-se e após 5 min., adicionou-se a levedura *Saccharomyces cerevisiae*, nas concentrações definidas no planejamento experimental. Uma vez adicionada a levedura, o sistema foi colocado dentro do shaker na temperatura do planejamento. As variáveis dependentes: sólidos solúveis, teor alcoólico, acidez total e pH foram analisadas nos fermentados após 24 e 48h do início do processo. Para cada variável dependente foi gerado um modelo matemático e feita a análise de variância (ANOVA). Os modelos gerados apresentaram R^2 próximos de 0,8, exceto para o parâmetro pH (R^2= 0,613), uma vez que houve pouca variação deste parâmetro (2,2 a 2,8) nos tratamentos. Para o processo de otimização da fermentação, foram definidos alguns parâmetros: maior teor alcoólico, maior pH, menor acidez total e menor teor de sólidos solúveis. A condição ótima para a fermentação de polpa de tamarindo durante 24 horas foi: 25°C, 300µL/L de mix de enzimas e 2% de levedura. Também foi otimizado o processo de fermentação em 48 horas e, nesta situação, a condição ótima foi de: 25°C, mix de enzimas a 250 µL/L e 1,1% de concentração de levedura. Os valores dos parâmetros analisados foram satisfatórios para o resultado da fermentação alcoólica para posterior produção de um vinagre, e ambos os tempos de fermentação podem ser utilizados, dependendo dos objetivos e custos do processo. Para melhorar o rendimento alcoólico do fermentado (mínimo de 4%), sugere-se o emprego de aditivos para reduzir a acidez pronunciada da polpa.

Keywords: Pectinase, Planejamento experimental, Vinagre

Food Processing Technologies

Fermentation

Poster Communications

Brewer spent yeast susceptibility to protein hydrolysis: effect of serial repitching and yeast supplier

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Many yeast strains and cultivars are available for beer production because each one may result in a distinct flavor profile and beer characteristics. Brewer spent yeast (BSY) is the second most relevant sub-product from the brewing industry but it is usually discarded or used as unexpensive animal feed. This material is rich in proteins and may be a source of bioactive peptides after enzymatic treatment. The aim of this study was to investigate the susceptibility to hydrolysis of yeasts for Lager Pilsen production using Alcalase™ 2.4L, Protamex™ (Novozymes, Denmark) and a commercial protease mixture for yeast cell hydrolysis, Brauzyn® 100 L (Prozyn, Brazil). Three samples of brewer spent yeast were collected after 11 days of maturation: repitched *Saccharomyces pastorianus* from Lallemand (RSP-L), non-repitched *Saccharomyces pastorianus* from Lallemand (NSP-L) and non-repitched *Saccharomyces pastorianus* from Fermentis (NSP-F). Then, the effect of serial repitching (no repitching and 5 times repitching) and yeast supplier on the degree of hydrolysis (DH*) with those three enzymes was studied, at the same hydrolysis conditions (pH, temperature and enzyme/substrate ratio (E:S), in U $g_{protein}^{-1}$), using an automatic titrator. Protease activity results show that maximum Brauzyn® activity was achieved at low pH (5.6) and high temperature (74°C), but this enzyme showed 17 and 2 times less protease activity per mL when compared to Alcalase™ and Protamex™. When comparing non-repitched yeasts from different suppliers, NSP-F samples presented 18.5% higher DH* than NSP-L samples, when hydrolyzed using Brauzyn®. The effect of serial repitching of *Saccharomyces pastorianus* showed that non-repitched yeast samples were more easily hydrolyzed than the repitched ones. At the same hydrolysis conditions, RSP-L samples took 3.5 more time to achieve the same DH* (3.2 %) using Brauzyn®. Very low DH* where achieved using Brauzyn®, for E:S from 50 to 1500 U $g_{protein}^{-1}$, suggesting this enzyme could not effectively break RSP-L yeast cells alone. Using Alcalase™, higher DH* could be obtained, but RSP-L had to be diluted 1.4 times and a higher E:S was needed to reach the same degree of hydrolysis of NSP yeast during 2 h of hydrolysis. These results suggests that, although all fermentation yeast are imposed to stressful conditions, the successive reuse of BSY cells makes them more exhausted and resistant to breakdown. In conclusion, technologies and approaches proposed to add value and reuse BSY must contemplate yeasts differences in terms of its characteristics and susceptibility to breakdown so that they can be successfully processed.

Keywords: Brewer by-products, Yeast cell wall rupture, Yeast protein hydrolysate, Repitched yeast, Saccharomyces pastorianus, Valorisation of food by-products

Alternative technology for fermentable sugars release from sugarcane bagasse

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Supercritical technologies offer the possibility of new products and processes development with a sustainable approach by reducing the energetic consumption. The use of carbon dioxide in supercritical conditions is a green technology and its use can enhance mass transfer rates. The hydrolysis of the cellulose present in the sugarcane bagasse (lignocellulosic byproduct from the sugar and ethanol industry) into fermentable sugars using enzymatic and supercritical technology is an alternative pathway for the valorization of this byproduct. The objective of this study was to evaluate the effect of supercritical carbon dioxide (SC-CO_2) on the enzymatic hydrolysis of sugarcane bagasse aiming the fermentable sugars release. The influence of the supercritical treatment on the enzymatic hydrolysis of sugarcane bagasse (2 % m v^{-1}) was assessed using a commercial cellulase Cellic CTec2 (Novozymes®) in a Central Composite Design (CCD) to determine the effect of the temperature (40 a 60 ºC), pressure (100 a 300 bar) and time (60 a 180 min). After the treatment, the samples were kept at 50ºC for 24 hours to complete the hydrolysis. The fermentable sugars concentrations were quantified by chromatography. The fermentable sugars release was increased in 32,49% in comparison to the control experiment (without supercritical treatment) in the condition of 200 bar, 50ºC and 120 min. The condition that provided the highest concentration of released sugars (2.340 g.L^{-1}) achieved a cellulose hydrolysis yield of 32.4%. In this way, it was possible to increase the hydrolysis of a lignocellulosic by-product using sustainable technologies.

Keywords: Supercritical fluid, Cellulase, Sugarcane hydrolysis

Evaluation of different lignocelulosic biomasses as a source of xylan for the production of xylooligosaccharides by enzymatic hydrolysis

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Xylooligosaccharides (XOs) are non-digestible oligomers consisting of 2 to 10 xylose units. These compounds are considered prebiotics and have several biological effects on human health. Two different agricultural residues, called sugar cane straw (SS) and coffee peel (CP) were tested for the XOs production. The production of XOs was performed by enzymatic hydrolysis of xylan, which was obtained by alkaline extraction of these agricultural wastes. Depending on the source, these two agricultural wastes were found to contain different amounts of hemicellulose, cellulose and lignin. The highest amount of arabinose was found in SS xylan, while CP xylan had mainly xylose and small amount of glucose. The commercial xylanase (Endo-1,4-β-xylanase) *Aspergillus niger* from Megazyme® was evaluated for the production of XOs from these xylan sources using a 2, 4, 6 and 10U /mL enzyme concentration in a solid loading of 5% (w/v) for 12 hours at 50°C. The higher enzymatic loading (10 U / mL) provided the higher conversion of xylan to both residues, however both also presented lower concentration of XOs and higher xylose concentration. When decreased to 4U / mL, the highest total concentration of XOs (678.78 ± 1.08 mg / L) was found mainly in X3 and X4 in CP xylan, while in SS xylan (789.56 ± 1.19 mg/L), although using 6U/mL. HPLC analyzes of the hydrolysis products indicated that the two sources of xylan showed a similar profile of xyloligosaccharides (X2> X3> X4> X5> X6), thus demonstrating that both are potential sources of xylan for the production of xyloligosaccharides.

Keywords: Enzymatic hydrolysis, Coffee peel, Sugarcane straw, Xylooligosaccharides

Produção de bebida fermentada de extrato de arroz utilizando kefir de leite

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Kefir é uma cultura simbiótica de microrganismos utilizada para produção de bebidas fermentadas. Existem dois tipos de grãos de kefir – de leite e de água, comumente utilizados para fermentar leite ou solução aquosa açucarada, respectivamente. O kefir de leite promove hidrólise da lactose, produzindo ácido láctico, gás carbônico, etanol e outros compostos minoritários. A bebida obtida é de baixo teor alcoólico, levemente efervescente e refrescante. Apesar do leite ser a principal matéria-prima para fermentação de kefir de leite, tem crescido consideravelmente o número de consumidores que apresentam algum tipo de restrição à lactose ou proteínas do leite e também aqueles que desejam uma alimentação vegana. A indústria de alimentos tem investido no desenvolvimento de produtos a base de extratos vegetais como alternativa aos derivados de leite. Um dos extratos com potencial de aplicação nesta área é o de arroz, que apresenta alto valor energético, proteínas e aminoácidos, sais minerais, vitaminas do complexo B e baixo teor lipídico. O objetivo deste estudo foi avaliar a produção de fermentado de extrato de arroz utilizando kefir de leite. As fermentações foram realizadas em Erlenmeyers de 250 mL, contendo 100 g de extrato de arroz e 5 g de kefir de leite (fornecido por um produtor local), a 25 °C, por 24 h, sem agitação. Foram feitas medidas da massa (inicial e final) dos grãos de kefir e substrato e com estes dados foram calculados o crescimento celular (X), rendimento da bebida (Y) e produção de CO_2 (C). Foram realizados também medidas de pH, concentração de sólidos solúveis (SS) e acidez (inicial e final). As fermentações foram realizadas em quintuplicata e foi feito uma condição controle com leite de vaca. Os resultados obtidos para o fermentado de arroz foram: X = 23,21, Y = 91,43 e C = 9,94 (g/100g), pH variou de 5,16 para 4,21 e SS de 3,5 para 3,3 °Brix, enquanto a acidez aumentou, de 0,72 para 0,98 g/100g em ácido láctico. Os resultados foram semelhantes aos obtidos com leite de vaca, exceto quanto à produção de gás carbônico, cerca de duas vezes maior com o extrato de arroz. Os dados também se encontram dentro dos valores estabelecidos pela legislação brasileira para bebidas fermentadas por kefir, o que permite concluir que o extrato de arroz é um substrato em potencial para produção de fermentado por grãos de kefir de leite.

Keywords: Extrato vegetal, Arroz, Fermentação, Kefir

Estudo da cinética de fermentação na elaboração artesanal de hidromel

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Antigas civilizações não tinham muitas fontes de açúcar disponível para a produção de bebidas alcoólicas, sendo o mel a principal fonte da época, assim, o hidromel é a mais antiga bebida alcoólica conhecida, sendo substituído pelo vinho com o desenvolvimento agrícola. O hidromel é produzido a partir da fermentação de leveduras do gênero Saccharomyces no mosto, sendo este preparado a partir da diluição do mel em água e adição de sais minerais. Atualmente, o consumo de hidromel retoma importância em diversos países, porém, no Brasil, a bebida ainda é pouco difundida, por falta de investimento e avanço científico nessa área. Tendo em vista problemas encontrados no processo de produção artesanal, este trabalho teve como objetivo elaborar um hidromel e avaliar os parâmetros envolvidos na cinética de fermentação, viabilizando sua fabricação para pequenos produtores e agregando valor à apicultura. O hidromel foi obtido a partir da preparação do mosto, que se deu pela diluição do mel em água potável (1:4); adição de sais minerais e correção do pH (4,0). Posteriormente, inoculou-se a levedura *Saccharomyces cerevisiae*, sob a forma de fermento de panificação (0,5 g/L-1). O processo fermentativo foi conduzido a 20 ± 2ºC por 10 dias. O acompanhamento do processo era realizado diariamente a partir das análises de sólidos solúveis totais (°Brix) por refratometria e teor alcoólico por ebuliometria. Ao cessar a fermentação, o mosto foi acondicionado sob refrigeração para decantar, realizando posteriormente sua trasfega e envase. Analisando o processo de fermentação do hidromel, observou-se que o consumo dos açúcares pelas leveduras teve início a partir do segundo dia. Em nove dias de fermentação, 50% dos açúcares do mosto foram transformados em álcool. A partir daí, o valor do °Brix foi estabilizado e a fermentação encerrou-se no dia seguinte (décimo dia). Já a produção de etanol pelas leveduras alcançou uma concentração final de 12% v/v. Entre os dias 7 e 9 de fermentação a produção de álcool foi mais intensa. Dado o aumento da concentração de álcool no hidromel, a partir do nono dia, as leveduras não conseguiram dar continuar a fermentação, interrompendo a conversão de açúcar em álcool. Através dos resultados obtidos é possível concluir que a levedura utilizada no processo, na forma de fermento de panificação, tem potencial para produção artesanal de hidromel, posto que a partir dela os açúcares presentes no mosto foram consumidos e transformados em álcool, resultando em um hidromel com teor alcoólico de 12% v/v.

Keywords: Mel, Bebida alcoólica, *Saccharomyces cerevisiae*

Simultaneous bioproduction of sweeteners and ethanol from sisal hydrolysis

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Biotechnology production is an important alternative for industry, as is the use of renewable biomass that has been generating cleaner energy because of the power to minimize environmental impacts. In this context, sisal is a biomass obtained in hot and dry climate regions and has low economic value and shows potential in obtaining fermentable sugars, valuing the productivity of industrial sweeteners and ethanol, reaching the challenges of sustainability. Thus, the aim of this study was to use pre-hydrolyzed fiber, bagasse and sisal mixture (bagasse + fiber) for the simultaneous bioproduction of xylitol, arabitol and ethanol from sisal hydrolysis. Physical-chemical analyzes were performed for the lignocellulosic characterization of sisal biomasses, cell growth analyzes, as well as characterization and quantification of sugars in the prehydrolysed liquors were analyzed by high performance liquid chromatography during the experimental factorial design, in which we evaluated the concentration of acid solution and the time of hydrolysis as independent variables on the amount of monomeric sugars in response. The consumption of sugars and the production of polyols and ethanol were also analyzed by HPLC in the fermentation culture of each sisal biomass (fiber, bagasse and mixture). Cultures were performed using Debaryomyces hansenii yeast to evaluate the production of xylitol, arabitol and ethanol. In this work, the fermentative parameters were evaluated. According to the results obtained, it is possible to emphasize that the yeast Debaryomyces hansenii was able to grow in the media with sisal hydrolysates, besides being able to assimilate all the sugars present in the liquors like glucose, xylose and arabinose to produce xylitol, arabitol and ethanol, concomitantly, during 96 hours of fermentation demonstrating the efficacy of sisal in the supply of high susceptibility substrates.

Keywords: Lignocelulosic biomass, Polyols, Debaryomyces hansenii, Xylitol, Arabitol

Production of lipids and carotenoids by *Rhodorotula mucilaginosa* using agroindustrial medium based on molasses and corn steep liquor

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The carotenoids and lipids have great industrial applicability, among them as food colorants and biofuels, respectively. Biotechnological production is an alternative to obtain these compounds naturally. Oleaginous yeasts, such as *Rhodotorula mucilaginosa*, stand out because they present high growth rate and assimilation capacity of several substrates. Therefore, the aim of this work was the carotenoids and lipids production in agroindustry medium using corn steep liquor (CSL) and sugar cane molasses (SCM) as subtrate, by the yeast *Rhodotorula mucilaginosa* CCT 7688. The culture was accomplished in erlenmyers containing 225 mL and added with 10% of the inoculum, incubated at 25 ° C, 180 rpm. Two agro-industrial mediuns were tested: M1 (70 g L^{-1} of SCM and 3.4 g L^{-1} of CSL, in batch process) and M2 (30 g L^{-1} of SCM and 6.5 g L^{-1} of CSL, in fed-batch process, feed being carried out with 10% of the initial volume of the culture with the medium 10 times concentrated). The recovered biomass was dried at 35 ° C for 48 h, macerated and standardized (mesh 125). Cellular disruption was performed with dimethyl sulfoxide and quantification of carotenoids by spectrophotometry (448 nm). The determination of lipids was carried out at the end of the cultivation, using a mixture of methanol and chloroform with 3 phases, where the lower phase was rotavaporator and dried at 70ºC quantified by dry mass gravimetry. The carotenoid production in medium M1 was of 467.3 µg L^{-1} (33.3 µg g^{-1}) and a biomass of 7.2 g L^{-1} with a culture duration of 168 h. The medium M2 in fed-batch carotenoid production of 450.9 µg L^{-1} (27.5 µg g^{-1}) and biomass of 16.3 g.L^{-1} feeding in 168 h, duration of the 240 h culture. The lipid content at the end of the culture was 10.0 and 12.0% for the media M1 and M2, respectively, for comparison a culture with standard medium YM (malt and yeast extract) was carried out where the lipid production was of 19% and carotenoids of 448.6 µg L^{-1} (77.42 µg g^{-1}). The production of carotenoids was similar when compared to YM and reached on average approximately 60% of the standard medium for lipid production. Therefore, agroindustrial medium have shown promise in the production of lipids and carotenoids and it is an alternative of utilizing and valuing these co-products of the food industry.

Keywords: Bioproduction, Oleaginous yeast, Co-products

Production of vinegar from green and mature coconut water

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Coconut water is a natural drink with low calories, pleasant taste and known worldwide which contains considerable amounts of total soluble solids, vitamin C, minerals and phenolic compounds. When the coconut water is poorly preserved, become susceptible to microbial grow with high enzymatic activity favoring the acetic fermentation. The use of coconut water in vinegar production would be an alternative resulting in added value product. This work is aimed to compare the physical properties and the fermentation time of the vinegar produced from green and mature coconut water, at different conditions (dark and light). It was carried out alcoholic fermentation in plastic bottles with in dark and light environment followed by acetic fermentation. The produced vinegars were submitted to determination of total soluble solids (as brix), pH and titrable acidity before and after the acetic fermentation process using standard methods. The results showed that the vinegar produced from green coconut water had a better quality in terms of soluble solids content which was low
(2.13 ± 0.031), lower pH (3.7 ± 0.005) and higher acidity (4.8 ± 0.082%) compared to vinegar from the mature coconut, which contained 4.21 ± 0.019 (soluble solids), pH (5.4 ± 0.008) and lower acidity (4.3 ± 0.026%). Dark environment is the better condition to carry out the fermentation process (14 days) than in light environment which takes 28 days.

Keywords: Vinegar, Coconut water, Acetic fermentation

Mead production using Red Star Montrachet and AWRI 976 strains of *Saccharomyces cerevisiae*

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Honey and water are the main ingredients in the mead production by microorganisms. The production of mead still occurs in an empirical and homemade way and during the last fifteen years, research has been carried out to improve the manufacturing process, such as selection of fermentation agent. The aim of this work was to evaluate the mead production by Red Star Montrachet and AWRI 976 strains of *Saccharomyces cerevisiae*. Honey was diluted to 30°Brix with distilled water supplemented with yeast extract (5 g/L), malt extract (5 g/L), peptone (10 g/L), magnesium chloride (0.05 g/L), ammonium sulfate (0.3 g/L) and dibasic ammonium phosphate (0.05 g/L). The fermentations were carried out in triplicate using a system that consisted of 500 mL flasks containing 250 mL of wort mixture in pH 5.0, at 30 °C in a biochemical oxygen demand (BOD) incubator during 288 h using 10^6 cells/mL as initial inoculum. The bentonite used to purify the mead was previously hydrated (10% stock solution in distilled water, prepared 24 h in advance) and added to the wort in the ratio 0.5 g/L. A mead containing 3.6 g/L and 6.4 g/L glucose (consumption of 96.8% and 55.6%), 27.4 g/L and 39.6 g/L fructose (consumption of 78.6% and 65.4%), 104.3 g/L and 94.53 g/L ethanol and cell concentration of $12.4x10^7$cel/mL and $11.5 x10^7$ cel/mL after 288 h were obtained using *S. cerevisiae* Red Star Montrachet and AWRI 976, respectively. The highest transmittance value (99.3%) of mead, obtained with *S. cerevisiae* AWRI, differs statistically from 92.3% obtained with *S. cerevisiae* Montrachet ($p < 0.05$). The highest values of color intensity (1.947), tonality (2.1) and the percentage of yellow color (63%) in the mead produced by Montrachet differed statistically ($p < 0.05$) from those obtained with AWRI.

Keywords: Honey, Saccharomyces cerevisiae, Mead, Purification

Elaboração de Kombucha E Estudo da Sua Composição Microbiológica

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Originada no Nordeste da China, a Kombucha é uma bebida que tem sido consumida em todo o mundo, sendo conhecida por promover ações antioxidantes, antimicrobianas, anticancerígenas, dentre outras. Entretanto, no Brasil ainda não existe legislação específica, apenas um projeto de lei para estabelecer padrões de identidade e qualidade da Kombucha. Dessa forma, é indispensável a realização de estudos que contribuam para isso. Assim, o objetivo do presente trabalho foi elaborar uma Kombucha a partir da fermentação do chá preto, observando aspectos do seu processo fermentativo, bem como analisar os microrganismos presentes na bebida. A bebida foi preparada a partir da fermentação do chá preto (2%) adoçado com açúcar (10%) e a "mãe da Kombucha" - uma película de celulose contendo os microrganismos responsáveis pela fermentação. Foram testadas duas condições de fermentação: temperatura ambiente e 30°C. O processo de fermentação foi controlado diariamente através das análises de pH e sólidos solúveis (°Brix) e encerrou-se após a formação de uma nova película de celulose. Para as análises microbiológicas, as amostras da Kombucha foram inicialmente inoculadas em Caldo Extrato de Malte para o enriquecimento e em seguida em meios de cultura específicos de isolamento para o crescimento de bactérias acéticas e leveduras presentes na bebida. As colônias formadas foram avaliadas macroscopicamente (visualmente) e microscopicamente, através de um microscópio ótico (BIOFOCUS/BIO16000). Os resultados obtidos demostraram que a fermentação da Kombucha foi mais eficiente sob temperatura de 30 °C, formando uma nova película (± 0,5 cm de espessura) após seis dias de fermentação, enquanto que, sob temperatura não controlada, essa película só foi observada após 15 dias de fermentação. No decorrer do processo fermentativo (30°C) o valor do °Brix decaiu de 8,1 para 6,7 comprovando que os açúcares do chá foram convertidos pelas leveduras em etanol e este oxidado pelas bactérias formando ácidos, como acético, lático e glucônico, reduzindo o pH da bebida. As bactérias avaliadas na bebida apresentaram características semelhantes às das espécies *Acetobacter pasteurianus, Leuconostoc, Enterococcus* e *Propionibacterium*. Já as leveduras demostraram semelhança com as espécies *Brettanomyces, Zygosaccharomyces, Kluyveromyces marxianus, Lachancea fermentati* e *Kazachstania unispora*. A presença desses microrganismos confirma o potencial probiótico da bebida, uma vez que todos eles auxiliam no bom funcionamento do intestino. Por fim, tendo em vista que a Kombucha não é tão difundida no Brasil, estudos que ajudem a determinar suas características e composição microbiológica são importantes para sua comercialização e seu consumo de forma segura.

Keywords: Chá preto, Fermentação, Mãe da Kombucha

Effects of an enzymatic treatment with xylanase and transglutaminase on the technological parameters of flaxseed enriched form-type breads

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Flaxseed (*Linum usitatissimum* L.) has high content of α-linolenic acid, as well as fibers and phenolic compounds such as phytoestrogens. Bread is a staple food consumed worldwide, representing a good vehicle for nutritional enrichment. However, the addition of raw materials high in fiber can negatively affect the specific volume and texture, making necessary the alternative for their improvement through the addition of coadjuvants. The objective of this work was to study the effect of brown flax meal (BFM) and enzymes on the technological and nutritional parameters of form-type breads. The fatty acid composition the content of phenolic compounds and the oxidative stability were determined by the induction period (IP). Wheat flour was partially replaced by flax meal in form-type breads, with addition of transglutaminase and xylanase, at 11 treatments levels determined through a Rotational Central Compound Design (DCCR). After the analysis of specific volume (SV), density (D) and expansion index (EI), the optimized treatment was chosen. The statistical evaluation of the DCCR was made by regression analysis, (p-value < 0.1), analysis of variance, response surface and contour curves. The BFM content of phenolic compounds (as gallic acid equivalents) was 211.53 mg GAE/100g flour, α-linolenic acid (C18:3) was the most abundant fatty acid and the IP of the flaxseed flour oil was up to 3.76 hours at 80 °C. From the DCCR, the treatment with 7.5% of transglutaminase and 6.0% of xylanase was selected (SV: 2.71±0.12; EI: 1.07±0.01 and D: 0.37±0.12). This treatment showed an increase of 74.17% in lipid content and of 39.02% in proteins, respect to the standard formulation. The sensory attributes averages were of 7.76±1.66; 7.27±1.67; 7.23±1.56; 7.48±1.63 for color, aroma, flavor and texture, respectively. Therefore the use of transglutaminase and xylanase contributed to the improvement of the physico-chemical and sensory quality parameters of flaxseed fiber rich-bread.

Keywords: Enzymes, Bread research, Linseed

Food Processing Technologies

Food Physicochemical Properties (Rheology)

Oral Communications

Effect of fat substitution using long-chain inulin and fortification with microencapsulated alcium in the rheological and sensory properties of yogurt mousse

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Background: Fortification with nutrients and fat reduction are current trends in the development of dairy products. Reducing fat decreases attributes of quality like the creaminess. Also, adding minerals like calcium could increase the chalky texture. A possible solution to these defects is the addition of fat substitutes such as long-chain inulin and micro-encapsulated minerals. Rheology is a useful tool that evaluates structural changes of semi-solid food that could also be related to the sensory texture. Objective: The aim of this study was to evaluate the effect of fat reduction using inulin as a substitute and the addition of microencapsulated calcium, in the rheological and sensory properties of four yogurt mousse samples. Methods: Three yogurt mousse samples (MY1 and MY2 MY3) with different levels of fat (0, 4, 8%), inulin (0, 2.8, 4.8%) and calcium (0.17, 0.25, 0.50%), as well as a standard yogurt mousse (MYe) (8% fat, 0% inulin and 0.17% calcium) were elaborated. Small and large deformations rheological tests, and sensory profiles by a multidimensional approach were performed to all samples. Results: Total fat reduction (MY1) decreased the creaminess, softness, firmness, yield stress (σ_0) and consistency index (K) with respect to MYe. On the other hand, MY2 (with intermediate levels of fat, inulin and calcium) showed similar results to MYe in these sensory and rheological (small and large deformations) variables. Finally, the addition of microencapsulated calcium did not significantly increased the chalky texture of yogurt mousse fortified samples. Conclusions: The use of inulin as fat substitute and the fortification with microencapsulated calcium not only enhances yogurt mousse structure, but also maintains its sensory quality in terms of creaminess and chalky texture related to these nutritional modifications.

Keywords: Yogurt mousse, Long-chain inulin, Microencapsulation, Rheology, Sensory analysis.

Analysis of textural characteristics in bread prepared with incorporation of ewe's whey

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Bread is considered one of the basic foods consumed all over the world. Because the flours used for baking bread vary greatly in terms of chemical composition and also because of the differences in the baking processes used, breads constitute a group of food products with extremely heterogeneous structures, which in turn determine bread textural characteristics. The present trend to enrich breads with nutritional components has led to the utilization of residues from the food industry as a way to join the advantages of recuperation of beneficial compounds with the minimization of environmental impacts.
The objective of this work was to develop new breads incorporating whey residue obtained from ewe's milk after the production of Serra da Estrela Cheese. The developed products were analysed in terms of textural properties, and compared with a basic wheat bread also produced under similar conditions. To measure the textural properties, two types of test were performed (compression and puncture). The results indicated that the whey residue could be successfully used to produce bread with desirable textural properties, and this was particularly important for the improved formulation, which aimed to bring additional nutritional benefits to the consumer. The improved whey bread presented good textural characteristics, which remained practically unchanged after 24 h without any special type of container. This consistency in the textural properties was verified for all the properties evaluated: hardness, chewiness, resilience, cohesiveness, springiness evaluated by the compression test and external firmness, inner firmness, stickiness, adhesiveness evaluated by the puncture test. Furthermore, very strong correlations were found between some of textural properties, namely between cohesiveness and resilience and between adhesiveness and stickiness.

Keywords: Compression test, Puncture test, Residue valorisation, Textural properties

Morphometric properties of popcorn geometries

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Popcorn is an important corn-snack food, relatively inexpensive, which is easily and quickly prepared and is sold through retail outlets, fast-food shops and confectionary industries. The expansion phenomena has been analysed to obtaining quality parameters such as expansion volume (σ), flake size (π), and the percent of unpopped kernels (ω) aiming to the optimization and improvement of shelf life of food commodities such as cereal-based products, mainly popcorn maize. Moreover, they can have different morphologies such as mushroom, unilateral, bilateral and multilateral, which are classified according to the direction of expansion of the corn kernel. These morphologies are important to their quality and consumption preferences. The objectives of the present work were to study popping features and popcorn morphology as related to the moisture content of the corn kernels, by using digital image analysis (DIA) of hot air popped popcorn. Popcorn kernels were conditioned to 14% mc (wb) and then popped on a hot-air popper. Morphometric parameters evaluated were, area, perimeter, circularity, Feret's diameter, aspect ratio, roundness and solidity by using the ImageJ software for DIA performance. Also, physical properties such as kernel volume, surface area and angle of repose were correlated to morphometric parameters. Physical properties of popcorn were dependent on the analysed parameters. The different morphologies had equal values of Vp, Sp, area, perimeter, and circularity. Physical properties of the morphologies were the result of the energy dissipated during the expansion process. Average expansion volume for the whole batch of popped kernels, flake size and unpopped kernels values were: 37.96 cm3/g, 5.19 cm3/kernel and 4.53%, respectively, which resulted higher than reported values for popcorns obtained by microwave oven, oil pan and hot air methods. This study contributes to the quantitative analysis and understanding of the geometric structures of the popped corn by means of their physical properties and morphometric parameters, providing valuable information for further research on popcorn production by the application of DIA.

Keywords: Popcorn morphology, Image analysis, Morphostructure, Digital image analysis

Effect of modification with guar gum and microwave heating on rheological properties of cassava starch

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Modified cassava starch is a prospective ingredient for the food industry. Starch modification by physical processes as microwave radiation is environmentally sustainable, enables better conditions for the use of energy resources and can provide different functionalities to the starch. This work aims to study the effect of microwave radiation and the addition of guar gum (1 g gum/100 g starch) to cassava starch. The starch was modified by dissolving the hydrocolloid in distilled water followed by the addition of the cassava starch under magnetic stirring. After oven drying (45 °C/ 12 h) the samples were treated with microwave (620 W, 2450 MHz) for 4 and 6 minutes in adjusted initial moisture at 25%. Effects of modification on rheological properties of starch were evaluated. The gelatinization temperature (T_{gel}) was determined by temperature sweep (oscillatory shear) using the starch dispersion (10% w/w). Starch dispersions (5% w/w) were gelatinized at 95 °C for 30 min followed by cooling to 25 ºC. Small-amplitude oscillatory shear (strain and frequency sweeps) and flow curves were performed at 25 ºC. No significant difference was observed in T_{gel} of the samples, which was approximately 62.0 ± 1.6 ºC. The frequency sweeps tests, for all samples showed predominantly elastic behavior as indicated by larger G' (elastic modulus) than G" (viscous modulus) values and can be described as weak gels. Microwave treated starches had higher G' values throughout the frequency range studied (0.1 - 10 Hz) compared to untreated starch (native and guar), with starch treated for 4 minutes having the highest G'. The modification with guar gum and microwave treatment promoted higher gel stability, which may be attributed to the stronger composite network structures of the starch-guar mixtures. All samples exhibited non-Newtonian behavior (Herschel-Bulkley) with flow behavior index (n) ranging from 0.49 to 0.60. It was observed the increase of consistency index (k) from 1.88 to 7.45 and the yield stress from 0.76 to 4.72, suggesting a trend of increase in viscosity. It can be concluded that the proposed modification has a positive effect on the rheological properties of cassava starch, allowing to improve technological properties such as retrogradation and enabling an application as a thickener in food products.

Keywords: Gel rheology, Cassava starch, Hydrocolloids, Microwave

Application of chemometrics in the identification of the origin of coalho cheeses from different mesoregions of Bahia-Brazil analyzed through texture and physico-chemical properties

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The objective of this work was to analyze the texture and physic-chemical properties of coalho cheeses from different mesoregions of Bahia-Brazil for origin identification, applying chemometrics. Coalho cheeses produced in three different mesoregions that produce the largest coalho cheeses in Bahia-Brazil were analyzed: Center-South, Far-West and South, with different batches and expiration dates, totaling 61 experimental units. Samples were collected individually and refrigerated at 6 °C for 20 consecutive days, frozen at -20 °C on the 20th day of refrigeration until the analyzes, under standardized experimental conditions. The physic-chemical characterization was performed in triplicate, being determined fat, total proteins, moisture, ash, acidity, pH, total dry extract and the melting capacity. The Texture Profile Analysis (TPA) was carried out in five times, being evaluated the parameters of hardness, elasticity, cohesiveness and chewing. The chemometric analysis was performed using the Principal Component Analysis (PCA) technique to reduce the dimensionality of the data, differentiate and classify the samples. The physical-chemical parameters of humidity, pH, ash, fat and protein were in accordance with the values recommended by the legislation. Three PC (90% of the variance) were required to explain the dimensionality of the data. With the dispersion analysis, the separation of the samples was observed according to the mesoregions, and the cheeses of the Far-West differed from the South and Center-South and the fat, moisture, total dry extract and melting contributed significantly to it. This can be explained by the regional peculiarities that exist in the production process, that affect the composition of the final product. In analysis of the textural properties, it was observed that the greater the cohesiveness, the greater the chewability, parameters related to the firmness of the product. Two PC were able to explain 99.24% of the data variability and showed a significant correlation with hardness and chewing ($\alpha = 0.001$), which had great influence on the behavior of the samples. With the dispersion analysis, it was observed the formation of different groups in a discrete way, evidencing the separation of the cheeses of the South mesoregion in relation to the others, considering that all texture parameters in this region were higher, which can be explained by the particularity of the coastal cities, which present their own characteristics. Thus, it was possible to separate and identify the origin of the coalho cheeses by mesoregion from the analysis of the physical-chemical and textural properties and the application of chemometrics.

Keywords: Dairy products, PCA, TPA

Extracción, estabilización y caracterización reológica del mucilago de Sanky (*Corryocactus brevistylus*)

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El Sanky (*Corryocactus brevistylus*) es una cactácea considerada un fruto promisorio del Perú que viene siendo materia de estudio por sus propiedades funcionales y nutricionales de la pulpa, que va desde su contenido de potasio superior a frutas como el plátano hasta en un 40%, posee 43.40 mg de vitamina C/100 g y una capacidad antioxidante de 474.8 µg TEAC/g [1; 2]; por lo que la utilización industrial del fruto se basa en la obtención de su pulpa y que trae consigo la generación de residuos que son comúnmente desechados como las cascaras y una torta compuesta por fibras y semillas (aproximadamente 25 % de la producción). La torta del Sanky presenta un aspecto viscoso que denota la existencia de mucilagos que podrían ser usados para modificar la reología de soluciones acuosas. El objetivo de este trabajo fue desarrollar un proceso a escala semi-industrial para obtener y estabilizar el mucilago presente en la torta del Sanky. Para establecer las mejores condiciones de extracción del mucilago y estabilización por atomización se experimentó un diseño factorial 2^3. Para la etapa de extracción se tuvo como variables al pH, temperatura y el tiempo, y como respuestas al rendimiento de extracción (% en base seca) y a la viscosidad del extracto (Cp máximo); mientras que para la atomización se tuvo como variables operativas a la temperatura de aire caliente, flujo de alimentación y la proporción de encapsulante Maltodextrina DE10, sobre el rendimiento del polvo obtenido. Bajo las condiciones ensayadas se obtuvo como parámetros optimizados en la extracción acuosa-alcalina a un pH 10, temperatura 60°C y 1 hora; mientras que en la estabilización por atomización se encontró como factor significativo al flujo de alimentación con un parámetro optimizado de 500 mL/Hora. Las temperaturas ensayadas (130 y 170 °C) y la concentración de encapsulante (5 y 10 % Maltodextrina 10 DE) no fueron significativos en el rendimiento del polvo obtenido. Finalmente, los ensayos reológicos practicados al mucilago en polvo suspendido en agua al 2% p/v, demostró un comportamiento reológico similar a la goma arábiga al 2 % p/v y goma guar al 0.1 % p/v; resultados que abre la posibilidad de ser usado como estabilizante y coadyuvante de procesos en la industria alimentaria y farmacéutica.

Keywords: *Corryocactus brevistylus,* Sanky, aditivos naturales, propiedades reológicas, mucilago

Food Processing Technologies

Food Physicochemical Properties (Rheology)

Poster Communications

Propriedades reológicas de emulsões de oleo essencial de laranja doce e diferentes encapsulantes

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O presente estudo avalia a capacidade espessante de nanofibras de celulose (NFC), extraídas do resíduo de eucalipto, em emulsões poliméricas contendo goma arábica (GA), maltodextrina (MD) e óleo essencial de laranja doce. Seis tratamentos foram avaliados em delineamento inteiramente casualizado, subdivididos em dois grupos (sem e com adição de NFC), com três repetições. O comportamento reológico foi determinado na temperatura ambiente (25°C) utilizando o reômetro HAAKE ReoStress 6000 (Thermo Scientific), equipado com banho termostático e sistema de controle de temperatura universal, acoplado a um conjunto de sensor de geometria de cilíndricos concêntricos (5,3 mm GAP). Cada amostra foi submetida a rampas contínuas de cisalhamento (crescente, decrescente e crescente) com taxa de deformação entre 0 a 300 s^{-1}, durante 2 min para cada curva. Os dados da segunda curva crescente foram utilizados no ajuste dos modelos Lei de Newton, Lei da Potência e *Herschell-Buckley*. Dentre os modelos empregados, o modelo Lei de Newton apresentou os melhores ajustes para as emulsões sem adição de NFC, com altos valores de coeficiente de determinação ($0,9997 \leq R^2 \leq 1$) e baixos valores do erro do quadrado médio ($0,0411 \leq RMSE \leq 0,3504$). Tal comportamento evidencia a tendência linear da viscosidade, independentemente do tempo de aplicação de cisalhamento ao fluido e da taxa de deformação aplicada, típico de fluídos Newtonianos. A substituição parcial de GA por MD contribuiu para reduzir a viscosidade Newtoniana (μ, Pa·s) [0.242 ± 0.002 (GA), 0.172 ± 0.002 (GA/MD 3:1), 0.100 ± 0.001 (GA/MD 1:1)], determinada por este modelo. Por outro lado, o comportamento reológico, apresentado pelas emulsões adicionadas de nanofibras de celulose, foi descrito pelo modelo Lei da Potência ($0,9996 \leq R^2 \leq 0.9999$ e $0,0411 \leq RMSE \leq 0,3504$). A presença de NFC promoveu o aumento do índice de consistência (k, $Pa \cdot s^n$), ou seja, a viscosidade do meio [0.985 ± 0.017 (GA NFC), 0.837 ± 0.004 (GA/MD 3:1 NFC), 0.857 ± 0.027 (GA/MD 1:1 NFC)], quando comparados aos mesmos tratamentos sem a presença deste material. Em relação ao parâmetro índice de comportamento de fluxo ($0,779 \leq n \leq 0,872$), também determinado pela Lei da Potência, foram verificados valores menores que uma unidade ($n < 1$), típico de fluidos pseudoplásticos, que apresentam variação da viscosidade em função da taxa de deformação. Assim, a adição de NCF mostrou-se adequada para aumentar a viscosidade e manter a estabilidade das emulsões de óleo essencial de laranja para posterior secagem em secador por nebulização.

Keywords: Polimeros, Viscosidade, Oleos essenciais

Influence of *Spirulina* on textural and microstructural properties of cereal bars

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Cereal bars attract the consumers due to their versatility and convenience, besides the high sensorial quality. In the development of this product, the physical properties should be carefully evaluated since are directly related to the acceptance by the consumers. *Spirulina* microalga is considered a functional ingredient to these foods due to the high content of nutrients and biocompounds present in its composition. The Food and Drug Administration (FDA) approved *Spirulina* as safe food without toxicological effects on human health. Foods such as pasta and extruded snacks have already been enriched with *Spirulina*. These foods showed modifications on physical and structural properties after addition of high biomass content into the formulation. In this context, this study aimed to evaluate the influence of *Spirulina* addition on the textural and microstructural properties of cereal bars. Three formulations were developed: C (Control), SP2 (2% *Spirulina* biomass) and SP6 (6% *Spirulina* biomass). The samples were evaluated regarding hardness and microstructure, using the texture analyzer and scanning electron microscope, respectively. Furthermore, the moisture content was evaluated. Data were analyzed using analysis of variance (ANOVA), and the Tukey test was used to determine the differences between the means ($p < 0.05$). The results of the hardness were 81.35±3.74 N, 82.45±5.42 N and 52.36±3.37 N, respectively for C, SP2, and SP6, without significant differences ($p > 0.05$) between the Control and SP2. The micrographs confirm that the C and SP2 samples presented a more compact structure when compared to SP6 structure. These results indicate that the addition of 2% *Spirulina* does not alter the hardness of the cereal bars. The SP6 showed hardness significantly lower ($p < 0.05$), probably due to the moisture content of this sample (12.68±0.66 g/100g) that was statistically higher ($p < 0.05$) than the content observed in samples C (10.73±0.38 g/100g) and SP2 (10.75±0.10 g/100g). Despite that, the moisture content obtained for all the samples are in agreement with previous studies that developed cereal bars. Therefore, we concluded that *Spirulina* could be used as an ingredient of cereal bars in the concentration of 2% without hardness and microstructural change.

Keywords: Snack bars, Microalga, Hardness

Yoghurts enriched with β-carotene nanoemulsions: effect on texture and reology

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Different technics of nanoencapsulation has been demonstrating a high capacity to protect bioactive compounds during storage and facilitated its manipulation. But the addition of this nanostructures, as nanoemulsions, can affect the appearance and texture of the products. In the yogurt consistency and viscosity are one of the main factors involved in the quality and acceptance of the product, so the present work aimed to evaluate the effect in the rheology and texture parameters of the enrichment of yogurts with β-carotene nanoemulsion. The nanoemulsion were formulated with corn oil (70 % w/v), β-carotene (0.2 mg mL-1), Span 80 (30 % w/v) and Tween 20 (0.1 % w/v) by applying high-pressure homogenization (10.000 psi, 2 min). Yogurt preparation with reconstituted whole milk powder and milk culture mix was fermented at 45 °C to pH 4.7. Two formulations were developed: one control and the other with the addition of 15% (w/w) of the nanoemulsion. Penetration assays were used to determine the texture of the yogurt in the texture analyzer (TA.XT plus). For the viscosity analysis a Brookfield digital rheometer was used, and from the curves, the Waele Ostwald model was tested to determine the parameters of consistency coefficient (K) and flow behavior index (n). The texture parameters were significantly ($p<0.05$) affected by the addition of nanoemulsion. The values of firmness, consistency, cohesiveness and the viscosity index of the control yogurts were 13.08±0.78, 238.56±27.55, -12.11±0.76 and -14.55±2.88, respectively, while the yogurts with nanoemulsion presented reductions of 43 % (firmness), 55% (consistency), 39% (cohesiveness) and 66% (viscosity index) in the texture parameters. Yogurts with and without nanoemulsions showed a good fit to the Waele Ostwald model (R^2 0.98 and 0.87). The addition of nanoemulsion decreased significantly ($p<0.05$) the consistency coefficient, from 6.93±1.14 Pa/s (control) to 3.68±0.009 Pa/s (with nanoemulsion) and increased significantly ($p<0.05$) the flow behavior index, from 0.07±0.01 (control) to 0.20±0.007 (with nanoemulsion) presenting behavior of pseudoplastic fluids. The addition of nanoemulsions to yogurts significantly affected the rheology and texture of the product because of these formulations having large amounts of water, which alters the structure of the yogurt. Despite that the enrichment of yogurts with a bioactive vitamin A precursor compound such as β-carotene is interesting, and the use of nanoemulsions facilitates the incorporation of these lipophilic compounds into the alimentary matrix.

Keywords: Nanotechnology, Carotenoids, Food

Comparación de la producción y comportamiento reológico de exopolisacáridos bacterianos sintetizados en medios a base de manitol y coproductos lácteos

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Los exopolisacáridos (EPS) son polímeros de carbohidratos producidos por microorganismos, con amplia variedad de estructuras y capaces de formar geles, emulsiones, aumentar viscosidad y biodegradables; podrían ser producidos a partir de coproductos industriales para reducir costos y mejorar características. El objetivo de este trabajo fue comparar parámetros de cultivo, rendimiento y comportamiento reológico de una solución acuosa de un EPS bacteriano producido en un medio con manitol y un medio con coproductos lácteos. La bacteria *Mesohizobium huakuii* Semia 6454 fue cultivada en medio YMA (*Yeast Manitol Agar*) y en medio modificado (PC) con 10 g/L de permeado de suero en substitución del manitol y 2,28 g/L de calostro bovino en polvo en substitución del extracto de levadura, conservando la misma relación C/N (20). El cultivo fue realizado durante 96 h a 30°C y 200 rpm por triplicado y se determinó la biomasa, pH y rendimiento final de EPS. Posteriormente, el EPS fue dializado y liofilizado y se analizó la viscosidad (1% m/v) y comportamiento reológico por el modelo matemático Ostwald-de-Waele (Ley de la Potencia). El análisis estadístico fue realizado por medio de prueba T Student (95% de significancia). La biomasa final en ambos medios fue estadísticamente igual ($p \geq 0,05$) registrándose en YMA 0,57 ± 0,08 g/L y en medio PC 0,42 ± 0,01 g/L, además el pH inicial de los cultivos inició cercano a la neutralidad y disminuyó a 5,40 ± 0,08 para YMA y para para el medio PC inició cerca de 6,1 y terminó en 5,88 ± 0,05. El mayor rendimiento de EPS fue encontrado en medio YMA con 3,69 ± 0,172 g/L y en el medio PC fue de 1,69 ± 0,17 g/L, siendo estadísticamente diferentes ($p \leq 0,05$), por lo que, para la producción de EPS por esta bacteria, el manitol resulta mejor asimilado que los coproductos lácteos. Las soluciones acuosas presentaron un comportamiento no Newtoniano, correspondiente a este tipo de materiales, y la mayor viscosidad fue determinada para el EPS proveniente del medio YMA. Además, se determinó el carácter pseudoplástico por medio del índice de comportamiento de flujo ($n < 1$) y el índice de consistencia K, siendo ambos estadísticamente mayores para el EPS proveniente de YMA. El uso de los coproductos lácteos no mejoró el rendimiento ni el comportamiento reológico del EPS, comparado con el sintetizado en medio YMA. Se agradece a CAPES y OEA por la concesión de la beca para la elaboración de este trabajo.

Keywords: Biopolímeros, Rizobios, Comportamiento reológico

Encapsulation of pitanga (*Eugenia uniflora* l.) Leaves extract into w/o emulsion: rheological properties and stability

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Emulsions are systems formed by two immiscible liquids, where one liquid is dispersed in the other in the form of droplets. Water-in-oil (W/O) emulsions may be used for encapsulation of aqueous active compounds to protect their active properties and increase their stability. The Pitanga (*Eugenia uniflora* L.) is a tree plant of the Myrtaceae family, whose leaves extract has high antioxidant and antimicrobial activity. The objective of this research was to study the rheological behavior and stability of W/O emulsions containing pitanga leaves hydroethanolic extract (PLHE). The PLHE was obtained by extraction with ethanol 60% (v/v) and freeze-dried. W/O emulsions were produced in the proportions of 10/90, 20/80 and 30/70 using the PLHE resuspended in water (1 g PLHE/10 mL water) as the inner aqueous phase, and soybean oil as the dispersing lipid phase. Polyglycerol polyricinoleate (PGPR) was used as emulsifier, added in the lipid phase (3 and 5 g/100 g oil). The aqueous and lipid phases were emulsified using a Ultraturrax homogenizer (15000 rpm/5 min) and an ultrasonic homogenizer (30% amplitude and 3 cycles of 30 s). The physical stability of emulsions was measured with a multisample analytical photocentrifuge, and the emulsion with the lowest instability index was characterized in relation to particle size and rheological behavior (shear stress, shear rate, apparent viscosity). Regardless of the formulation, the emulsions presented a very low instability index. Emulsion 20/80 containing 3% (w/w) of PGPR showed instability index of 0.015 ± 0.003 and was chosen as the optimum emulsion (ME). The mean particle size and span determined from ME were 1.9 ± 0.01 µm and 1.0 ± 0.01, respectively. Regarding the rheological behavior, the ME showed a Newtonian behavior with low viscosity (104.6 ± 0.6 mPa.s), but consistent with the stability results. As conclusion, these results suggest that the use of W/O emulsions for encapsulation of pitanga leaves extract is efficient, since the emulsion produced with 20% pitanga leaves hydroethanolic extract as aqueous phase and 89% soybean oil dispersant phase is highly stable.

Keywords: *Eugenia uniflora* L., W/O emulsion, Rheology, Stability, Particle size

Effect of esterification with octenylsuccinic anhydride and dual modification on morphological, functional and structural properties of potato starches

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The starch esterification with octenylsuccinic anhydride (OSA) is a reaction of the starch hydroxyl group with the OSA reagent, in which OSA groups are introduced into starch chains to produce esters that have hydrophilic and hydrophobic properties. In food industry, OSA starches are applied in carbonated drinks, juices, energy drinks, alcoholic beverages, salad dressing, coffee cream, among others. The objective of this study was to evaluate the effect of two esterification methods on the morphological, functional and structural properrties of the modified potato starches. Two modifyng methods were used: the first, esterification with OSA (OSA-starches), and the second, a pretreatment with ultrasonic homogenizing and esterification with OSA (US-OSA-starches). The starches isolated from three Andean native potato varieties: *Imilla blanca* (IB), *Imilla negra* (IN) and *Loc'ka* (LK) were modified. The degree of substituition (DS) was measured. The OSA and US-OSA granules morphology was analyzed by SEM, the particle size granule was measured by laser diffraction, granules structure was evaluated by FTIR, gelatinization properties were analyzed by MCDSC, and pasting properties were measured by hybrid rheometer. The DS of OSA and US-OSA starches were ranged between 0.0092-0.0105 and 0.0105-0.0145, respectively. Both modified starches showed the Maltase cross, indicating that the modification process did not disorganize the granular structure in the starch components; although these methods produced visible changes in the surface of the granules. The granule size distribution for OSA-starches showed two granule size populations, ranged between 0.6 and 400 µm; meanwhile, the US-OSA starches showed three granule size populations, ranged between 0.1 and 1000 µm. The gelatinization temperatures of OSA-LK starch were lower than those of US-OSA-LK starch. The peaks viscosities of OSA and US-OSA starches, ranged from 4500 to 5550 mPa·s. The X-ray diffraction pattern for both modified starches was B type, US-OSA starches showed the lowest crystallinity. Fourier transform infrared spectroscopy (FTIR) showed an increase in the 995/1022 cm^{-1} ratio in US-OSA starches respect OSA starches, which indicated an alteration of the double helical structure. Also, FTIR showed two new peaks (1739 and 1575 cm^{-1}) after modification for OSA and US-OSA starches. The OSA starches (IB and IN) showed higher viscosity (PV) than US-OSA starches; although, OSA-LK and US-OSA-LK starches showed the same PV. Thus, the US-OSA starches showed higher DS than OSA starches, and similar functional properties; nevertheless, further studies within this project will evaluate the application of these US-OSA-starches as an agent for emulsion preparation.

Keywords: Esterification, OSA starch, Ultrasonic homogenizing, Crystallinity, FTIR, Pasting

Secagem de quiabo e caracterização física do pó

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O quiabo é um fruto de origem africana, da família *Malvaceae*, com cultivo disseminado em países tropicais. Apreciado na composição de pratos quentes, tem a comercialização restringida ao produto *in natura*, com vida útil curta mesmo sob refrigeração. A secagem acompanhada de transformação em pó permitiria a ampliação da oferta dessa hortaliça para compor as mais diversas combinações, sobretudo àquelas que requerem aumento de consistência, devido a propriedade de conferir viscosidade, própria do quiabo. Este trabalho foi realizado com o objetivo de desidratar quiabos com casca por liofilização, avaliando as características do pó obtido. Estudou-se o comportamento reológico do pó de quiabo dissolvidos em três meios de diluição, água, leite e leite de coco (*Cocus nucifera*) na proporção pó:diluente de 1:15, obtendo-se os dados viscométricos em viscosímetro Brookfield, nas temperaturas de 20, 30, 40 e 50 °C e velocidades de rotação de 5 a 200 rpm, ajustando-se os modelos reológicos de Casson, Herschel-Bulkley, Lei-da-Potência e Mizrahi-Berk aos dados experimentais. As soluções preparadas com o pó reconstituído apresentaram comportamento pseudoplástico em todas as temperaturas e taxas de deformação, com viscosidades mais baixas nas diluições com água (até 858 mPa.s) e mais altas em leite (até 41133 mPa.s). Em rotação de 5 rpm, estado próximo ao repouso, como em ocasião de consumo, a viscosidade aparente das soluções decresceu de 41133 para 26067 mPa.s entre 20 e 40 ºC, aumentando para 28333 mPa.s a 50 ºC, comportamento que pode ser atribuído a gelatinização de amido. Em velocidade de rotação elevada a 200 rpm, que simularia processos de transferência industriais, as viscosidades aparentes repetiram o comportamento, decrescendo de 3545 para 858 mPa.s entre 20 e 40 ºC. Dos modelos reológicos ajustados, os de Herschel-Bulkley, Lei-da-Potência e Mizrahi-Berk apresentaram coeficientes de determinação (R^2) entre 0,89 e 0,99 e desvios percentuais médios entre 0,37 e 8,5, enquanto o modelo de Casson resultou em ajustes menos precisos, com valores de R^2 entre 0,77 e 0,98 e desvios percentuais médios entre 3,3 e 6,4.

Keywords: *Abelmoschus esculentus* (L.) Moench, Espessante, Viscosidade, Consistência

Rheologic effect of selected acrylamide reducing agents from plant extracts in wheat and rye bread

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Bread is a staple food worldwide with an annual intake recommended by the WHO of 60kg / capita. Strategies to mitigate the occurrence of substances harmful to human health such as acrylamide (AA) should not interfere in food properties perceived by the consumers.
The objective of this work was to assess the rheologic (texture and color) effect on two types of bread formulas (wheat and rye) that the addition of acrylamide reducing agents from vegetable extracts (oregano, fennel, lemongrass, pear Rocha peel) may generate. Thirty-four batches of bread dough were prepared, with the extracts (liquid and dried). Each batch was composed of one control sample and five replicates added with extracts. Selected flour formulas were mixed followed by: controlled fermentation, division of units; cooking in traditional oven (TO) and convection oven (CO), 8 of wheat and 9 of rye for each oven. All variables were defined and controlled (fermentation and cooking time, cooking temperature, homogeneity of premixes). A Texture Profile Analysis (TPA) assay was performed. Six parameters of bread texture profile were determined: toughness; springiness; cohesiveness; gumminess; chewiness. Objective color measurement was calculated by the determination of colorimetric coordinates in the CIE L * a * b * color space. Through the chromatic coordinates a * and b *. The following reduction values were obtained: oregano in rye bread 17.7% (CO), in wheat bread 31.6% (TO) and 21.7% (CO); lemongrass in rye bread 27.5% (TO) and 7.8% (CO); fennel in wheat bread 33.5% (TO) and 41.5% (O2); peel of Rocha pear in rye bread 27.3% (CO), in wheat bread 19.2% (TO) and 12.5% (CO). Regarding to toughness, in wheat flour, the addition of the extracts of lemongrass (dry and aqueous) and fennel (dried) made the bread softer. In rye flour, the toughness was not influenced by the addition of extracts. There were changes in cohesiveness related to the type of oven. Extracts didn't influence elasticity of breads neither cause changes in the color. Crossing the acrylamide mitigation effects, and the rheological results will enable the election of the best baking process according to the varieties of bread.

Keywords: Wheat Bread, Rye bread, Rheology, Plant extract, Acrylamide

Effect of enzymatic treatment on jackfruit pulp viscosity

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Fruit growing is an extremely important activity for income generation and agricultural development in Brazil. Jackfruit (*Artocarpus heterophyllus* Lam.) is a wild plant distributed throughout the tropics and subtropics, and widely disseminated in the northeast of Brazil. Due to it is high carbohydrate content and nutritive value, jackfruit pulp has a great potential for the production of alcoholic beverages, but is still underutilized. Nowadays, the pectinases are an integral part of fruit juice and winemaking industry, to reduces viscosity, clarification and juice treatment to optimization of fermentation process in wine industry. Pectinases are a group of enzymes responsible for the degradation of the long and complex chains of pectic substances, a structural polysaccharide which makes up the wall of plant cells. The main objective of this work was evaluate the effect of enzymatic treatment on the viscosity of jackfruit pulp, aiming the application of the pulp for mead production, a beverage obtained by fermentation of the honey wort diluted in water. The hydrolysis was performed with Pectinex Ultra SP-L (Novozymes, Denmark), using an experimental design with three independent variables: enzyme concentration (X1 0,01 - 0,09%), temperature (X2 30 - 60ºC) and time (X3 20 - 100 min). Response surface methodology was used in the results analysis, the software Statistica 7.0 was used to generate the statistical model with analysis of variance (ANOVA), the response function measured was the viscosity of the samples. The temperature was adjusted to the desired level in a water bath and at the end of experiment the enzyme was inactivated by heating the suspension at 90ºC for 5 min in a water bath. Viscosity was measured using a Brookfield Viscometer (model DV II+ Pro), at 5 rpm with spindle S04. The use of the highest enzyme concentration (0.09%) produced a significant reduction in the viscosity of jackfruit pulp, from 3353 cP to 108 cP, being thus highly efficient in this process. It was observed that samples with lower viscosities (108 and 111 cP) were obtained using a longer hydrolysis time and a higher enzymatic concentration, regardless the temperature used. The statistical analysis indicates that the proposed model was adequate, with lack of fit no significant and value of R^2 0,994. All parameters were significant at a 95% confidence level. Thus, the different conditions for enzymatic treatment showed that all the variables markedly affected the viscosity of the pulp.

Keywords: Jackfruit, Enzymatic treatment, Viscosity

Effect of slaughter weight and beef cut on the tenderness of 'Cachena' meat

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Despite recent recommendations towards a reduction, the moderate consumption of meat is desirable due to its high biological value protein content, containing all essential amino acids in adequate proportions.

The consumer usually considers three attributes when buying meat: appearance, colour and presumed tenderness considering the meat cut. After purchase, the most important attribute is tenderness.

The aim of this study was to assess the effect of slaughter weight and beef cut on 'Cachena' meat tenderness. Texture was evaluated by texture profile analysis (TPA) and Warner-Bratzler shear force (WB) of the muscles *Longissimus dorsi* (LD) and *Psoas major* (GP) of two groups of animals. The first group (light animals) consisted of 16 animals with live weights between 142-225 kg, and the second group (heavy animals) with 16 animals with live weights that between 272-335 kg. Sensory attributes were assessed by a trained panel of tasters through a quantitative descriptive analysis of the LD muscle. The animals were reared on a farm in Barrancos and were slaughtered at the Beja slaughterhouse. Meat cuts were kept at 2°C and analysed 72h after slaughter. Results were analysed with Statistica v.12 software using ANOVA and Tukey's HSD test ($P<0.05$).

Slaughter weight and meat cut influence meat tenderness. There are differences ($P<0.05$) in meat hardness between animal groups, the meat of light animals being more tender than that of heavy animals (11.12N±4.57 and 15.17N±7.22, respectively). However, according to WB, the LD shows higher shear forces compared to the GP muscle (27.82N±10.48 and 25.58N±5.37, respectively), which may be related to the fact that light animals have more connective tissue.

Regarding meat cuts, LD (15.70N±7.83) is harder than GP meat (10.92N±3.21). The same was observed for chewiness, with more energy needed to chew LD (5.95J±3.50) compared to GP meat (3.99J±1.64). These results agree with those from WB, because it is necessary to apply greater shear forces to LD than to GP meat (27.82N±10.48 and 25.58N±5.37, respectively).

Concerning sensory analysis, the tasters consider heavy animals to have tender meat ($P<0.05$), which agrees with WB results. Therefore, sensory evaluation is better correlated with the meat's WB than with the force necessary for compression (hardness) or the energy needed for chewing (chewiness).

Further studies are being undertaken considering higher slaughter weights and less noble beef cuts.

Keywords: Texture profile analysis (TPA), Warner-Bratzler shear force (WB), Longissimus dorsi (LD), Psoas major (GP), Meat tenderness, Beef cuts

Food Processing Technologies

Optimization of Food Processes

Oral Communications

Improving the quality of carob spirit drinks

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Carob spirit is a typical drink from Algarve that has been prepared since the 18th century by local producers. However, the properties of raw materials, which possess low content of fermentable sugars, and the poor control over the fermentation process, has lead to a reduced quality spirit drinks.
The present study aims the improvement the carob spirit quality to make it accepted and more appreciated by consumers. The studies were conducted in an industrial distillery. Before fermentation fruit carob fragments after removing the seed was macerated for 3 days in a pH 1 aqueous solution prepared with phosphoric acid, to promote the release of fermentable sugars. Before fermentation calcium carbonate was then added to adjust the pH to 3. Commercial yeasts were then added and the fermentation allowed to take place in closed containers for 15 days. Distillation was performed immediately after fermentation using a copper distiller. A calcium carbonate filter was placed on the top of the distillation column to remove acids. The physical and chemical properties of the obtained drinks were analysed according to the International Organization of Vine and Wine (OIV). The distillates were also analysed by GC-FID, GC-MS. One hundred individuals, 50 from Portugal and 50 from foreign countries performed a sensory evaluation of the drinks. This evaluation was achieved in a sensory laboratory and in an event organized in Vale do Lobo (Algarve). The traditional and laboratory prepared spirits show similar contents of methanol, 1-propanol, 2-methyl-1-propanol, 2-methyl-1-butanol + 3 methyl -1-butanol and acetaldehyde. However important quality parameters such as total acidity, ethyl acetate and copper, which are commonly in excess in traditional drinks and decrease their quality, showed contents of 13.3 ± 0.2 g/hl pure alcohol (p.a.) (expressed as acetic acid), 68.3 g/hl p.a. and less the 0.1 mg/L, respectively, which denotes a reduction greater than 80 % in all the cases. Therefore, the above-described procedure allowed for a significant quality improvement of carob spirit. Moreover, all the foreign individuals and 90 % of Portuguese gave positive sensorial appreciation of the drink.

Keywords: Carob spirit, Copper distiller, Calcium carbonate filter, GC-FID, GC-MS

Agglomeration process of rice protein concentrate powder using grape pulp as binder: in-line monitoring of particle size

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Rice protein concentrate (RPC) has raised interest in food industries due to its nutritional value and nutraceutical properties. However, RPC powder presents fine particles (D_{50} = 54.2 µm) with moderate flowability and low wettability (wetting time of 140 s), limiting its use as a food ingredient or dietary supplement. The production of porous granules with high wettability, called instant powders, is performed by agglomeration process, which represents an efficient way to improve the quality of the RPC powder. Grape pulp can be a potential binder for the agglomeration since it is rich in anthocyanins, that are associated with human health benefits. The application of the Spatial Filter Velocimetry (SFV) as a process analytical technology (PAT) tool for in-line particle size monitoring in agglomeration of pharmaceutical products is already under investigation, but this use in agglomeration of food products is in the early stage. This study aimed to establish the optimal condition to produce an instant and nutritional food powder by fluidized bed agglomeration of RPC using grape pulp as binder. The influence of binder flow rate (1.5 - 2.5 mL/min) and fluidizing air temperature (65 - 85 °C) upon the process yield, median particle size and anthocyanins content in the agglomerated powder was examined. Moreover, the effect of operating conditions on particle size evolution was evaluated by a SFV probe. Statistical analysis showed that the binder flow rate was the variable that most influenced the process yield as well as the median particle size. The temperature, in turn, was the variable that most influenced the anthocyanins content. The factorial design allowed the establishment of an optimal operating condition (77 °C and 1.98 mL/min) that provided an increase in the median particle size of about 6 times (D_{50} = 302.8 µm) and high process yield (71.1 %). This condition afforded an instant powder with anthocyanins incorporation (11.79 mg/100g), low moisture content (3.33 %), reduced wetting time (4.1 s), very good flowability, and high protein content (81.56 %). The results suggest that grape pulp can be of special value for application as a binder in agglomeration of RPC. In-line particle size information showed the particle growth and the breakage of the granules. High binder flow rates, as well as low air temperatures, favour the formation of granules which were more resistant to breakage during the drying. The instant powder produced presents high potential for the development of functional products and hypoallergenic formulations.

Keywords: Agglomeration process, Rice protein, Anthocyanins, In-line particle size monitoring

Alternative inhibition mechanisms to sulphur dioxide for polyphenol oxidase reduction in apricots

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Turkey is the world leader in production of both fresh and dried apricots, and ranked first as it shares 74% of total export value of dried apricots around the world. Certain limit of sulphur dioxide (SO_2) in dried apricots is strictly set by the authorities for the human well-being. Inhibiting polyphenol oxidase (PPO) enzyme in apricots using SO_2 is a crucial step to retard enzymatic browning and obtain golden color of dried apricots popular in market. In conventional method of dried apricot production, apricots are first exposed to SO_2 gas prior to drying. Excess sulphuring of apricots may cause reduction in export volume of the products due to the SO_2 limitations set by the authorities and also threaten the human health. In this study, thermal treatment and dipping the apricots into different inhibitor organic acid solutions, as the alternative methods to sulphuring or supportive methods for low level sulphuring were investigated in order to prevent enzymatic browning in two commercially important apricot cultivars, “Hacıhaliloğlu” and “Kabaaşı” from Turkey. Methods for optimum thermal process conditions and organic acid usage prior to drying of fresh apricots were developed as the pre-treatment for enzymatic browning. Freshly harvested apricots that are at different maturation stages (semi-mature, mature, over-mature) were first blanched with steam for 5 min and then dipped into 3% and 5% (w/v) of organic acid (citric acid, ascorbic acid, oxalic acid, or cocktail) solutions containing 0.6% (w/v) NaCl for different time intervals. Pine needle extract was also applied to observe its inhibitor effect on PPO enzyme as well. As a result, ascorbic acid exposure was more effective at inactivating PPO enzyme in apricots at semi-mature stage than the enzyme in fresh apricots at mature and over-mature stages. The inactivation rate of PPO enzyme was 99% just after steam blanching the fresh apricots prior to organic acid application. However, enzyme regeneration occurred within 24 hours after holding blanched apricots at room temperature. Combined effect of blanching and organic acid applications was investigated and 5% (w/v) of ascorbic acid and oxalic acid applications for 10-15 min were effective at reducing PPO enzyme in significant values without allowing regeneration. Blanching followed by dipping the fresh apricots in oxalic acid solution for 15 min was found most useful application as an alternative to potential allergenic SO_2 or supportive treatment for the less sulphured apricots while producing dried apricots that are accepted by most of the consumers.

Keywords: Apricots, Hacıhaliloğlu, Kabaaşı, Organic acid, Polyphenol oxidase, Sulphur dioxide

Optimization of the synthesis of acetylated potato starches using Taguchi robust method

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Starch is a biodegradable and environmentally acceptable material used for energy storage in seeds, roots and tubers. Native starches (NS)are desirable for a range of industrial applications; although, may not be appropriate in some food process. Acetylation alter starch structure which involves the develop its functional properties. The objective of this study was optimizing the reaction conditions for synthesizing acetylated starch (ACS). The three potato starches were isolated from Andean native potato varieties: *Imilla blanca* (IB), *Occucuri blanca* (OB) and *Piñaza* (PÑ). Acetic anhydride (AA) was used for acetylation, and the optimization process was conducted using a L_9 orthogonal array of Taguchi method. The independent factors for the optimization were: AA concentration (X_1), starch/water ratio (X_2) and reaction time (X_3) with three levels: X_1 (4, 6, 8%), X_2 (100/225, 62.5/225, 25/225) and X_3 (15, 45, 75 min); and the dependent factor was viscosity of starch gels (mPa·s, Y_1). The criterion considered for optimization was lower S/N ratio is best for Y_1. The ACS granules morphology was analyzed by SEM, granules structure was evaluated by FTIR, gelatinization properties were analyzed by MCDSC, flow behaviour and viscoelasticity properties were measured by hybrid rheometer. It was possible to optimize the acetylation process for each starch: IB (4%, 25/225 g/mL, 15 min), OB (4%, 25/225 g/mL, 75 min) and PÑ (4%, 25/225 g/mL, 75 min). The degree of substitution (DS) of ACS for use in food was according to FDA standards. The acetylation did not affect the morphological structure of the granules. FTIR spectra confirmed some new absorption bands at 1727, 1643 and 1361 cm^{-1} assigned to carbonyl, acetyl antisymmetry deformation vibration and acetyl symmetry deformation vibration, respectively. The ACS showed lower gelatinization temperatures and enthalpy than NS, and ACS-PÑ showed the lowest. Pasting properties such as peak viscosity (PV) was the lowest for ACS-OB, and ACS starches showed higher PV than native ones. NS and ACS gels showed a shear-thinning behavior (n<1) with a low yield stress (σ_0), ACS-OB showed the lowest σ_0. Starch gels storage modulus values (G') were higher than those of the loss modulus (G") for NS and ACS; also, both showed their frequency dependence. Thus, acetylation decreased functional properties of ACS, this is very important to the food industry due to the need of low-power applied to the process. Further study within this project will evaluate the application of these ACS as barrier materials for natural extracts encapsulation.

Keywords: Acetylated starch, Optimization, Pasting, Viscosity, FTIR, Taguchi

Extracción supercrítica del aceite y producción de azucares fermentables a partir de semilla de uva (*Vitis vinífera L*) var. Malbec.

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El procesamiento de uva para la obtención de productos como vinos y piscos, pueden generar alrededor del 20 -25 % de residuos sólidos, de los cuales el 50% son cascara de uva, el 25% tallos y el 25% restante semillas [1]; lo que termina haciendo de estos residuos un recurso biológico renovable y barato para ser utilizado como materia prima en la obtención de aceites funcionales y carbohidratos (azucares fermentables), que en el caso del aceite podrían ser utilizados en la industria cosmética, mientras que los azucares fermentables sería un sustrato adecuado para procesos biotecnológicos orientados a la producción de etanol y otros productos de mayor valor agregado como el ácido polimálico. El objetivo de esta investigación fue aprovechar la semilla de uva variedad malbec, para la obtención de un aceite nutracéutico usando CO2 supercrítico y para la producción de azucares fermentables mediante hidrolisis químico-enzimático luego de la extracción supercrítica. La obtención del aceite se realizó utilizando un equipo de extracción de fluidos supercríticos - FSC (FST 150 – FTE System,USA), teniendo como parámetros operativos a la temperatura 60 °C, 6615 PSI y un flujo de CO2 de 5 pie3/H; seguidamente se determinó el perfil de ácidos grasos mediante GC-MS. Con los residuos de la etapa previa, se realizó el proceso de hidrólisis en dos fases: un tratamiento con ácido clorhídrico [HCL 0.1 N] a una ratio de 1:10 y por un periodo de 30 y 60 minutos, para luego someterse a un tratamiento con enzimas celulasas a 2,4,6,12 y 18 horas. Las condiciones operativas del hidrolisis químico-enzimático se establecieron determinando el incremento de azucares fermentables, medido por el contenido de Azucares Reductores Totales (ART). En cuanto a los análisis practicados al aceite obtenido por FSC, se determinó que el 64.9 % fueron poliinsaturados, 22.2 % monoinsaturados y 12.9% saturados, teniendo como ácidos grasos predominantes al linoleico 62.4%, oleico 23.9 % y palmitico 9 %. Finalmente, de los ensayos de hidrolisis se determinó que el tiempo mínimo del tratamiento acido debe de ser 60 minutos; mientras que para el tratamiento enzimático debe de ser 12 horas considerando una dosificación de enzimas celulasas mayor o igual a 1 µL/mL, permitiendo producir 8.43 g glucosa/ L. El hidrolizado obtenido deberá ser concentrado para alcanzar niveles de azucares para la producción industrial de etanol u ácido polimálico.

Keywords: Vitis vinífera L, Residuos agroindustriales, Industria vitivinícola, Azucares fermentables

Food Processing Technologies

Optimization of Food Processes

Poster Communications

Combined Ultrasound-Microwave Assisted Extraction of polyphenols from avocado peel var. Hass

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Introduction: Avocado peel is rich in phenolic compounds which can be extracted by green technologies such as Ultrasound and Microwave. Thus, the objective is to study the extraction applying UAE and MAE and to combine both methods for the maximum recovery of TPC. The phytochemical characteristics of yield (%), Total Phenolic Content (TPC), Total Flavonoid Content (TFC), Total Anthocyanin Content (TAC) and color (L*a*b); antioxidant and antibacterial inhibition are determined.

Materials and methods: Before optimizing the UA-MAE combined method, the principal factors affecting the TPC were identified by multivariate ANOVA for each method separately. For UAE time (15,30 and 60 min) and temperature (40,50 and 60 ^{o}C) were evaluated while 250, 500 and 700 watts for 30, 60 and 120 s were applied for MAE. All the extractions were performed employing a hydroethanolic solvent (80%). The maceration was carried out for 12 h. The optimal extracts were dried; the phytochemical and biological activities were assessed through DPPH, FRAP, Lipid peroxidation inhibition (LPO) assay, as well as *L. monocytogenes, Sta. aureus, B. cereus, E coli, and Salmonella spp.* % of inhibition.

Results and discussion: Up to15 min of sonication at 60^{o}C and 500 W in a range of 60 to 120 s significative affected the TPC ($p<0.05$).Thus, 15 min of sonication and 95.1 s of microwaving were the optimal parameters to recover 166.3±4,9 mg GAE/ g DM, which was approximately 1.3, 1.2 and 1.1 times higher than UAE, MAE, and maceration respectively. The experimental values agreed with the predicted by the model (absolute error ~ 0.3%). Likewise, the UA-MAE was upper in yield (25.3 ± 0.6 %), TPC (281.4 ± 0.2 mg GAE), TFC (62.0 ± 0.4 mg QuE) and TAC (4.8 ± 0.1 mg cyanidin-3-O-glycoside) and DPPH, FRAP and LPO (779.1 ± 0.6 ,167.0 ± 2.3 µg TEAC, 70.03 ± 0.62 % respectively) per gram of dry extract. Since all the extracts showed activity against gram-positive and negative bacteria (30-96%) the macerated presented the higher *L. monocytogenes* inhibition (53.7±2.07 %). Cavitation and microwaves synergistically increase the metabolites release.

Conclusion: Ultrasound and microwaves were successfully combined to optimize the extraction of phenolics from the avocado peel. The TPC is upper than those already reported. For the very first time, the total anthocyanins contented in avocado peel are quantified. The reddish blue color of the extracts opens the possibility to be exploited as co-pigment and to preserve food systems.

Keywords: Phenolics, Sustainable extraction, Byproducts, Avocado

Acceptance-rejection and liking level of whole-milk and low-fat and calcium-enriched yogurt mousses, by a population of older adults

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'Percoca Terzarola' is a cultivar of peach that grows in Southern Italy, especially in Campania Region. Peaches are rich source of phenolics and antioxidant compounds which offer health promoting benefits. Drying is widely used in food industry, to prolong the shelf life, improve the food stability and reduce the quality changes. In this context, drying combined with various pretreatments has been proposed with the aim of reducing various adverse changes. For all the reasons above, optimization of drying parameters (i.e. temperature and drying time) should be taken into consideration for the overall quality of final products. In this study, the influence of hot air drying temperature and an innovative dipping solution on drying kinetics, quality parameters (i.e. colour, shrinkage, antioxidant activity), sensorial evaluation and rehydration behaviour of 'Percoca Terzarola' slabs was investigated. Drying experiments were conducted on slabs with a thickness of 6 mm and diameter of 29 mm in a convective drier at 45, 50, 55 and 60 °C with a fixed air velocity of 2.3 m/s. Afterwards, all dried slabs were rehydrated in distilled water at 30 °C. Samples pre-treated with innovative solution (TR) were found to have a shorter drying time: 480, 390, 360 and 330 min at 45, 50, 55 and 60°C respectively, compared to untreated (UTR) ones with 540, 480, 465 and 390 min at the same respective temperatures. Furthermore, at the same moisture content, treated peaches had lower shrinkage by comparison with untreated ones for all temperatures.

Colour coordinates (L*, a* and b*) were collected and Hue angle (H°) was calculated. The fresh peaches showed values of L* (lightness) (74.28±1.53) and H° (94.85±1.04). TR slabs dried at 60°C had the highest L* (77.06±0.40) and H° (90.65±0.38) values. On the contrary, the lowest L* value (65.63±1.12) was found for UTR ones dried at 45 °C. Furthermore, the TR samples dried 60°C resulted in the highest rehydration ratio (5.82±0.03). With regards to antioxidant activity, at lowest temperature it was found the highest antioxidant activity; specifically, TR slabs dried at 45°C showed the best EC_{50} value (29.97±0.42 mg/mL) with respect to fresh peach (12.06±0.36).

Overall results showed that for treated peach slabs drying conditions of 60°C air temperature are the optimum for the product quality in terms of drying kinetics, colour, shrinkage, rehydration behaviour and sensorial evaluation.

Keywords: 'Percoca Terzarola' peach, Hot air drying, Pre-treatment, Rehydration, Valorization

Influence of the alcoholic extraction process on the fatty acid profile and minor compounds content of baru almond cake oil

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The baru tree (*Dipteryx alata Vog.*) is a native Brazilian cerrado plant that stands out for its use in the furniture and charcoal industries, as well as the interest in agriculture for human and animal consumption. Due to the significant amount of oil (43%) in its seed (almond), it is extracted by mechanical pressing. This process results in the baru almond cake, a partially defatted and protein-rich residual material, which gives rise to the baru flour, widely used in the local cuisine. In order to add value to the processing chain and to improve the quality of the defatted meal, this study proposes to evaluate the influence of the oil extraction process using alcoholic solvents, ethanol or isopropanol, replacing the industrial solvent, hexane, highly toxic, pollutant and flammable. Besides being considered safer operationally, these alcohols demonstrated a great capacity of extraction of minor compounds with antioxidant and nutraceutical characteristics, due to their higher polarity. In this way, the viability of solvent substitution was evaluated in terms of the influence of the extraction process variables (solvent type, temperature and number of theoretical stages) on the oil extraction yield, fatty acid profile and content of minor compounds, notably tocopherol isomers. Solid-liquid extraction experiments in two or three stages were performed by contacting the baru almond cake (Flora do Cerrado Ltda - Pirenópolis/GO - Brazil) with ethanol or isopropanol, with 0, 6, and 12 mass% of water, at temperatures of 60 and 90 °C, and keeping constant the mass ratio solid:solvent in 1:4. The extraction yield was calculated based on the initial and residual oil amount, the fatty acid profile was determined by GC-FAME, and the tocopherol content was evaluated by HPLC. Results showed that the addition of water to the alcoholic solvent negatively affected the oil extraction efficiency, while the increase in temperature favored this process, being possible to extract approximately 98 % of the oil with absolute solvents at 90 °C. The fatty acid composition of oils obtained from sequential alcoholic extraction was characteristic of baru almond oil, with predominance of oleic and linoleic unsaturated fatty acids and palmitic saturated fatty acid (approximately 51, 28 and 7%, respectively). Also, the different process conditions did not significantly influence the content of α- and γ-tocopherol isomers, but tocopherols-rich oils were obtained (80-112 mg/g oil).

Keywords: *Dipteryx alata Vog.*, Ethanol, Isopropanol, Solid-liquid extraction, Tocopherols

Determination of fat partition coefficients for systems composed of cocoa shell and ethanol, at different temperatures

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Cocoa derivatives are extremely important inputs to the food industry, since the chocolate flavor is among the top consumer preferences. Due to the decrease in cocoa production and the increase in consumption of its derivatives, strategies have been developed to identify and commercialize new products or to give new applications to existing by-products. Part of this effort focuses on the use of the cocoa shell (12 to 20% of the seed) which is commonly underutilized as fuel for boilers. However, studies report its possible application in human feed as a source of dietary fiber and phenolic compounds with high antioxidant activity. In this way, the fat contained in the cocoa shell can become a raw material for the food industry if the extraction process employed is adequate to obtain it. Due to its lipid composition (between 18 and 22%), this material must be subjected to the extraction process using solvents. The industrial solvent, hexane, despite its stability and great extraction capacity, is also highly toxic, flammable and pollutant. Among the alternative solvents that can replace it are short chain alcohols, especially ethanol. These solvents are considered safer and, due to their high polarity, have also been efficient in the extraction of phenolic compounds, increasing the nutritional value of the obtained product. Aiming at the valorization of this by-product and the monitoring of variables that directly impact on design projects of industrial vegetable oil extractors using renewable solvents, partitioning coefficients of fat ($k = (w_{fat})^{extract} / (w_{fat})^{solid}$) were experimentally determined for systems composed of cocoa shell (Ilhéus/BA - Brazil) and ethanol (with 0 and 6 mass % of water, Et0 and Et6, respectively), varying the solid:solvent mass ratio in 1:2.5, 1:3, 1:4, 1:5 and 1:10, at temperatures of 75 and 90 °C and extraction time of 3 hours. It has been found that Et0 and higher extraction temperatures provide higher partition coefficients (k = 0.23 for ratio of 1:2.5), while Et6 is easiest saturated with fat (k = 0.028 at 75 °C). The higher partition coefficient values obtained for Et0, when compared to Et6, indicate that its use in extraction processes would require a lower number of contact stages for the depletion of the solid, making it more suitable in technical aspects.

Keywords: Cocoa husk, By-products, Renewable solvents, Vegetable oil extractors

Oil partition coefficients in systems composed by spent coffee grounds and green solvents

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Coffee is one of the most consumed beverages in the world and the main residue of its production, spent coffee grounds (SCG), is generated by the soluble solids extraction process using water as solvent. Although this material is usually burned to production of energy, it presents a considerable content of lipids, near to soybean (around 20%). Allied to this fact, the industry of oil production normally uses n-hexane to recover oil from vegetable matrices, even this solvent being considered neurotoxic and to be derived from fossil source. Thus, the main aim of this study was to investigate the extraction of oil from SCG using ethanol, a renewable solvent recognized as safe in substitution of hexane. For this, experimental data of oil partition coefficients (k_{oil} = $(w_{oil})^{extract}$ / $(w_{oil})^{solid}$) in systems containing different mass ratios of industrial SCG and solvent (SCG / solvent from 1/2 up to 1/15) were determined. Ethanol with different hydration levels (0 and 6% mass of water – Et0 and Et6) were used as solvents, under temperatures of 60 and 80 °C, 400 rpm of speed agitation, during 1 hour of contact. The increase in temperature resulted in higher values of k_{oil}, regardless solvent type The extraction trials using Et0 resulted in higher values of k_{oil} (0.52 and 0.97 at 60 and 80 ºC, respectively) than those using Et6, regardless temperature. It was possible to observe a limit of oil concentration in the extract phase when Et6 was used (k_{oil} of 0.21 and 0.41 at 60 and 80 ºC, respectively). A Langmuir-type equation was used to describe experimental data showing an adequate description, with high values of coefficient of determination (at least 0.985) and reasonable values of average relative deviation (ranging from 6.9 up to 19%). These data are useful for a future design of industrial extractors devoted to the extraction of oil from SCG using renewable solvents.

Keywords: Renewable solvent, Oil extraction, Langmuir-type equation, Ethanol, Coffee byproduct, Industrial waste

Optimización de los parámetros de extracción de compuestos fenólicos totales de las hojas de quinua (*Chenopodium quinoa willd*.) variedad INIA 420 – Negra collana

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Las hojas de quinua, fuente rica de compuestos bioactivos in vitro, vitaminas y minerales, forman parte de la dieta de los pobladores de los Andes desde la antigüedad. En Asia y América se acostumbraba consumir este alimento en forma de ensaladas, y en el Perú, las hojas eran dispuestas como antiinflamatorios contra el dolor de muelas, fracturas, hemorragias internas y desinfectantes del tracto urinario. Por lo tanto, la falta de recursos para la investigación en el lugar de origen conduciría al descuido de algunos cultivos alimentarios. La escasa literatura con respecto al contenido fenólico y actividad biológica de las hojas de quinua condujeron a la investigación cuyo objetivo fue la optimización de los parámetros de extracción de compuestos fenólicos totales en la variedad INIA 420 – Negra Collana. La composición fisicoquímica de las hojas de quinua demostró un contenido de humedad (84%), lípidos (2%) y proteínas (1.3%) acordes a los reportes de investigación. Por otro lado, la optimización de los parámetros de extracción, basada en un diseño factorial 2^2 y posterior Diseño Central Compuesto, demostró que el contenido fenólico total fue obtenido a la concentración de solvente de 30% y temperatura de 50°C a los 60 min. Los extractos obtenidos en este proceso fueron sometidos a los ensayos DPPH (2,2 Difenil 1 picrilhidrazilo) y TEAC (Trolox Equivalent Antioxidant Capacity) los cuales reportaron valores de 6414.35 y 5009.97 µmol T.E./100 g, respectivamente. La optimización de los parámetros de extracción demostró que las hojas de quinua poseen un contenido fenólico mayor a otras hojas del grupo de las Chenopodiaceas cuya actividad anticancerígena podría convertirla en parte de una dieta saludable. Finalmente, la aplicación industrial de esta investigación en el lugar de origen sería un procedimiento relativamente nuevo que reaprovecharía las hojas de quinua y combatiría la desnutrición infantil.

Keywords: Hojas de quinua, Compuestos Fenólicos Totales, Capacidad Antioxidante, Diseño Central Compuesto

Desenvolvimento de bolo com açaí em polpa *in natura* e liofilizada como alternativa à contribuição na geração de renda

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O açaí é um fruto proveniente do açaizeiro (*Euterpe* spp.), uma palmeira típica da Amazônia, sendo muito apreciado pelo seu valor nutricional, devido à presença de aminoácidos, ácidos graxos, fibras, cálcio, ferro, vitaminas A e C em sua composição. O açaí apresenta elevada importância cultural, econômica e social na região norte do Brasil, e tem mostrado crescente inserção no mercado nacional, sendo consumido na forma de polpa ou até mesmo adicionado em diversos alimentos. A adição de açaí em produtos, como bolos e iogurtes, pode promover o enriquecimento nutricional destes, proporcionando benefícios a saúde dos consumidores, como efeitos anti-inflamatório, antienvelhecimento, auxílio no sistema imunológico, prevenção do câncer e redução do colesterol. Dessa forma, o objetivo deste trabalho foi desenvolver e avaliar duas formulações de bolo com açaí, adicionadas de polpa *in natura* e polpa liofilizada. A polpa de açaí *in natura* foi oriunda da Região do Arquipélago do Bailique (AP- Brasil), a qual foi posteriormente seca por liofilização. O bolo com a polpa de açaí liofilizada foi elaborado com açúcar, farinha de trigo, fermento químico, sal, açaí liofilizado, leite, ovos e margarina. A formulação com a polpa *in natura* foi constituída de açúcar, farinha de trigo, fermento químico, sal, ovos e margarina. Ambos produtos foram avaliados quanto a composição proximal, sendo determinados os teores de lipídios, proteínas e carboidratos. O bolo produzido com polpa liofilizada apresentou maior teor de lipídios (11,8 ± 0,01% m m^{-1}) e de proteínas (12,7 ± 0,06% m m^{-1}) em comparação ao bolo com polpa *in natura* (lipídios= 9,6 ± 0,2% e proteínas= 9,2 ± 0,9% m m^{-1}). A informação nutricional demonstrou que o bolo adicionado de polpa de açaí liofilizada e leite integral pode fornecer 256,84 kcal para cada 110 g de produto (forma pronta para o consumo), enquanto o bolo preparado com polpa *in natura* pode fornecer 265,44 kcal. Portanto, a utilização de açaí para formulação de produtos contribui para o desenvolvimento, rentabilidade e valorização da agrobiodiversidade das comunidades do Arquipélago do Bailique, além de promover benefícios para a saúde do consumidor devido a composição nutricional.

Keywords: Açaizeiro, Agrobiodiversidade, Alimentos funcionais, Composição nutricional, Rentabilidade

Evaluación del uso de leche en polvo y condiciones de elaboración del dulce de leche sobre las características sensoriales

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El dulce de leche (DL) (manjar, cajeta, arequipe, etc.) es un producto muy apreciado por su color, sabor y textura desarrolladas por reacciones de pardeamiento no enzimático durante el tratamiento térmico y concentración de leche y azúcar. La sustitución de parte de la leche fluida por leche en polvo puede redundar en una reducción de costos estacional, pero podría modificar las características sensoriales del producto, influyendo en su calidad. Si bien tradicionalmente el perfil sensorial de un producto alimenticio se ha obtenido utilizando análisis descriptivo con jueces entrenados, en la actualidad han surgido numerosas técnicas conocidas como métodos descriptivos rápidos que pueden ser aplicadas con jueces semi-.entrenados o consumidores, como la técnica de Napping.El objetivo del presente trabajo fue evaluar el uso de leche en polvo en la elaboración del DL, donde variando también el pH inicial permitan obtener un DL similar en características sensoriales al DL elaborado con leche fluida; evaluado mediante la metodología Napping con jueces semi-entrenados. Se elaboró el DL a pequeña escala utilizando una formulación básica de leche entera adicionada de 25% de sacarosa y llevando a una concentración final de 69±1 °Brix. Se utilizó un diseño factorial completo de dos variables con tres niveles: sustitución de leche fluida por leche en polvo (25,0%, 37,5% y 50,0%) y pH inicial (6,8; 7,3; 7,5). También se elaboraron dos muestras de referencia con 100% leche fluida. 14 jueces sensoriales semi-entrenados evaluaron las 11 muestras de DL con la técnica Napping. A cada panelista se le presentaron todas las muestras a temperatura ambiente, codificadas y se le pidió que las probaran y distribuyeran sobre una hoja de papel A3, considerando que las muestras que coloquen más cercanas entre sí, indicarán similitudes entre ellas y más alejadas, diferencias. Posteriormente, debían anotar atributos sensoriales o comentarios para describir las muestras. Se realizó un análisis multifactorial (AMF) sobre la tabla de coordenadas y de frecuencias de términos descriptivos generados. Los resultados mostraron que la principal diferencia entre los DL fue debida al pH inicial, siendo las muestras con pH 7,5 caracterizadas *espesas, gomosas, amargas, con color intenso* y *con sabor extraño*. Las muestras con pHi 6,8 se describieron como con *sabor lácteo, poco sabor a dulce de leche, empalagosas, con color claro* y *fluidas*. Las muestras más similares a las de referencia fueron las de pHi 7,3, en particular la de 25% de sustitución con leche en polvo.

Keywords: Dulce de Leche, Napping, Leche en polvo

Improvement of Distillation Thermodynamic Efficiency by Phase Division

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Distillation is used to produce a variety of spirits. Although it is a traditional and widely used process, distillation is highly energy intensive. Several techniques have been proposed to optimize the energy and separation efficiency of distillation columns. One of these techniques, known as columns with parallel streams, comprises the division of the liquid or vapor phase. This technique includes parastillation and metastillation processes. In the case of parastillation, the vapor phase is divided into two or more streams, which contact the entire liquid flow. In the case of metastillation, the division occurs in the liquid phase. Parastillation and metastillation are promising techniques to reduce energy consumption in distillation. However, the mechanisms associated with the improvement of energy and separation efficiency due to phase division are not well known. This study aims to elucidate the improvement in thermodynamic efficiency and operational cost savings that may be possible by increasing the number of phase divisions. The ethanol/methanol distillation, a purification step important in the production of potable alcohol, was adopted as a case study. Global and stage-by-stage exergy loss profiles were used to illustrate the improvement in separation performance over conventional distillation. The arrangement of the internal vapor or liquid flows, in columns with parallel streams, decreases the total exergy loss and improves the stage exergy loss distribution. Considering two-phase divisions, para- and metastillation stage-by-stage exergy loss profiles presented standard deviation about 60% smaller than the corresponding conventional distillation. The decrease in total exergy loss for the alternative columns contributed to an increase in thermodynamic efficiency of approximately 15% in comparison with conventional distillation. Furthermore, a conventional distillation column can be replaced by a para- or metastillation column with two-phase divisions, allowing an approximate 25% of reduction in energy. For three vapor divisions, the energy saving was even more significant, up to 30%. These results are associated with the fact that the alternative parastillation columns may arrange a higher number of stages per column height, considering the same tray spacing used in conventional columns. In fact, in the case of parastillation columns with two-phase divisions, it is possible to allocate twice the number of stages of a conventional distillation column with the same height. Therefore, two parastillation trays are responsible for a better separation than one conventional distillation tray. These results indicate that parastillation and metastillation columns may be a good alternative to reduce energy consumption in distillation processes.

Keywords: Distillation, Parastillation, Metastillation, Energy intensive, Exergy

Mass transfer mechanisms during brine salting of chickpea: influence of temperature and salt content

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Chickpea (*Cicer arietinum* L.) is a widely used pulse for snack production and also in home-cooking by soaking in brines. To achieve a maximum quality and high nutrient content it is helpful to model the mass transfer during this operation.
The objective of this work was to identify patterns of mass transfer based on water, salt and non-ash solids contents and model it using Fickian diffusion.
Individual chickpeas of kabuli type were soaked in brines with the proportion of 1 pulse per 15 mL of solution. Sodium chloride concentrations studied were of 1, 5 and 20% and in pure water at temperatures of 25, 50, 75 and 100°C. Water and solids contents were analyzed by gravimetric methods and the salt content by the Mohr's method. Volume was measured by the pycnometer method and porosity was determined by mercury porosimetry using Micrometrics' AutoPore IV 9500. 2.3.1. Observation of the seed coat-cotyledons interface was done with a stereo microscope (Leica EZ4D, Leica Microsystems, Germany) at 35 magnification.
Three periods of mass transfer were identified. The first period of mass transfer is predominantly governed by the filling of void spaces by water and hydration of chickpea solids, with a higher water gain compared to solids loss and volume gain. The porosity of 7.341% (±0.115) justifies partially this period, that for soaking in water varies between 2 min (100°C) and 15 min (25°C). The end of the second period is reached at 5% of solids loss when soaking in water and at 7% of non-ash solids when soaking in brines, it takes up to 105 min (50°C) and 250 min (25°C) when soaking in water. The third period is characterized by a negligible mass gain and high solids loss at soaking temperatures at which gelatinization and protein swelling occur, being an avoidable period if mass gains are the objective of the soaking.
Assuming Fick's law of diffusion, the values obtained for the diffusivities of water, salt and non-ash solids have the same order of magnitude, respectively, 0.62-5.56×10^{-10} m2/s, 0.10-2.98×10^{-10} m2/s 0.18-9.78×10^{-10} m2/s, as all depend on the same phenomena, the uptake of the salting solution. The final volume of chickpea is higher at 1% salt, reaching 2.8 times the volume of the dry seed, what enable the production of crispier snacks.
These new insights support the improvement of mathematical modeling during soaking of chickpea to be based on more realistic mass transfer mechanisms.

Keywords: Chickpea, Porosity, Mass transfer, Soaking, Salting

Extraction of sodium alginate of *Sargassum* and antioxidant capacity evaluation

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One of the most commercial and cost effective processes involving alginate isolation involves the utilization of brown sea weed *Sargassum* spp which is widely spread along coastal areas in tropical and subtropical regions of Brazil. Sodium alginate finds use in different industries ranging from food, cosmetic to pharmaceutical applications due to its attractive properties as a thickener, emulsion stabilizer and encapsulating agent. In recent studies, antioxidant properties of alginate were highlighted resulting in increased research efforts to explore this natural antioxidant. In this context, the aim of this study was to optimize and establish a sodium alginate extraction method in the alkaline phase to yield alginate with highest antioxidant capacity. Box-Behnken design was used to have different combinations of alkaline treatment duration (90, 195, 300 minutes), temperature (50, 65, 80 ºC) and pH (8, 9, 10), resulting in 15 different and unique combinations. Antioxidant activity was estimated using ABTS analysis. The alginate with the best antioxidant capacity was obtained with median conditions of 65 ºC; pH=9; 195 minutes. The study confirmed that temperature had the greatest positive influence on sodium alginate antioxidant activity.

Keywords: Alginate, Brown algae, Experimental design, Antioxidant capacity

Effect of application of ozonium and cut type on the antioxidant capacity of minimally processed Pitaya (*Hylocereus polyrhizus*)

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Increasing fitness awareness in recent times has led to changes in lifestyle and raised the demand for healthy, nutritious fruits which can be consumed with minimum processing. However, the food processing or treatments applied to these foods, on most occasions cause damage to the healthy fruit tissues, resulting in darkening, loss of taste, texture, and increase in microbial load in the product. These production methods and procedures of disinfection and decontamination are measures of extreme importance to guarantee higher quality of the fresh cuts of fruits and vegetables. Studies have shown that ozone is a powerful antimicrobial agent, and can have many advantages for the fruit industry and plays as active role inincreasing the shelf life. Pitaya (Hylocereus polyrhizus) is a fruit with 70-80% pulp, and is increasingly becoming a popular fruit of choice in the Brazilian market due to its high sensory quality and nutritional value. Considering the effective food sanitization processing by ozonation and the relevant sensory and nutritional characteristics of pitaya, this research had an objective to study the influence of fruit cut diameter, ozone concentration and ozonation time on antioxidant capacity using an experimental design of the Box Behnken type. It was verified that the experiments using the variables, presented better yield when compared with the fruits which did not undergo treatment. Among the variables studied, ozonization time had the greatest positive influence on antioxidant capacity. The best condition for ozonization of minimally processed pitaya was observed when the pitaya was cut in 4 cm sections and subjected to 14 mg / min of ozone during a treatment time of 20 mins, obtaining the highest results of antioxidant capacity by ABTS (89.86 µM trolox / g) and DPPH (121.18 µM trolox / g) with maximum desirability value of the predicted parameters of 0.982.

Keywords: Ozonium, Fresh cut, Pitaya, Antioxidant capacity

Elaboração de cupcake com adição de polpa de mangaba (hancornia speciosa gomes) fruto típico do cerrado tocantinense

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Os frutos das espécies nativas do cerrado apresentam um alto valor nutricional, além de atrativos como cor, sabor e aroma característicos e intensos, mas ainda sendo pouco explorados comercialmente. A mangaba é considerada uma boa fonte de ferro, manganês, zinco e vitamina C. Devido aos excelentes aroma e sabor ela pode ser consumida *in natura* ou sob forma de vários outros produtos. O objetivo desse trabalho foi avaliar a aceitabilidade de um produto (*cupcake*) derivado da mangaba. O experimento foi conduzido no Laboratório de Análise Sensorial do Instituto Federal de Educação, Ciência e Tecnologia do Tocantins Campus Paraíso do Tocantins. Os bolinhos tipo *cupcake* foram elaborados em uma unidade da cozinha experimental. A matéria-prima utilizada foi à polpa de mangaba congelada. Três formulações do *cupcake*, com porcentagens de 25%, 50% e 75% de polpa de mangaba foram utilizadas. Estes valores foram definidos através de testes preliminares realizados com o produto. Os demais ingredientes utilizados na formulação do *cupcake* são: açúcar, margarina, ovo, farinha de trigo e fermento químico. Os testes sensoriais aplicados foram aceitação global, avaliação de atributos e intenção de compra seguindo metodologia do Instituto Adolfo Lutz (2008). Para a realização do painel sensorial foram distribuídas três amostras a 100 julgadores não treinados, jovens e adultos de ambos os sexos, Os avaliadores expressaram sua opinião através de questionário estruturado com perguntas fechadas de múltipla escolha. Quanto à aceitação utilizou-se escala hedônica de nove pontos, variando de “desgostei extremamente” até “gostei extremamente”, em relação aos atributos textura, odor, cor, sabor, aparência e impressão global. Para intenção de compra foi avaliada utilizado a escala de sete ponto, que vai desde” compraria sempre até nunca compraria”. Para avaliação da aceitação aplicou-se a análise de variância (ANOVA) e teste de Tukey na média das amostras obtidas. De acordo com os testes comprovou-se que um nível de adição da polpa 25% e 50% foram mais bem aceitos pelos provadores. Conclui-se com a análise sensorial aplicada que um nível de adição de polpa de mangaba de 25% e 50% foi bem aceito pelos provadores sendo possível afirmar que essas formulações apresentaram maior aceitação quanto aos atributos avaliados, proporcionando um produto de sabor diferenciado. Já adição de 75% de polpa alterou características do produto final relacionada com a formulação a qual influenciou na estrutura aerada e em outras características prejudicando a aceitabilidade.

Keywords: Aceitabilidade, Polpa de mangaba, Cupcake

Obtención de aislado proteico a partir de torta desengrasada de sacha inchic (*Plukenetia volubilis* L.)

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El cultivo de sacha inchic (*Plukenetia volubilis* L.) se ha incrementado en la Región San Martín existiendo, en consecuencia, una gran cantidad de torta resultante del proceso de extracción de aceite. Esta torta, con alto contenido de proteínas, puede ser utilizada para la producción de aislados proteicos. El objetivo del presente trabajo fue determinar las condiciones adecuadas de extracción alcalina (pH, relación soluto/solvente y tiempo de proceso) para la obtención de aislado proteico de sacha inchic (APSI) por precipitación isoeléctrica. Fue utilizada torta de sacha inchic, suministrada por una empresa local productora de aceite mediante el proceso de prensado en frío. Un diseño compuesto central rotable, con tres factores de proceso y cinco niveles, fue empleado: relación soluto/solvente (8/60, 7/60, 6/60, 5/60 y 4/60 g/mL), pH (8, 9, 10, 11 y 12) y tiempo de proceso (20, 25, 30, 35 y 40 minutos). Para el ajuste del pH se utilizó NaOH 2N y la precipitación isoeléctrica fue realizada mediante HCl 2N. La determinación de proteína durante el proceso fue realizada mediante el método de Biuret con lectura en espectrofotómetro a 545 nm. El contenido de proteína en la torta de sacha inchic fue de 54,15%. Las condiciones de extracción más adecuadas ($p < 0,05$) fueron: pH 12, relación soluto/solvente de 6/60 y tiempo de proceso de 30 minutos, con un rendimiento de 84,4%.

Keywords: Sacha inchic, Aislado proteico, Precipitación isoeléctrica, Extracción alcalina

Qualidade microbiológica e aceitação sensorial do doce em massa produzido a partir da guapeva (*Pouteira Gardneriana* Raldk)

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A Savana brasileira possui uma das floras mais ricas do mundo, diante dessa grande diversidade da flora, seus frutos vêm despertando o interesse de pesquisadores devido as suas características químicas e seu alto valor nutricional, sendo a guapeva (*Pouteira Gardneriana* Raldk) um bom exemplar dessas características. O desenvolvimento de um novo produto com características peculiares é uma alternativa para o aproveitamento de frutas sazonais pouco estudadas, tendo em vista a diversidade e a quantidade encontrada no Brasil. Nesse sentido avaliou-se a aceitabilidade e a intenção de compra do doce em massa da guapeva seguindo um planejamento fatorial completo onde as variáveis reais foram razão polpa/açúcar, acido cítrico e albedo de maracujá em substituição da pectina comercial, totalizando 11 formulações, onde segundo a legislação brasileira para ser considerado doce em massa é necessário que o doce esteja com pH entre 3 e 3,5 e o teor de sólidos solúveis totais seja superior a 75º. Para avaliar a qualidade microbiológica todas as formulações foram submetidas às analises de contagem de bolores e leveduras, *Staphylococcus aureus, Salmonella typhimurium* e Coliformes totais. As amostras do doce foram analisadas mediante escala hedônica, sendo realizado por um grupo de 46 julgadores não treinados que avaliaram atributos como aroma, sabor, textura e impressão global além da intenção de compra. Os dados obtidos foram submetidos à ANOVA e quando necessário ao teste de Tukey (5% de probabilidade). Para que a análise sensorial fosse realizada, o projeto foi submetido à apreciação do Comitê de Ética da Universidade Federal do Tocantins ao qual foi aprovado com Certificado de Apreciação Ética número 93357718.3.0000.5519 e parecer número 3.096.189. Os resultados obtidos revelaram que os doces de guapeva estavam isentos dos microorganismos analisados, mostrando assim condições higiênico-sanitárias eficientes o que denota boas práticas de manipulação e armazenamento, todas as formulações apresentaram boa aceitabilidade global, não apresentando diferença significativa entre si, porém as médias atribuídas pelos provadores indicaram preferência pelos doces F2 (689) e F3 (451) aos quais provavelmente comprariam, esse fato pode ser explicado devido a sua alta concentração de açúcar. De todos os parâmetros analisados o aroma foi o que obteve o maior índice “regular” 6,28%, e o menor 6,17% para textura. O estudo revelou que a elaboração do doce para conservação do fruto guapeva pode tornar-se uma boa alternativa de valorização desse fruto.

Keywords: Aceitação, Guapeva, Doce, Atributos sensoriais

Processo de desenvolvimento de misturas em pó à base de café solúvel

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O objetivo do trabalho foi estabelecer uma metodologia de desenvolvimento para misturas em pó à base de café solúvel (cappuccinos), aplicando a ferramenta de desdobramento da função qualidade (QFD), aliado ao planejamento de experimentos utilizando a Metodologia de Superfície de Resposta Triangular. Primeiramente, para a aplicação da ferramenta QFD, voluntários foram recrutados para responder um questionário, que levou em consideração requisitos do produto e dos consumidores. Baseado nas respostas de 106 participantes, foi elaborada a matriz da qualidade. Nesta matriz, foi possível verificar os requisitos de qualidade que precisavam ser melhorados, para então desenvolver novas formulações de cappuccino, para a segunda etapa do trabalho. Para tanto, foi aplicado um planejamento experimental de delineamento de misturas com restrições nos limites inferior e superior, composto por três variáveis independentes (leite em pó integral, café solúvel em pó e cacau em pó). As proporções dos ingredientes foram determinadas utilizando o software *Statistica* versão 10.0 e a opção "*Design for constrained surfaces and mixture"*, e resultou em nove formulações. As variáveis dependentes deste planejamento foram as respostas do teste sensorial de aceitação realizada com 85 participantes. As três variáveis independentes de maior impacto e destacadas com a aplicação da metodologia QFD, foram considerados para a aplicação de um novo teste de preferência com 80 participantes, que avaliaram três formulações: a formulação 1 do planejamento anterior (36,20% de leite integral, 5,00% de café solúvel e 1,00% cacau em pó), uma formulação nova (34,70% de leite integral, 6,00% de café solúvel e 1,50% cacau em pó) e um cappuccino comercial. Pelo fato da composição da nova formulação ser completamente diferente das formulações propostas no planejamento de experimentos, e a quantidade de cacau ser maior do que 1%, esta foi escolhida para ser submetida ao teste de preferência. Os resultados deste teste indicaram que, para os atributos sabor de chocolate, dissolução, cremosidade e impressão global, as proporções ótimas sugeridas corresponderam à formulação 1 do planejamento de experimentos. Os provadores alegaram que esta formulação era mais cremosa e tinha sabor mais acentuado. No caso dos atributos aroma geral, aroma de café e sabor geral, as porcentagens ótimas das variáveis leite em pó integral e café solúvel ficaram definidas dentro das faixas estudadas; e no limite inferior destas faixas, para a variável cacau em pó. Conclui-se que a utilização das ferramentas propostas neste trabalho auxilia no desenvolvimento de misturas em pó à base de café.

Keywords: Desenvolvimento de novos produtos, Cappuccino, Análise sensorial, Consumidor, QFD

Otimização de doce de Guapeva (*Pouteria Gardneriana Radlk*) através da análise do perfil de textura

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O Cerrado brasileiro dispõe de um grande número de espécies nativas frutíferas e exóticas, que possuem grande potencial de exploração para a agroindústria. Os frutos oferecerem alto valor nutricional e são sensorialmente atrativos pela cor, aroma e sabores peculiares. A guapeva (Pouteria Gardneriana Radlk.) é uma espécie nativa do Cerrado com grande potencial econômico devido às suas propriedades nutricionais e antioxidantes. O processamento de frutos para produção de doces e geleias, além de um método de conservação, é uma alternativa de aproveitamento, contribuindo para a diversificação do mercado no desenvolvimento de novos produtos com boas propriedades funcionais. A boa aceitação destes produtos tem relação com a textura, que é um importante fator na percepção e qualidade de um produto pelos consumidores, além de ser um reflexo da composição e estrutura do alimento. Dessa forma, o objetivo deste trabalho é analisar o perfil de textura de diferentes formulações de doces em massa elaborados a partir da polpa de guapeva e albedo de maracujá em substituição da pectina comercial. Para o processamento do doce foi utilizada a metodologia de superfície de resposta com planejamento fatorial completo para avaliar a influência de três fatores como a concentração de ácido cítrico, razão polpa/açúcar e concentração do albedo, totalizando 11 formulações. Os doces foram elaborados e concentrados até atingir valores para sólidos solúveis totais acima de 75°Brix como preconiza a legislação. Para as análises de perfil de textura das amostras foi utilizado um texturômetro, cujos parâmetros foram: velocidade de pré-teste: 2 mm/s; velocidade de teste: 2 mm/s; velocidade pós teste: 2 mm/s; distância: 15 mm e altura das amostras: 40 mm, ao qual foram avaliados os seguintes atributos: dureza e adesividade. Para os resultados de otimização, o modelo recomendou como ótimo, tanto para o parâmetro de dureza quanto para adesividade, os doces que possuem a mesma proporção de polpa e açúcar e menor adição de ácido cítrico, demostrou que essa relação influencia positivamente nos parâmetros avaliados, além de que proporções iguais de polpa e açúcar contribuem para manter o sabor característico do fruto no doce.

Keywords: Doce em massa, Otimização, Textura

Formação de ésteres de 3-MCPD em óleo de palma durante etapa de desodorização

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Os ésteres de cloropropanóis (CL) são uma classe de contaminantes produzidos durante o processo de refino, e atualmente, são uma preocupação para a indústria de óleos vegetais devido as altas concentrações destes compostos nos óleos refinados. O óleo de palma é muito utilizado na indústria de alimentos, sendo também o óleo vegetal que apresenta as maiores concentrações destes contaminantes. A formação dos CL se dá principalmente durante etapa de desodorização, na qual o óleo é submetido a temperaturas superiores a 200 °C. Em geral, os ésteres de 3-monocloropropano-1,2-diol (3-MCPDE) são os contaminantes mais reportados na literatura para contaminação de óleo de palma. Desta forma, o objetivo do presente estudo foi avaliar a geração 3-MCPDE durante o processo de desodorização do óleo de palma em escala laboratorial em diversas condições de tempo (30 – 120 minutos) e temperatura (210 °C – 270 °C). Seguindo o procedimento padrão utilizado nas refinarias, a pressão e a porcentagem de vapor foram fixadas na faixa de 2 a 4 mbar e 1% da massa de óleo desodorizado respectivamente. A análise do 3-MCPDE seguiu a metodologia oficial da AOCS Cd 29a-13, onde utilizou-se cromatografia gasosa acoplada a espectrometria de massas (GC-MS) para quantificação do composto. De acordo com os resultados, as concentrações variaram de 1,97 – 2,31; 1,93 – 2,09; 1,90 – 2,35; e 2,29 – 2,70 mg/kg de óleo de palma refinado nas temperaturas de 210, 230, 250 e 270 °C, respectivamente. Através dos resultados é possível verificar que a maior temperatura apresentou os valores de 3MCPDE mais altos em todos os tempos avaliados. Sendo assim, a redução do composto está intrinsicamente associada a menores temperaturas de processo.

Keywords: Óleo de palma, Cloropropanóis, Ésteres 3-MCPD

Food Processing Technologies

Dehydration

Oral Communications

Pre-treatments to improve the infrared drying of food

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Drying is an ancient unit operation performed to obtain food products with longer shelf life and a wide range of uses. However, there are still challenges to improve this process (reducing the time, temperature, energy) and product quality (improve technological characteristics, decrease the nutrient degradation). In this work, pre-treatments based on mechanical perforations (17 perforations using a 1.2 mm thin cylinder) and ethanol (92.8% v/v) impregnation were applied to improve the infrared drying (100°C) of potato slices (2.0x0.5 cm). Perforations were performed to evaluate the effect of promoting routes to capillarity flow, while ethanol treatment was performed to evaluate the effect of Marangoni flow (by promoting gradient tension surface). A synergism between these two treatments was expected. Four pre-treatments were studied: Control (without any pre-treatment), E (samples immersed in ethanol for 15 min), P (Perforated samples), and P+E (perforated samples immersed in ethanol for 15 min). The effect on drying and further rehydration (immersion in distilled water at 25 °C) kinetics were evaluated. All pre-treatments reduced the drying time compared to control treatment. However, a great time reduction was observed with P+E pre-treatment, increasing the drying rate in 135%. The samples with perforations (P and P+E) increased their rehydration rate as well as the water retention capacity. However, the pre-treated samples with ethanol only shows poor rehydration properties. Possible mechanisms were discussed. These results show that simple operations, creating routes to water flow (through mechanical perforations) combined with drying accelerator (ethanol), can improve both drying and rehydration of food products.

Keywords: Infrared drying, Water flow, Rehydration, Potato

Tratamiento por microondas y convección con aire caliente de peras fortificadas con Ca y Zn

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La pera, variedad Packham's Triumph se cultiva en Argentina, en los Valles de Río Negro y Neuquén. Sus índices de madurez en fresco fueron: firmeza de la pulpa: 6,8±0.7 kg, sólidos solubles: 13,3 ±1,3 ºBrix y acidez titulable 3,8 ±0,4 g/l. El objetivo fue obtener peras secadas por microondas y convección con aire caliente, previo pretratamiento por impregnación con calcio y zinc para mejorar su valor nutricional y alcanzar una adecuada humedad.

Las rodajas de peras de 5 mm de espesor se sumergieron en una solución acuosa de 40% m/m de sacarosa, 5% m/m de lactato de calcio, 5% m/m de ácido ascórbico, 1% m/m de ácido cítrico y 0,1 % m/m de acetato de zinc (49° Brix) a 40°C. Se empleó una relación masa de solución/masa de peras de 4 y un nivel de agitación de 120 rpm. Se analizó la impregnación durante el tiempo (30 min, 1h, 2h, 3h y 4h). La concentración de minerales se determinó por espectrofotometría de absorción atómica de llama. Se aplicó el método de Crank basado en la 2° ley de Fick, el que ajustó los datos experimentales satisfactoriamente y se calculó el coeficiente de difusión efectivo del agua ($2.08\ 10^{-10}$ m^2/s), de los sólidos solubles ($2.92\ 10^{-10}$ m^2/s), de Ca ($1.27\ 10^{-10}$ m^2/s) y de Zn ($6.33\ 10^{-11}$ m^2/s).

Para el diseño del producto se tomó la muestra impregnada durante 1 h y posteriormente, en el microondas se realizaron pruebas a diferentes potencias de microondas y tiempos de manera tal de alcanzar un contenido de humedad final igual o menor al 20% (b.h), según las recomendaciones del Código Alimentario Argentino. Se obtuvieron dos posibles productos: uno tratado por microondas a una potencia de 60 %, en el que la muestra se rotó tres veces, permaneciendo 4 min de cada lado y otro a 50 %, que se cocinó primero de un lado a 6 min y del otro a 5 min. La impregnación de la fruta con iones incrementa su factor de pérdida dieléctrica. Así, se alcanzan calentamientos más rápidos y se mejora la eficiencia energética.

Estas muestras se analizaron sensorialmente. Se contrastaron con una muestra similar de pera comprada en el mercado local (no fortificada y secada por convección con aire) mediante un test de consumidores (80).

El producto final preferido posee un 891,90 mg de calcio y 28,30 mg de Zn por cada 100 g.

Keywords: Peras fortificadas, Peras secadas por microondas y convección, Peras impregnadas con Ca y Zn

Zero-carbon-vacuum food dryer – ZCD food dryer

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Traditional drying processes use a large amount of energy, which increases the production and product costs. The use of fossil fuels as a source of energy causes the emission of carbon dioxide into the atmosphere, associating drying with a high carbon footprint. Solar energy is an abundant and non-polluting source of energy that can be applied in drying processes, contributing to the reduction of greenhouse gas emissions. However, traditional solar drying has some limitations, as the lack of control of the drying conditions and product quality. On the other hand, solar hybrid dryers use solar radiation and another source of energy (electric, fossil fuels or biomass), making it possible to control the drying process. The present study is about a hybrid food dryer, which uses solar thermal energy and electric energy, and can operate under vacuum. The low pressure allows obtaining products of high nutritional and sensorial quality. The dryer also allows applying the conductive multi-flash drying (KMFD) procedure, which is an innovative drying process that has been reported as suitable to produce dried-and-crisp fruits and vegetables in short times. In this process, food is heated by conduction under atmospheric pressure until 70 °C before the application of a sudden decompression (vacuum pulse - 40 mbar) that leads to flash evaporation and sample expansion. The drying system consists of drying chambers, with a capacity of 4-5 kg of raw material. The water is heated up to 90 °C by solar collectors' tubes and electrical resistances. The water steam was in contact with the base of the drying chamber, providing the evaporation energy to the samples arranged therein. The equipment is named "Zero-Carbon Vacuum Dryer." The electric power was used for the operation of the vacuum pump, water circulation pumps and electrical resistances used to control the temperature of the water tank. Bananas were cut into slices and dried in approximately 4 hours, resulting in products with water activity less than 0.3. Therefore, this innovative drying system allows the production of dehydrated-and-crisp fruits with attractive sensory properties in approximately four hours. Thus, dehydrated products with higher added value can be obtained in small or medium scale production, increasing the income and productivity of small farmers.

Keywords: Hybrid solar dryer, Vacuum, Multiflash, Crispness

Effect of the type of drying process on the antioxidant activity of artichoke bracts discarded industrially

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Globe artichoke (*Cynara scolymus*) is one of the greatest sources of antioxidant compounds in vegetable kingdom. Also, it is a rich source of dietary fiber. Its marketing is in fresh form or canned. In the latter process only about 30% of the vegetable is used, generating by-products in a large amount, as bracts. This by-product of artichoke is currently used as animal feed or just discarded, wasting the potential it has as source of antioxidants. One of the first considerations when looking for alternative revaluation of agro-industrial by-products is their stabilization by dehydration, to limit the proliferation of microorganisms; however, antioxidant compounds can be affected by high temperatures of process. Due to this fact, in this work the effect of drying process on artichoke bracts antioxidant activity (AA) was evaluated. Conventional convective drying, convective solar drying, drying in rotary tube and double rotary drum drying were tested. In addition, lyophilization was done as control process. The drying temperatures depended on the characteristics of each equipment. The processes were carried out until the final product had a moisture less than 10%. AA of dried artichoke bracts was assayed by ORAC method after an extraction done with ethanol 75% at 45°C for 10 minutes. Results shown that lyophilization, which work at low pressure and freeze temperature conditions, allows dehydrated bracts to contain an activity of 44,858.9 µmol Trolox equivalent (TE)/100 g dry bracts; while, drying in systems like rotary tube and double drum drying, working at temperatures about 97-105°C and total contact time of 120 and 5 minutes respectively, produces bracts with an average AA of 30,991.7 µmol TE/100 g. When a similar temperature was used (100°C) in a convective oven, the required process time was at least of 180 minutes, and the AA was about 6,500.4 µmol TE/100 g; if the temperature is reduced to 60°C, the AA increase up to 10,800.3 µmol TE/100 g. In the case of convective solar drying, the maximum temperature of process was 45°C and the AA was 15,023.9 µmol TE/100 g. According to the results it is possible to indicate that among the processes and equipment evaluated, those are performed in short times like drum dryer or rotary tube, it allows to obtain a product with a high AA (slightly low than that obtained with lyophilization); but even higher to some well-known superfruits.

Keywords: Globe artichoke bracts, Agroindustrial discard, Drying processes, Antioxidant activity

Food Processing Technologies

Dehydration

Poster Communications

Efecto de la temperatura y concentración sobre la deshidratación osmótica del banano "manzano" (*Musa acuminata* AA)

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El objetivo de esta investigación fue evaluar la influencia de la temperatura y la concentración de la solución de sacarosa en la deshidratación osmótica del banano manzano (*Musa acuminata* AA). Rodajas de banano de 30,01 mm de diámetro y 3,05 mm de espesor fueron osmodeshidratadas en soluciones de sacarosa a 40, 50 y 60 ^{o}Brix y a temperaturas de 30, 45 y 60 ^{o}C en el intervalo de tiempo 0-360 minutos, manteniendo una relación en peso de muestra/peso de solución de 1:10 y una velocidad constante de agitación de 210 rpm. La masa total de las rodajas se determinó por Balanza Analítica AVENTURER™ OHAUS® ARC120, los sólidos solubles totales de la rodaja se determinaron por el método de la AOAC 932.12/90, la humedad de la rodaja se determinó por el método de la AOAC 934.06/96 y los cambios de color se determinaron por visión computacional. Se utilizaron los modelos matemáticos de Crank y Magee para ajustar los datos de masa total, sólidos solubles totales y humedad. La temperatura y la concentración de la solución tuvieron efecto significativo ($p<0,05$) sobre la masa total, sólidos solubles totales, la humedad y el cambio de color. Como resultado se determinó que el modelo matemático de Crank es el que mejor representa el efecto de la temperatura y la concentración de las soluciones evaluadas. La difusividad efectiva para el agua tuvo valores entre $3,101\times10^{-8}$ y $8,34\times10^{-8}$ m^2/min y la difusividad efectiva para los sólidos tuvo valores entre $0,449\times10^{-8}$ y $2,783\times10^{-8}$ m^2/min. En los cambios de color se observó una disminución de la claridad (L*), el parámetro a* se mantiene constante y b* aumenta con la temperatura para los tratamientos a 50 y 60 ^{o}Brix, la concentración de la solución y la temperatura afectaron significativamente ($p<0,05$) el cambio de color (ΔE^*), los cuales fueron mayores con el aumento de la temperatura para una misma concentración de la solución.

Keywords: Osmodeshidratación, banano, Crank, Magee, Visión computacional

Ultrasound and ethanol pre-treatments to improve drying and rehydration of pumpkin

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High power ultrasound and the addition of ethanol have been proposed as individually pre-treatments for improving drying. This work demonstrated for the first time the effect of using both technologies as pre-treatments to improve convective drying of foods. Pumpkin cylinders were used as model food. Effects on drying and rehydration kinetics, as well as the energy consumption were studied. Pumpkin cylinders were immersed on ethanol up to 30 min, without or with ultrasound (25 kHz, 72 W/L, 25 °C). Convective drying was carried out using hot air at 50 °C and 0.8 ± 0.1 $m.s^{-1}$, while rehydration was carried out under water immersion at 25 °C. The drying kinetics showed a super-diffusive behaviour. All pre-treatments decreased the drying time in 50-60%, also reducing the energy consumption. The combination of ethanol and ultrasound presented the greatest reduction in both drying time (~60%) and energy consumption (44%), demonstrating a possible synergistic interaction. Possible mechanisms, involving structure modification and mass transfer through capillarity were discussed. The pre-treatments also enhanced the rehydration properties, ataining higher rehydration rates (30-40%) and water retention capacity (~20%). The results open new perspectives about an innovative method to improve drying process and product quality by combining ethanol and ultrasound.

Keywords: Ultrasound, Food processing, Convective drying

Drying kinetics and mass transfer properties for the drying of thistle flower

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Because the drying of tistle flower is important due to its utilization as curd coagulant in *Serra da Estrela* cheese production, this work intended to study the drying process of thistle flower, by comparing the convective drying at constant tepetrature with the natural drying with variable temperature. For that, the natural drying process was monitored as to the evolvution of water loss along time and different experiments were conducted for the convenctive drying with air at 0.5 m/s at different tenperatures (between 35 and 65 ºC). The kinetic data were fitted to different thin layer models from literature and also to the Fick's second law of diffusion. Also the mass transfer correlations were used to compute the mass trnafer properties.
The results obtained indicated that the different thin layer models tested fitted wel the experimental data, with values of R between 0.972 and 0.999, but with slightly best results if using the Modified Page model (loest value of R equal to 0.997). The values of the moisture diffusion and mass transfer coefficients in all cases were found to increase with increasing temperature of the drying air, from 35 to 65 ºC. The values of diffusivity increased from 1.902×10^{-10} to 1.300×10^{-9} m^2/s and the values of the mass transfer coefficient increased from 5.731×10^{-9} to 8.049×10^{-8} m/s. The values of activation energy for moisture diffucion and for mass transfer were found to be 56.48 kJ/mol and 77.66 kJ/mol, respectively.

Keywords: Activation energy, Convective drying, Diffusivity, Mass transfer coefficient

Efecto de la variedad y del tratamiento de secado sobre el contenido en polifenoles y la capacidad antioxidante de los extractos de hojas de olivo (*Olea europaea* L.)

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La hoja de olivo es un subproducto relacionado con la prevención de hipertensión, diabetes tipo II o cáncer debido a su contenido en polifenoles [1]. La concentración de polifenoles y su capacidad antioxidante dependen de factores medioambientales, genéticos y de procesado [2]. El objetivo es estudiar el efecto de la variedad y del secado sobre el contenido en polifenoles y la capacidad antioxidante de la hoja de olivo.
Las hojas se recolectaron en Navarra en 2017-2018 y las variedades estudiadas fueron arbequina (convencional y ecológica), arroniz, arbosana, empeltre y picual. Las muestras se secaron por estufa a vacío (40 °C / 150 mbar / 7 días) o por liofilización (-78 °C / 100 mbar / 3 días). El contenido en polifenoles se determinó por el método Folin-Ciocalteu y la capacidad antioxidante mediante la reducción del radical DPPH. Los resultados se expresaron como equivalentes de ácido gálico (GAE) y equivalentes de trolox (TE), respectivamente, referidos a materia seca (MS). La estadística se realizó utilizando ANOVA y test de Tukey, considerando significativo un p-valor < 0,05.
En fresco, las variedades con más polifenoles y mayor capacidad antioxidante son arbequina (37,5 ± 2,0 mg GAE/g MS y 154 ± 19 µmol TE /g MS) y arbosana (33,3 ± 2,7 mg GAE/g MS y 132 ± 5 µmol TE /g MS). La liofilización aumenta el contenido en polifenoles de arbequina (43,0 ± 0,4 mg GAE/g MS), arbequina ecológica (34,8 ± 1,4 mg GAE/g MS), arroniz (35,5 ± 1,8 mg GAE/g MS) y empeltre (28,2 ± 1,5 mg GAE/g MS). El secado por estufa a vacío disminuye el contenido en polifenoles en todas las variedades: arbequina (18,2 ± 0,7 mg GAE/g MS), arbequina ecológica (15,1 ± 1,1 mg GAE/g MS), arroniz (14,6 ± 0,8 mg GAE/g MS), arbosana (18,5 ± 0,3 mg GAE/g MS), picual (20,4 ± 1,3 mg GAE/g MS) y empeltre (17,6 ± 0,6 mg GAE/g MS).
En conclusión, en fresco, arbequina y arbosana tienen el mayor contenido en polifenoles y capacidad antioxidante. La liofilización conserva mejor los polifenoles de la hoja que la estufa a vacío.

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Keywords: Olive leaf, Byproduct, Polyphenol, Antioxidant, Variety

Avaliação da influência da temperatura e do resíduo de polpa na secagem de sementes de noni

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O noni é um fruto de origem asiática que tem se disseminado pelo mundo devido as suas propriedades nutracêuticas. A polpa do fruto é utilizada na elaboração de sucos e concentrados, porém as numerosas sementes geralmente são descartadas, apesar de conter teores de lipídios superiores a 6% e cerca de 16% de açúcares, constituindo-se em um alimento nutritivo e com potencial de aproveitamento comercial. Após separadas da polpa e contendo resíduos desta, as sementes chegam a apresentar mais de 60% de umidade, exigindo redução desse teor para adquirir estabilidade química e microbiológica necessárias para resistir aos tempos inerentes a etapas de processamento e comercialização. A variabilidade natural dos produtos biológicos define comportamentos diversos sob processos de perda de água, demandando estudos específicos de cinética de secagem. Este trabalho foi realizado com o objetivo de se determinar a cinética de secagem de sementes de noni, com e sem resíduo de polpa, secadas em camada fina em secador convectivo nas temperaturas de 40, 50, 60 e 70 °C, com velocidade do ar de secagem média de 0,75 $m.s^{-1}$. As amostras foram caracterizadas quanto ao teor de água, cinzas, atividade de água, acidez total titulável, pH, açúcares redutores, amido e parâmetros instrumentais de cor. Os modelos de Henderson & Pabis, Dois Termos, Logarítmico, Page e Thompson foram ajustados aos dados experimentais de secagem. As sementes com e sem resíduo de polpa apresentaram teor de umidade inicial de 73 e 18%, respectivamente, e teores de umidade finais, após secagem, entre 1,47 e 8,6%, em tempos entre 345 e 650 minutos, seguindo relação inversa com o aumento de temperatura. Os coeficientes de determinação (R^2) obtidos com os ajustes mantiveram-se entre 0,814 e 0,999 e os desvios quadráticos médios (DQM) entre 0,000 e 0,583. Todos os modelos testados proporcionaram bons ajustes aos dados de cinética de secagem das sementes de noni, destacando-se o modelo de Page, com coeficientes de determinação acima de 0,99 e DQM menores que 0,02.

Keywords: *Morinda citrifolia* L., Aproveitamento de resíduos, Secador convectivo, Modelagem matemática

Aplicação de processos combinados osmoconvectivos e secagem convectiva para aproveitamento da casca da banana

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A banana é um dos frutos mais produzidos mundialmente. No Brasil sua produção se concentra na região nordeste, no estado da Bahia. Para atender as demandas exigidas pelo mercado, o comércio de bananas gera grandes quantidades de resíduos e parte destes são formados por cascas representando cerca de 40% do fruto. A casca possui alto teor de nutrientes comparado à polpa, além de ser uma fonte de fibras, podendo ser utilizada como recurso alimentício. Para minimizar o impacto causado pelos resíduos ao meio ambiente e agregar valor a estes, esta pesquisa tem como objetivo estudar o aproveitamento das cascas de banana da variedade prata, por meio de processos combinados de secagem: desidratação osmótica e secagem convectiva. As cascas foram caracterizadas *in natura* quanto aos parâmetros: pH, acidez total titulável (ATT), sólidos solúveis totais (SST), razão SST/ATT, teor de água e sólidos totais, cinzas, ácido ascórbico, açúcares redutores, cor e atividade de água. O planejamento fatorial 2^2+3 pontos centrais foi realizado para avaliar o efeito das variáveis de entrada: concentração de sacarose variando entre 40 e 60 °Brix e temperatura variando entre 40 e 60°C, sobre as variáveis de resposta: perda de umidade e de massa, e ganho de sólidos nas cascas das bananas. A condição otimizada de desidratação osmótica que apresentou maior redução no teor de umidade e maiores ganhos de sólidos, foi no ensaio (60 °Brix e 60°C), sendo caracterizado em seguida quanto aos parâmetros físico-químicos citados. A secagem convectiva foi realizada em um secador de bandeja a 60°C, por 26,5 horas, e os modelos de Page, Henderson & Pabis e Midilii foram ajustados aos dados da cinética de secagem. O modelo de Page foi o que melhor se ajustou aos dados da secagem das cascas de banana. A difusividade efetiva (2,2 x 10^{-8} m^2/s) foi determinada pela segunda lei de Fick para a geometria de placa plana infinita considerando quatro termos da equação para a amostra desprezando o encolhimento. O armazenamento por 30 dias promoveu pequenas alterações físicas e físico-químicas no produto desidratado mostrando que o processo foi eficiente.

Keywords: Resíduo, Fruta, Desidratação osmótica

Elaboração de manga passa cv. Espada por processos combinados de desidratação osmótica e secagem convectiva

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A manga (*Mangifera indica*) é uma das frutas tropicais mais bem aceitas, reunindo atributos de sabor, odor, cor e valor nutricional que a tornam largamente apreciada. Além do consumo *in natura*, pode ser desidratada, originando um novo produto, com sabor distinto, estabilidade química e microbiológica e maior valor agregado. A utilização da desidratação osmótica como pré-tratamento para a secagem convectiva é uma técnica eficiente para a melhoria da qualidade do produto final, diminuindo as perdas de nutrientes voláteis e sensíveis às temperaturas durante a secagem, resultando também na obtenção de uma textura próxima à do produto *in natura*. Este trabalho foi realizado com o objetivo de se produzir manga-passa da variedade Espada, por processos combinados de desidratação osmótica e secagem convectiva. Foi realizado um planejamento experimental fatorial 2^3 com três pontos centrais, tendo como variáveis independentes a espessura da fatia (1,0, 1,5 e 2,0 cm), a concentração de sacarose (35, 45 e 55 ºBrix) e a temperatura de desidratação osmótica (30, 40 e 50 ºC) e como variáveis dependentes, perda de massa, perda de umidade, ganho de sólidos, teor de umidade, atividade de água, cor e difusividade efetiva. As amostras osmodesidratadas foram submetidas a secagem convectiva nas temperaturas de 50, 60 e 70 ºC, com velocidade do ar de 1,5 m/s. Os modelos de Page, Henderson & Pabis e Midilli foram ajustados aos dados experimentais da cinética de secagem convectiva. A difusividade efetiva foi determinada usando-se a segunda lei de Fick aplicada à geometria de placa plana infinita considerando os quatro termos da equação, com e sem encolhimento das amostras em função da perda de água. A melhor combinação de condições de processo para desidratação osmótica das fatias de manga foi 1,0 cm de espessura da fatia; 55 °Brix da concentração de sacarose e 50 °C. Nessa condição as fatias osmodesidratadas apresentaram teor de sólidos solúveis totais de 36 ºBrix e ácido ascórbico de 27,5 mg/100 g. As amostras osmodesidratadas submetidas a secagem convectiva apresentaram teores máximos de sólidos solúveis de 65 ºBrix e 34,3 mg/100 g de ácido ascórbico, na temperatura de secagem de 70 ºC. O modelo de Page foi o que melhor se ajustou aos dados da cinética de secagem, com coeficientes de determinação $R^2 > 0,99$ e DQM < 0,01. A difusividade efetiva apresentou valores de $7,03 \times 10^{-10}$, $7,86 \times 10^{-10}$ e $8,91 \times 10^{-10}$ para as temperaturas de 50, 60 e 70 ºC, respectivamente.

Keywords: *Mangifera indica*, Osmodesidratação, Difusividade efetiva

Criosecagem da polpa de manga cv. Keitt

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A manga pertence à família *Anacardiaceae*, nativa da Ásia e está entre as dez culturas mais plantadas no mundo. Tem excelente sabor, características nutricionais e funcionais, sendo rica em cálcio, ferro e vitaminas, entre outros compostos. Por se tratar de uma fruta perecível, no período de safra uma grande parte é desperdiçada por conta da impossibilidade de se conseguir comercializar toda a produção *in natura*. Logo, o estudo de processos que minimizem essas perdas, se faz necessário e uma forma de processamento que pode ser aplicada a manga é a criosecagem ou liofilização. Diante do exposto, este trabalho teve como objetivo liofilizar a polpa de manga cv. Keitt integral e com adição de maltodextrina em diferentes concentrações e avaliar as características químicas, físicas e físico-químicas dos pós produzidos a partir da liofilização. Verificou-se nos pós de manga que com o aumento da concentração de maltodextrina houve tendência de redução do teor de umidade, atividade de água, acidez total titulável, ácido ascórbico, intensidade de vermelho e de amarelo. Os pós de manga obtidos foram classificados como finos e ultra-fino, com fluidez variando de moderada a muito ruim ou péssima, alta coesividade, boa solubilidade em água e alta higroscopicidade.

Keywords: *Mangifera indica L.,* Liofilização, Manga em pó

Equilibrium moisture content determination of cambuci (*Campomanesia phaea* (O. Berg)) fruits using isotherms

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Campomanesia phaea (O. Berg), known as *cambuci*, is a native fruit from Brazilian Atlantic Forest. Some authors identified bioactive compounds associated to the control of obesity and metabolic disorders such as hyperglycemia, glucose intolerance, dyslipidemia and adipose tissue inflammation. It is astringent, the aroma is pleasant, but it tastes sour like lemon. Because of the high moisture content (X = 88.8 g/100 g), the fruit is very perishable. The dehydration is an alternative to increase the product stability and, among the dehydration techniques, the convective process is the most economical and widely used in food industry, although requires long time and high temperatures.

In order to minimize quality and nutritional losses during the dehydration, the processes variables must be studied. The isotherms study enables to identify the effect of temperature on the equilibrium moisture content (*EMC*) and can be used to predict the product stability reached according to drying conditions. This study aimed to determine the equilibrium moisture content of *cambuci* slices submitted to desorption at (40 and 50) °C in a Vapor Sorption Analyser (Aqualab, DECAGON, USA). The method used was the Dynamic Dewpoint (*DDI*) with airflow of 160 mL·min-1. The frozen fruits were purchased from the same producer and, before the measurements, were thawed, peeled and sliced with approximately 5 mm. The samples were dried in an oven until reach a water activity (a_w) of 0.90 or lower, as the equipment requires this condition for desorption isotherm measurements. Seedless samples were inserted into the equipment sealed chamber that registered the a_w and X (dry basis) changes during desorption and adsorption. The measurements were fitted according to BET and GAB models and the last provided the best adjustments, with higher regression coefficients (r^2), lower standard error (*SE*) and mean absolute error (*MAE*). The GAB model parameters were used to estimate the *EMC* at *RH* of (30, 40 and 50) % for each temperature during the desorption. At 40 °C, the estimated *EMC* were (0.05, 0.07 and 0.11) g/g and at 50 °C were (0.10, 0.13 and 0.17) g/g for the *RH* of (30, 40 and 50) %, respectively. As expected, lower *RH* provided higher driving force and removed easier water from the inner structure. At a particular *RH*, higher temperature provided higher *EMC*. The study concluded that lower *RH* might be a route to avoid higher temperatures.

Keywords: Fruit dehydration, Isotherms, Equilibrium moisture content, Cambuci

Comparação entre sacarose e frutoligossacarídoes na desidratação osmótica de kiwi amarelo

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Desidratação osmótica (DO) é um pré-processamento no qual ocorre remoção de água do alimento para um meio osmótico mais concentrado. Este processo diminui significativamente a atividade de água (aw) mesmo em condições brandas de temperatura. No entanto, a DO isoladamente não é suficiente para atingir aw necessária à preservação do alimento, sendo preciso aplicar outros processos de conservação (tais como secagem, liofilização, congelamento, etc). O agente desidratante mais utilizado em soluções osmóticas é a sacarose, devido ao baixo custo e alta solubilidade em água. Entretanto, o uso de sacarose aumenta a concentração de açúcares e o valor calórico do alimento, devido à difusão do soluto para interior da fruta. A aplicação de fibras solúveis, como frutoligossacarídeos (FOS), em DO, pode levar a alimentos desidratados com menor valor calórico e maior teor de fibras, fatores benéficos à saúde dos consumidores. O objetivo deste estudo foi comparar a eficiência de dois agentes desidratantes (sacarose e FOS) sobre DO de kiwi amarelo (*Actinidia deliciosa*). As amostras de kiwi foram higienizadas, descascadas e fatiadas com espessura de 0,5 cm; imersas em soluções osmóticas com 50 g/100g (sacarose ou FOS) e proporção de 1:3 m/m (fruta:solução osmótica). A DO foi conduzida a 60 °C, sem agitação, por 2 h. Foram medidas massa e sólidos solúveis (SS) (inicial e final) e com estes dados foram calculados perda de massa (PM), ganho de sólidos (GS) e perda de água (PA). Os resultados obtidos (em g/100g) foram: PM = (13,1 ± 1,2) e (12,1 ± 0,4); GS = (6,0 ± 0,5) e (2,0 ± 0,5) e PA = (19,0 ± 1,0) e (14,0 ± 0,6), para soluções osmóticas contendo sacarose e FOS, respectivamente. Os dados demonstraram que não houve diferença significativa de PM entre os dois sistemas, mas houve menor GS e PA no sistema utilizando FOS. Este resultado pode ser atribuído ao maior tamanho das cadeias de FOS (3 a 5 unidades) em relação à sacarose (2 unidades de monossacarídeos). O maior tamanho das cadeias dificulta a difusão do FOS para interior da fruta e reduz a PA, devido a menor pressão osmótica do sistema com FOS com mesma concentração mássica que a sacarose. Entretanto a PA obtida com FOS foi semelhante a valores citados na literatura, podendo ser esta fibra aplicada como agente desidratante. Além disso, as frutas desidratadas com FOS apresentam menor valor calórico e maior teor de fibras comparadas com aquelas desidratadas com sacarose.

Keywords: Desidratação, Fruta, Sacarose, Frutoligossacarídeo

Obtención de un snack de papa deshidratado y fortificado mediante impregnación al vacío

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La papa es uno de los productos de mayor consumo en el mundo, destacándose su procesamiento en la forma de papas fritas. El objetivo de este trabajo fue evaluar la viabilidad del uso combinado de la impregnación al vacío y técnicas de deshidratación: liofilización (L), secado convectivo (SC), microondas al vacío (MV), para la obtención de un snack de papa deshidratado y fortificado con vitaminas C, E y calcio. La metodología incluyó la determinación de las mejores condiciones del proceso de impregnación por medio de un diseño experimental Central Compuesto con variables independientes: presión de vacío (PV), tiempo de vacío (t_1) y tiempo de restauración (t_2). Posteriormente, la papa fue sometida a los métodos de secado, evaluando los compuestos adicionados. Se determinó el contenido de humedad final de la papa por medio de la AOAC 2005. En tanto que la vitamina E, vitamina C y calcio, se determinaron por HPLC, titulación con 2,6 diclorofenolindofenol y absorción atómica, respectivamente. Se realizó un análisis microestructural por SEM; finalmente se hizo un análisis sensorial, evaluando la calidad general, siendo 3 puntos la máxima calidad. Como resultado se encontró que las condiciones que optimizaron el proceso de impregnación fueron VP= 77.3 KPa; t_1 = 3.00min; t_2 = 4.05min, (deseabilidad = 0.89) y se alcanzaron niveles de Calcio, Vitamina C y E de 956, 472 y 35 mg·100 g^{-1} sólidos en la papa impregnada, respectivamente. El contenido de humedad promedio para el SC, L y MV fue 5.43, 3.09 y 6.49%, respectivamente. Como resultado principal se puede decir que los valores de Vitamina C fueron 429, 314 y 290 mg·100 g^{-1} sólidos; Vitamina E: 32, 13 y 11 mg·100 g^{-1} sólidos; Calcio 862, 875, 679 mg·100 g^{-1} sólidos, para el L, MV y SC, respectivamente. En cuanto a la evaluación sensorial, los valores de calidad general fueron 3, 2 y 1 para los secados de MV, L y SC, respectivamente. Se concluye que es posible obtener un snack de papa deshidratado y fortificado; evidenciando que todos los métodos de deshidratación conservan los compuestos impregnados; sin embargo, se podría decir que el MV es una alternativa promisoria debido a que se realiza en menor tiempo, tiene menor gasto energético y mejor aceptabilidad sensorial con relación a los otros procesos.

Keywords: *Solanum tuberosum*, Impregnación al vacío, Fortificación, Snack deshidratado

Effect of high hydrostatic pressure and enzymatic hydrolysis on the extraction of phenolic compounds from grape pomace

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O bacon é um produto derivado do abate suíno, que apresenta sabor e características diferenciadas provenientes das operações de cura e defumação. No processamento utiliza-se a barriga suína, condimentos, sal, nitrito e nitrato e cozimento com defumação. É amplamente utilizado na culinária brasileira, como feijoada, tortas, farofas, lanches, entre outros. A deterioração desse produto está associada ao teor de água disponível para que as alterações físico-químicas, bioquímicas e microbiológicas ocorram, e sua conservação é resultado de uma combinação de diversos fatores. Uma boa matéria prima pode não ser transformada em um produto de qualidade se as variáveis de processo não forem respeitadas e todas as transformações bem compreendidas. O conhecimento das isotermas de sorção de umidade de alimentos tem aplicação na predição do tempo de secagem, vida útil do produto, determinação do tipo de embalagem e na caracterização do produto. O estudo teve como objetivo a obtenção das isotermas de sorção de bacon comercial através de diferentes condições de temperatura e umidade relativa do ar, e ajusta-las ao modelo matemático que melhor reproduz os dados experimentais. A amostra comercial de bacon foi adquirida em mercado localizado em São José do Rio Preto, São Paulo, Brasil. Para determinar as isotermas, foram estudadas as temperaturas de 2, 7, 12, 17, 22 e 27°C, usando o método gravimétrico estático com soluções salinas saturadas. Os dados experimentais foram ajustados aos modelos (*Hailwood and Horrobin; Guggenhein, Anderson and de Boer – GAB; Oswin e, Halsey; Ferro e Fontan*) por regressão não-linear, através do software *OriginPro 8.0* (*OriginLab Corporation, Northampton, USA*) e a qualidade do ajuste medida através do coeficiente de determinação ajustado (R^2_{adj}) e raiz do erro médio quadrado (RQEM). Todos os modelos testados obtiveram um bom ajuste aos dados experimentais das isotermas de sorção nas temperaturas estudadas, entretanto, o melhor ajuste foi obtido pelo modelo de GAB para todas as temperaturas, onde os valores de R^2_{adj} variaram entre 0,99768 e 0,99982 o RQEM entre 0,00125 a 0,01502. O modelo de GAB é amplamente utilizado por diversos pesquisadores para descrever o comportamento de isotermas de alimentos devido a sua base teórica fundamentada, apresentando três parâmetros simples de significado físico e que possuem grande adaptação em quase todos os tipos de alimentos com um a_w entre 0,1 e 0,9. Conclui-se que o modelo de GAB foi o que melhor ajustou aos dados experimentais, sendo capaz de descrever os efeitos da temperatura no processo de sorção de bacon.

Keywords: High hydrostatic pressure, Enzymatic hydrolysis, Proanthocyanidins, Phenolic compounds

Efeito do tempo de secagem nas propriedades físico-químicas de pepino (*Cucumis sativus*) e curgete (*Cucurbita pepo* L.)

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As frutas e os vegetais contêm uma grande variedade de componentes nutritivos e saudáveis, como minerais, compostos antioxidantes, vitaminas e fitoquímicos. Estes produtos são muito perecíveis, sendo por vezes necessário recorrer a métodos de conservação, como a secagem, de forma a prolongar o seu tempo de vida. A secagem com convecção é a operação mais utilizada na indústria para a desidratação de produtos alimentares, sendo a sua cinética muito afetada pela temperatura do ar, assim como a dimensão do material. Com este trabalho, pretendeu-se avaliar o efeito do tempo de secagem em estufa convectiva (60 °C e 70 °C) sobre as propriedades físico-químicas (textura, cor, humidade e cinzas) de pepino (*Cucumis sativus*) e de curgete (*Cucurbita pepo* L.). Os vegetais, lavados, higienizados e cortados em discos de 4,5 mm de espessura, foram distribuídos em bandejas perfuradas, e retiradas amostras ao fim de 6, 8, 14, 16, 18 e 24 horas, a 60 e 70 °C, para análise do teor de humidade e cinzas (pelo método gravimétrico), textura (método instrumental) e cor (pelo sistema CIEL*a*b*). A análise de variância (ANOVA) e o teste Tukey foram utilizados para investigar diferenças significativas (p<0,05) nos parâmetros. No pepino, ao fim de 16 e 18 horas atingiu-se ±5% de humidade (5,61±0,84% e 5,88±0,50%), a 70 e 60°C, respetivamente. Na curgete, ao fim de 8 e 16 horas atingiu-se um teor de humidade de ±5% (5,84±0,66% e 4,86±0,25%), a 70 e 60 °C. Para ambos os vegetais constatou-se que não existem alterações significativas do teor de humidade até ao final do tempo de secagem (24 h). O teor de cinzas aumentou significativamente com os processos de secagem atingindo-se valores, ao fim de 8 h, de 11,21±0,08% e 11,09±0,12% para o pepino, a 60 e 70°C, respetivamente, não existindo alterações significativas até ao final do tempo de secagem (24 h). O mesmo foi verificado para a curgete, com valores de 10,01±0,23% e 9,62±0,13%, ao fim de 8 h, a 60 e 70 °C. A textura dos vegetais é significativamente influenciada, verificando-se a sua diminuição com a secagem. A cor é influenciada, tendo ocorrido escurecimento enzimático e amarelecimento dos produtos. A secagem a 70°C conduziu a maiores alterações na diferença de cor total, para ambos os vegetais. Pode-se concluir que a secagem por convecção, à temperatura constante de 60 ou 70 °C, é uma boa alternativa para valorização de produtos excedentários e para diminuição dos custos relacionados com o seu transporte ou armazenamento.

Keywords: Secagem, Liofilização, Pepino (*Cucumis sativus*), Curgete (*Cucurbita pepo* L.)

Seasonality effect on antioxidant activity of "Penca da Póvoa" (*Brassica oleracea* L. var. *costata*) cabbage flours from the Northern Portugal

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Cabbages are one of the most consumed vegetables in Portugal all over the year, being a common-side dish in Portuguese cuisine. They are high yielding, less susceptible to pests and diseases, and well-adapted to a wide range of climates. Cabbages are available throughout the year in two growing seasons, spring/summer and fall/winter, with consequences on plant growth and chemical composition. There is an epidemiological conviction that the consumption of these vegetables is beneficial for health which has been partly attributed to the antioxidant activity compounds. These vegetables, in the dried form, can be good sources of energy, minerals and vitamins. However, changes in quality parameters may occur during the dehydration process.

The aim of this work was to study the seasonal variation in antioxidant activity of cabbage flours produced under two different drying processes. "Penca da Póvoa" (*Brassica oleracea* L. var. *costata*) grown at two growing seasons was used in this investigation. Two different drying methods were used: convective air-drying (80 °C for 2h, with previous blanching) and freeze-drying. Antioxidant activity of fresh and respective flour was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging method.

The extractions and analysis were performed in triplicate and the data presented as mean ± SD values. SPSS software was used for statistical analyses and the analysis of variance (ANOVA) and the Tukey test were used to determine statistically different values at a significant level of ($p<0.05$).

Results showed that there were statistical differences on antioxidant activity in fresh cabbages cultivated in both growing seasons spring/summer and fall/winter. Fresh "Penca da Póvoa" cabbage grown in spring/summer showed higher antioxidant activity than cabbage grown in fall/winter season, revealing the lowest EC_{50} values (9.81 ± 0.32 and 26.0 ± 2.65 mg/ml, respectively). Drying methods had a remarkable effect on antioxidant activity. Cabbage flours produced of both growing seasons presented a higher antioxidant activity when compared with the fresh sample. However, lyophilized flours showed the lowest values of EC_{50}, with small differences between growing season (0.42 ± 0.02 and 0.47 ± 0.008 mg/ml, for fall/winter and spring/summer seasons, respectively) revealing a higher antioxidant activity when compared with convective air-drying (1.13 ± 0.05 and 0.93 ± 0.05 mg/ml, for fall/winter and spring/summer, respectively).

In general, results showed that the growing season influenced the antioxidant activity. Drying methods and respective cabbages flours presented an antioxidant potential and therefore may constitute an important natural source of antioxidants with great potential in the development of new value-added products in different food matrices.

Keywords: *Brassica* vegetables, Seasonality, Drying methods, Antioxidant activity

Influence of the ultrasonic power applied in the hot air drying of pork liver

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Nowadays, liver could be considered as a by-product of pork meat industry, it represents approximately the 3% of pork carcass weight. Current commercial use of pork liver is very limited being used as animal feeding in many cases. Liver presents a high protein and low fat content, which makes it a potential protein source. The recovery of protein requires a previous dehydration stage in order to avoid the interference of the moisture. Preliminary results have revealed that liver dehydration is a slow process and a very high energy demand operation. Therefore, the use of high power ultrasound could be useful to intensify the drying stage shortening the drying time and reducing the energy consumption.

This work explores the feasibility of using airborne ultrasonic application to improve the water removal during hot air drying of pork liver. Thus, drying kinetics of pork liver cylinders were carried out from at 30ºC at 1 m/s applying different ultrasonic powers (21.5 kHz; from 0 to 50 W). Drying kinetics were modelled using diffusion equation for finite cylinders and considering an average effective moisture diffusivity for the whole drying process.

Average initial moisture content of pork liver was 2.71±0.21 kg water/kg dry matter. Airborne ultrasonic application shortened drying time. The effect of power ultrasound application on drying rate was dependent on the power applied, thus, the higher the applied power, the faster the drying. Thereby, the drying time needed to reach a moisture content of 0.5 kg water/kg dry matter was reduced by 220±23 min if experiments without power ultrasound application are compared to those carried out at the maximum applied power (50 W). However, at low ultrasonic powers (<30 W), the influence of power ultrasound on drying rate was not significant ($p>0.05$). Ultrasound application increased the effective moisture diffusivity by up to 21.8%. Further studies should elucidate if the time shortening is linked to an energy reduction in order to corroborate if ultrasonically assisted hot air drying may be considered as a promising technique for industrial dehydration of pork liver.

Keywords: Pork liver, Drying, Ultrasounds

Secagem e avaliação da morfologia do pó de pequi

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O pequi é um fruto nativo do Brasil, perecível, cuja vida pós-colheita é, geralmente, inferior a uma semana quando armazenado à temperatura ambiente. Sua conservação depende, principalmente, das características físicas e da taxa respiratória no início do armazenamento, aos quais variam conforme as condições climáticas. Então, com vistas à ampliação de suas possibilidades de utilização, se faz necessário usar técnicas de processamento, como a secagem, visando à obtenção de um produto final de alta qualidade, que seja apreciado pelo mercado consumidor, com maior valor agregado e maior vida útil. Diante do exposto, este trabalho teve como objetivo secar a polpa de pequi e analisar o seu comportamento morfológico. A polpa de pequi foi espalhada uniformemente em bandejas retangulares de aço inoxidável formando uma camada fina com espessura de 0,5 cm, em seguida foi seca em estufa com circulação forçada de ar com velocidade do ar de 1,0 m/s e temperatura de 70 ºC. Durante a secagem as bandejas foram pesadas em intervalos de tempo regulares até massa constante (14 horas), após a secagem as amostras foram removidas das bandejas com auxílio de uma espátula de aço inoxidável e trituradas em processador para obtenção do pó. A morfologia do pó de pequi foi analisada empregando-se a técnica de Microscopia Eletrônica de Varredura (MEV), a amostra foi metalizada com uma liga de ouro/paládio em seguida foi observada no microscópio eletrônico de varredura com diferentes aumentos (50, 100, 200, 300, 400 e 500 vezes). O pó de pequi apresentou partículas aglomeradas, porosas, com formato irregular e desuniforme. Essas características são, possivelmente, decorrentes do tipo de processo de secagem combinado com o modo de trituração da polpa seca, temperatura de secagem e da composição nutricional. O processo de secagem em estufa sem aditivos favorece a desuniformidade das partículas do pó obtido, além de que o tamanho das mesmas pode ter sido influenciado pelo processo de trituração tendo em vista que é diretamente influenciado pelo teor de umidade do pó. Este fenômeno de aglomeração ocorre devido à presença de partículas com formatos pequenos, as quais se unem conforme as características químicas, físicas e físico-químicas dos pós. Os pós que apresentam características esféricas, aglomeradas devem ser decorrentes do processo de secagem, em virtude do encolhimento do material promovido durante a secagem.

Keywords: *Caryocar coriaceum* Wittm, Camada fina, Morfologia de partículas

Understanding the effect of different chloride salts on the water behavior in the salted meat matrix along 180 days of shelf life

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In general, salted meats have important nutritional properties and are an excellent source of protein mainly in regions where the cold chain is not fully established. However, they have been criticized due to high level of sodium, which when are consumed may increase the risk of developing several diseases. The objective of this study was to evaluate the effects of the partial replacement of NaCl (sodium chloride) by blends of KCl (potassium chloride) and $CaCl_2$ (calcium chloride) on the dehydratation characteristics of salted meat along 180 days of shelf life evaluating results of moisture, water activity (aw) and low field nuclear magnetic resonance (low-NMR). For that, in the dry and wet salting steps, 50% NaCl of the control treatment (FC1) was replaced by 50% KCl (F1), 50% $CaCl_2$ (F2), and blend containing 25 % KCl and 25% $CaCl_2$ (F3) at equivalent concentrations based on the ionic strength. The treatment F2 (50% NaCl + 50% $CaCl_2$) at day 0 obtained the highest moisture value ($P < 0.05$) in comparison with other treatments. During the storage time of the salted meat treatments, only the treatment F2 (50% NaCl + 50% $CaCl_2$) obtained a higher value of moisture ($P < 0.05$) on day 0 than days 45, 90, 135 and 180. During the salting steps, the addition of high $CaCl_2$ content (F2: 50% NaCl + 50% $CaCl_2$) probably caused a high dehydration, forming a very firm and dry surface barrier in the meat product, thereby impairing the water release from the inner regions of the outside flat, resulting in higher moisture values. The aw values of treatment F2 (50% NaCl + 50% $CaCl_2$) remained the highest ($P < 0.05$) over the entire storage time, followed by FC1 (100% NaCl) compared to treatments F1 (50% NaCl + 50% KCl) and F3 (50% NaCl + 25% KCl + 25% CaCl 2). Except F2 (50% NaCl + 50% $CaCl_2$) treatment, there was a gradual decline in aw values during storage. The results of low-NMR analysis are consistent and confirm the results of moisture and water activity during 180 days of salt meat storage. Evaluating the results, it can be seen that the addition of NaCl (FC1) or NaCl + KCl (F1) promote similar effects on the dehydration characteristics, while the addition of high $CaCl_2$ content (F2) impair a decrease in moisture content and aw values during processing and storage of salted meat treatments.

Keywords: Sodium chloride, Potassium chloride, Calcium chloride, Dehydratation, Sodium reduction

Isotermas de desorción y propiedades termodinámicas de las hojas de sacha culantro (*Eryngium foetidum* L.)

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El Sacha culantro (*Eryngium foetidum* L.) es una planta aromática nativa de América Central, usado como condimento y fuente de medicina, además de presentar también propiedades antioxidantes. El objetivo del presente trabajo fue determinar las isotermas de desorción y las propiedades termodinámicas (entalpia diferencial, ΔH_d; entropía diferencial, ΔS_d; teoría de compensación entalpia-entropía) de las hojas de Sacha culantro (HS). Las isotermas fueron determinadas utilizando el método gravimétrico estático a tres temperaturas, 30°C, 40°C y 50°C en un rango de humedad relativa de 10% a 90%. Todas las curvas mostraron un comportamiento de tipo II, de acuerdo a la clasificación de Brunauer. La humedad de equilibrio (X_e) disminuyo con el incremento de la temperatura. El modelo de GAB mostro un buen ajuste de los datos experimentales de isotermas de desorción de las HS, con un contenido de humedad de la monocapa (X_m) dependiente de la temperatura y variando entre 0.051 y 0.036 g agua/g m.s. La ecuación de Clausius-Clapeyron fue utilizada para evaluar la ΔH_d utilizando el modelo de GAB en el rango de temperatura estudiado. La ΔH_d y ΔS_d disminuyeron fuertemente a medida que la X_e se incrementó, variando de 188.18 a 0.96 kJ/mol y de 572.84 a 2.11 J/mol K respectivamente; y presentando ambas un buen ajuste mediante una relación exponencial empírica. La teoría de compensación entalpia-entropía demostró ser válida, ya que la relación entre la ΔH_d y ΔS_d fue lineal. Se encontró un valor positivo de la energía libre de Gibbs (ΔG) y la temperatura armónica (312.94 K) difería de la temperatura isocinética (327.53 K). A través de la teoría de compensación entalpia-entropía, se puede concluir que la isoterma de desorción de las HS es un proceso no espontaneo y controlado por la entalpía.

Keywords: Isotermas de desorción, Modelo de GAB, Propiedades termodinámicas, *Eryngium foetidum* L.

Determination of heat and mass transfer parameters during convective drying of watermelon rind (*Citrullus lanatus*)

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Mass (hm) and heat (hc) transfer parameters were determined for convective drying of watermelon rind, in factorial design 3^2 (2, 3 and 4 m / s) and (40, 50 and 60 ° C) using the Law of Fick and data adjusted to models of Henderson and Pabis, Newton and Page with simulation (Comsol). The hc was obtained using dimensionless numbers of Reynold and Nussel. Effective diffusivity was found (7.58×10^{-10} - 1.90×10^{-9} m^2/s), hm (3.761×10^{-7}-1.289×10^{-6} m/s), hc (12.03-21.70 w/m^2 K). The page model adjusted better the dry ($R^2 > 0.94$). The best condition 60 °C, 4 m/s for Def (1.90×10^{-9} m^2/s).

Keywords: Drying, Mass transfer, Heat transfer, Mathematical modelling, Effective diffusivity

Phytochemical and physicochemical properties of dried orange peel as affected by processing conditions

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The juice processing industry creates a large amount of orange wastes in the form of seeds, peel, pulp and rag, which represent 50-60 % of the whole fruit. Orange peel flour may be obtained from industrial by-products and incorporated into bakery products, improving their dietary fibre and bioactive compounds content. Therefore, the main objective of this study was to evaluate the phytochemical and physicochemical properties of orange peel as affected by three drying methods: convective drying, microwave drying and freeze-drying.

Orange peels of the 'Naranja Bollo' variety were dried with air at a velocity of 1.01±0.03 m/s, a temperature of 50.14±0.99 °C, and a relative humidity of 51.12±1.67 %. Microwave drying was carried out at a power of 340 watts (W), and freeze-drying at -50 °C with vacuum from 1.5 to 2.0 bar.

The assessed physicochemical properties were colour, moisture content and water activity (aw), and phytochemical properties included total phenolic compounds (TPC) and total antioxidant activity (TAA). The moisture content and water activity values of dried orange peels obtained with the three drying methods were in the range 13.03±0.56% to 5.49±0.26 % and 0.425±0.00 to 0.085±0.00, respectively. The phytochemical characteristics determination of dried orange peels showed that total phenolic compounds, when compared to fresh peel, had an average decrease of 13.71% after microwave drying and increased by 6.38% and 19.50% after convective and freeze-drying processes, respectively. Total antioxidant activities of dried orange peels improved on average 18.08%, 25.03% and 44.07%, after microwave, convective and freeze drying processes, respectively. Freeze-dried (FD) flour presented lower browning index when compared to microwave or convective dried, and therefore revealed higher colour quality. In this present study L*, a*, and b* values of the FD orange flour are statistically different from the values of the fresh samples, L* and b* values increased, and a* value decreased. This means that FD samples are more bright and yellow and less red than fresh orange peels. No significant differences ($p>0.05$) between the average browning index of fresh and FD orange flour were observed.

This study proved that the freeze-drying process enhanced the total phenolic compounds, total antioxidant activity, and colour properties, compared to those in dried orange peels obtained from microwave and convective drying. Furthermore, the dried orange peel flour may be an excellent value added ingredient, with potential to be implemented in the food pastry and bakery industry, by incorporation in cakes, biscuits, bread recipes, etc.

Keywords: Wastes, Orange peel, Drying, Phenolics, Antioxidant activity

Efecto del secado sobre la estabilidad oxidativa del β-caroteno presente en el chontaduro (*Bactris gasipaes*)

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El chontaduro (*Bactris gasipaes*) es una fuente prometedora de β-caroteno (127 mg β-caroteno/100g), siendo una alternativa natural para la industria de alimentos en su uso como colorante. La pérdida de calidad funcional y organoléptica de los ingredientes que proporcionan color se debe principalmente a las reacciones oxidativas que toman lugar durante el secado y que pueden ser catalizadas por la temperatura del proceso y la exposición de radiación en el rango visible.

El objetivo principal de la investigación fue evaluar el efecto de diferentes tecnologías tales como: secado por bandejas, secado al vacío, secado por atomización, ventanas refractantes y secado por microondas sobre la estabilidad del β-caroteno presente en chontaduro. Se emplearon temperaturas de 70°C para secado por bandejas, secado al vacío, ventanas refractantes y microondas y de 170°C con tiempos de residencia corta para secado por atomización.

La evolución en el tiempo del contenido de β-caroteno durante el secado mediante las diferentes tecnologías fue medido por cromatografía de gases acoplado a masas (GC-MS), el cambio de color se determinó con la medición de las coordenadas colorimétricas (CIE L*a*b*) y el cambio en la actividad antioxidante fue determinado con la medición de la capacidad de absorción de radicales de oxígeno (ORAC) y las especies reactivas al ácido tiobarbiturico (TBARS). Los resultados revelaron que el secado por ventanas refractantes brinda mayor protección al β- caroteno, siendo la temperatura de proceso y el tiempo de exposición variables influyentes en la pérdida de su funcionalidad tecnológica. Luego del secado por ventanas refractantes se conservó el 88,42% de β-caroteno comparado con un 11,44% por secado en bandejas, 23,94% en secado por microondas, 22,85% al vacío y 30% en secado por atomización.

Keywords: Secado, Chontaduro (Bactris gasipaes), β-caroteno, Estabilidad oxidativa

Effect of osmotic dehydration conditions in solution of sucrose followed by drying on losses of ascorbic acid from umbu

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The umbu (*Spondias tuberosa* Arruda Camara) is a native fruit of the Northeast semi-arid region with great capacity and excellent nutritional characteristics that has been underused in family farming region, although the species has a very diverse genetics population. The industrialization of umbu is limited to the underproduction of pulps, juices, jams and sweets on a small scale not characterized yet, particularly as regards the potential for industrialization. The work aim to assess the influence of the process of osmotic dehydration and drying on losses of ascorbic acid of umbu from variables of process: immersion and time of drying and solution osmotic concentration. The umbu was classified according to the degree of maturity (soluble solids content between 9 and 10 °Brix) and size (larger mesocarp), cleaned, wrapped and refrigerated. The fruit was peeled and sliced manually lengthwise fillets about 2 cm wide. It was carried out each test with 300g of processed umbu. The osmotic dehydration of fillets of umbu were prepared in sucrose solutions and performed in an oven with air circulation (2.0 m/s). Response surface methodology was used in this experiment, the software Statistica 7.0 was used to generate the statistical model with analysis of variance (ANOVA). The design experimental adopted was with 23 with 8 factorial trials, with three central points. The variables studied were immersion time (tI, 1, 2 and 3h), osmotic solution concentration (COS, 35, 40 and 450Brix) and drying time (tD, 5, 5.5 and 6h). Osmotic solution was prepared with distilled water, saccharose ($C_{12}H_{22}O_{11}$), 1% sodium chloride (NaCl) and 0.5 % citric acid ($C_6H_8O_7$), at temperature ambient conditions (±26 °C) and pressure ratio result: solution of 1:2 (weight/ weight), that is each kg of fruit has been submerged into two kg of solution. The umbu in natura presented content ascorbic acid of 16,73 mg/100g on a fresh matter is equivalent to 133,12 mg/100g dry matter. Osmotic dehydration process produced smaller losses of ascorbic acid between (31.35 and 62.79%), while during the drying process the retention was lower (71.16 to 83.44%). The model was considered valid and optimization process in the studied area occurred in tI = 1h; COS = 35 °Brix and tD = 5h, explaining 98% of variance with experimental error (pure error) low (0.81). Fcalc. = 40.23 and Ftab. = 6.16.

Keywords: Dehydration, Umbu, Ascorbic acid

Effect of oven drying on proximate composition and total phenolic content of cubiu (*Solanum sessiliflorum* Dunal)

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Cubiu is an Amazon native fruit of easy growing and large production, which has economic value potential, use and can be used in pharmaceutical, cosmetic and food industries. Research reports that cubiu has healthy improve substances. Due to this fact, it's important to developing techniques to extend the shelf life of cubiu and preserve all the functional compounds and nutrients. Based on that, the purpose of this study was to analyze the effect of drying process on the nutritional and functional composition of cubiu. The fruit was dried in convective dryer equipment at 65 °C. Some properties of the fresh fruit were determined as total phenolic, humidity, ashes, lipids, proteins and water activity. The drying process at 65 °C reduced the total phenolic content by 27.19%; the water activity by 78.32%; and proteins from 12.51% to 8.06%, in the dry fruit. The content of lipids and ashes did not suffer significant changes. Another drying was done at 55 °C, in order to analyze the decreasing temperature effects on drying kinetics, water activity and total phenolic content. The drying process at 55 °C reduced in 62.02% the water activity and 22.12% total polyphenols, comparing with the fresh fruit. Seven thin layer drying models were used to analyze the drying process in both temperatures. The Page model provided a better fit for the drying process. Our results demonstrated the significant effect of temperature on the degradation of functional components present in cubiu.

Keywords: Food drying, Mana-cubiu, Chemical analysis, Bioactive compounds

How the cooking method influences the quality of lyophilized carrot

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High quality food on an expedition is crucial for the participants. Balanced nutritional value is as important as the energy intake ensured by the consumed food. Freeze dried products seem to be a good solution to obtain the apropriate meal in challenging situations and also ensuring the minimal weight of the food carried along. Using this technology the loss of valuable food components can be kept at a very low level.
In our study carrots as a high nutritional value raw material was used - different pre-treatments were applied (cooking in boiling water at 100 °C, sous-vide cooking at 85 °C and steaming 100 °C) prior to lyophilization. The effect of these food processing methods were investigated: rehidration ratio, color (CIELab), texture, β-carotene content was measured and the NIR spectrums (700 – 1700 nm) of the samples were analysed. Heat treated samples were compared to the freeze-dried rehydrated samples. ANOVA and Canonical Discriminant Analysis (CDA) was used to evaluate the data.
Sous-vide treatment and steaming resulted the highest β-carotene content samples but three month storage of the liophylized samples reduced these values by 50%. As a related parameter redness (a*) value of the carrot samples also showed a significant (p=0,05) decrease during the three month storage period. The best rehydration ratio (7,2) was observed at the cooked (100°C) samples followed up by sous-vide (4,2) and steamed (2,7) ones respectively.
NIR spectrum analysis was able to detect the differences in accordance with the dissimilarities found at rehydration ratio, hardness and redness value (a*) and β-carotene content. The samples treated by the different cooking methods and the lyophilezed and rehydrated samples were recognised and separated from the control using the CDA.
This research revealed the importance of the preparation methods and the effect of storage on freeze-dried carrots.

Keywords: Carrot, Freeze-dried, Lyophilisation Sous-vide, Cooking, β-carotene

Sustainable Alternative Food Processing Technologies

Plenary lectures

Nonthermal technologies, a new dimension in food processing

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Conventional approaches to process foods have proven to offer very safe products but, in some cases, the quality of the finish product is significantly lower to the original one and the impact on the environment might be of great concern. Over-processing implies safety, but at a high cost in terms of nutrients and other quality attributes. Nonthermal processing of foods has emerged as a viable alternative to conventional processing techniques by offering safe products of excellent "total quality" at very reasonable cost where, in general, they are environmentally friendly, and they could be listed as "green technologies" with great confidence. It is the case; these nonthermal technologies could be used in combination among themselves or with other preservation approaches seeking synergistic effects in order to have shorter processes and very good quality food products. The Life Cycle Assessment (LCA) of most nonthermal technologies indicate they are contributing to the sustainability of the production chain. Therefore, the positive attributes previously identified for nonthermal technologies coupled with these new ones are making them even more attractive for inclusion in the "Food Factory of the Future". This presentation analyzes some of the most relevant nonthermal technologies which have been validated and implemented by the food industry, and when and how others will be in the near future. Special attention will be given to the impact they are making in environmental, health and socioeconomic issues, as well as emphasizing how they help to circumvent new rules and regulations while facilitating more efficient marketing strategies and distribution systems.

Potential biotechnological and food preservation applications of low to moderate pressure

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High pressure processing has assumed an undeniable role in food processing, allowing obtaining fresher-like food products with extended shelf-life, by applying hydrostatic pressures up to 600 MPa. Additionally, the potential use of hydrostatic pressure goes beyond these food processing applications and novel possibilities are being studied.

Hydrostatic pressure (up to ~ 50 MPa) can also be applied during fermentative processes to induce sub-lethal stresses in microorganisms, such as metabolic changes, to obtain different chemical compounds with biotechnological potential and, fermented food products with different characteristics than those produced at atmospheric pressure, as it is the case of yoghurt.

Recently, a new food preservation methodology, called hyperbaric storage (HS), is being investigated as a possible replacement (at room temperature)/improvement (below room temperature) of refrigeration. In HS (50-100 MPa) foods are kept under pressure for the whole storage period and the latest results indicate the possibility to increase the shelf-life compared to refrigeration, by controlling bacteria growth (both vegetative and spores). An additional advantage of HS is the energetic costs reduction and lower carbon foot-print, particularly when used at room temperature. In this talk, it will be presented results on yoghurt produced under pressure and on HS of several foods.

Sustainable Alternative Food Processing Technologies

Non-thermal Processing and Using Less Resources

Oral Communications

Feasibility of a novel pilot-scale treatment of clear and turbid juices by UV- C light exposure assisted or not by mild heat

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The aim of this study was to evaluate the effectiveness of a pilot-scale UV-C treatment (UV-$C_{total\text{-}output\text{-}power}$:176.4W; UV-$C_{energy\text{-}per\text{-}volume}$:1.7x$10^6$J/$m^3$) on *Escherichia coli* ATCC25922 and *Lactobacillus plantarum* ATCC8014 inactivation in clear and turbid systems. The influence of system absorbance, turbidity and colour was analyzed. The treatment chamber of the self- developed processor contains an UV-C plastic tubing (UV-$C_{transparency}$=98-99%/Length:13.9 m/Diameter:19mm) that is surrounded by 12 UV-C lamps (PhillipsT8/36W/UV-$C_{lamp\text{-}efficiency}$:41.7%). Inoculated systems (10^7 CFU/mL) were pumped (50L; 380 L/h; Re:4520-8700) creating Dean vortexes, thus enabling light to interact with the liquid (1894.8 kJ/L/pass, $t_{residence\text{-}time/pass}$:36.6 s, T:20 (UV-C) and 50±2^{o}C (UV-C/T and T). Pear juice (P; pH:3.8; 15.1±0.1^{o}Brix; 21.9±8.8 NTU; Abs_{254nm}:0.05; 21.7±0.9 NTU; L*:35.0±0.3/a*:-5.21±0.02/b*:30.8±0.4), orange- tangerine (OT; 50:50; pH:3.5; 12.4±0.2^{o}Brix; Abs254nm:0.68±0.01; 3100±3.6 NTU; L*:33.0±0.1/a*:-1.70±0.05/b*:26.2±0.1) and orange-banana-mango-kiwi-strawberry (OBMKS; 50:27:10:10:3; pH:3.6; 13.9±0.1^{o}Brix; Abs_{254}nm:0.37±0.01; 1767.3±2.5 NTU; L*:28.7±0.8/a*:0.5±0.1/b*:45.5±0.2) blends, without any additive, were provided by two local juice processors. Inactivation studies were also conducted in peptone water (PW; pH:7) and model solution (MS; 0.2%w/v tartrazine; pH:5.8; 5.8±0.0^{o}Brix; Abs_{254nm}:0.05; 2.4±1.6 NTU; L*:34.0± 0.3/a*:-5.80±0.02/b*:52.6±1.1). Both bacteria in PW and MS and *E. coli* in P, OT and OBMKS displayed inactivation curves with upward concavity. A pronounced tail was observed only in PW and MS. Whereas, *L. plantarum* inactivation curves exhibited either significant shoulder and concavity in the blends or linear behavior in P. After 31 passes, when single UV-C was applied, 4.5-5.3 and 2.0-3.3 log-reductions were achieved in clear (PW, MS and P) and turbid (OT and OBMKS) systems, respectively. Combined UV-C/T was significantly more efficient, achieving more than 5.0 log reductions for both bacteria, and exhibiting synergistic effects compared to UV-C and T. Inactivation curves were characterized by three conceptually different mathematical models. For *E. coli*, Weibull resistance distributions showed no mode, with lower mean (tc:0.31-4.21 min) and variance ($\sigma$$:2.7-29.3 min^2) and, higher skewness (σ':3.5-190.0) than *L. plantarum* (t_{cm}:0.1-5.8 min/t_c:0.4-11.0 min/$\sigma$$:16.0-91.8 min^2/σ':1.4-257.0) indicating that *E. coli* was more sensitive to UV-C and UV-C/T treatments. Biphasic-plus-shoulder model adequately characterized inactivation curves having significant shoulder (p.e.:L. *plantarum*). Coroller model was the best one characterizing microbial inactivation by UV-C light, indicating the existence of two Weibullian subpopulations with different resistance to single or combined UV-C. Principal component analysis revealed that UV-C effectiveness was positively associated to low values of Abs_{254nm}, turbidity, a* (less reddish samples) and to the assistance of mild T. This preliminary study paves the way for further research regarding feasibility of pilot-scale UV-C processing for the preservation of clear and turbid juices and blends.

Keywords: UV-C assisted by mild heat, Juice preservation, Predictive microbiology, Pilot-scale processor

Alicyclobacillus acidoterrestris and *Bacillus subtilis* endospore germination control by hyperbaric storage – case studies of carrot and apple juices

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Pasteurized acidic juices (pH<3.7) evidence longer shelf-lives than low-acidic juices (pH>4.5). Generally, pasteurized acidic foods are suitable to be kept at room temperature (RT), as endospores development is inhibited by low pH. Nevertheless, there are atypical cases of endospores able to germinate/outgrowth in acidic food products, as it is the case of Alicyclobacillus acidoterrestris endospores. Differently, low-acidic products are more prone to endospore development, thus needing to be kept under refrigeration to hurdle endospore development.

A new preservation methodology is being widely investigated as a quasi-energetically costless alternative of the conventional refrigeration. Hyperbaric storage (HS) states pressure control as a hurdle to slowdown microbial development. It allows considerable energetic savings, due to the needless temperature control, and the energy input is only required during the compression/decompression phases of the pressure vessel, and not to keep it along storage, contrarily to refrigeration.

To infer the feasibility of HS to hurdle A. acidoterrestris and B. subtilis endospores' development in apple (pH 3.4) and in carrot juice (pH 6.0), respectively, samples were inoculated with endospores and stored under pressure (25, 50 and 100 MPa, RT), and compared with atmospheric pressure storage, at both RT (18-23 °C) and refrigeration (4 °C), for up to 60 days.

The results showed that, for A. acidoterrestris, after 5 days, samples kept at atmospheric pressure and RT spoiled due to endospore development (increase of ≈1 log-unit), with acidity unable to hurdle microbial development, while spores in refrigerated samples remained unchanged for 30 days. For B. subtilis, the endospores germinated and outgrew after 9 and 60 days under RT and refrigeration, respectively.

Contrarily, at 50/100 MPa, it was observed endospore inactivation of ≈5 log units, being reached the detection limit (1.0 log CFU/mL), while at 25 MPa a less pronounced endospore reduction was observed (≈2 log-units). For B. subtilis, similar results were obtained at 50/100 MPa, but the inactivation rates occurred in a lower extension, while at 25 MPa, endospore germination/outgrowth occurred, thus spoiling the carrot juice.

These results suggest that HS/RT at uncontrolled RT might be a reliable alternative to control endospore germination and outgrowth in pasteurized fruit juices.

Keywords: *Bacillus subtilis*, *Alicyclobacillus acidoterrestris*, Endospores, Germination, Outgrowth, Refrigeration, Hyperbaric storage

Modification of cassava starch with ozone: effect on gel properties for 3D food printing application

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Ozone is an interesting alternative to the chemical oxidation of starch. Besides not requiring heating, this method does not cause wastewater disposal problems, being considered an environmental friendly technology. In this work, cassava starch was modified by ozone oxidation (10% in water; gas flow of 1 $L \cdot min^{-1}$ with ozone concentration of 41 mg $O_3 \cdot L^{-1}$; 25 ^oC) using different times (15 and 30 min). Starch structure and properties were investigated through carbonyl and carboxyl contents, pH, molecular size distribution profile, paste apparent viscosity and gel strength (3.6% of concentration), obtained in different temperatures (65, 75, 85, and 95 ^oC). The increase in ozonation time produced a starch with higher carbonyl and carboxyl content, and lower pH and molecular size, indicating that ozone modified starch molecules through both oxidation (adding electrical charge) and cleavage. The paste consistency was reduced with ozonation time, for all the gelatinization temperatures analyzed. It indicates that, under stirring and heating, the ozonated starch granules had less capacity to maintain its integrity, being easier ruptured. It was confirmed by optical microscopy: all the samples started to present granular rupture and higher amylose leaching at increasing temperatures. Unmodified starch showed more resistance for this granular rupture. Interestingly, when gelatinized at 65 ^oC, the ozonated starches for 15 and 30 min reached a gel strength value ~75% superior to the unmodified starch. At 75 °C, the ozonated starch for 15 min reached gel strength value ~50% superior to the unmodified starch. For superior temperatures (85 and 95 °C), native starch showed higher gel strength values than the ozonated starches. Even so, the modified starch gels showed 75% of the maximum strength obtained by native sample, but considering a 20 ^oC smaller gelatinization temperature, which is high relevant. Finally, using the ozone modification, it is possible to produce starches with lower apparent viscosity and higher gel strength at lower temperatures, being economically interesting for industrial applications.

Keywords: Cassava starch, Starch modification, Ozone, Oxidation, Industrial applications

Pulsed electric fields applied in the food industry

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The application of pulsed electric fields, PEF, for enhancing the mass transfer of valuable inner cellular content and for inactivation of microorganisms is a scientific demonstrated technique for food and biomedical applications, based on the electroporation phenomenon. However the use of this process in the industry has encountered several difficulties due to the industrial requirements and the lack of technological suitable equipment with the energy efficiency, flexibility, cost, size and reliability to meet the industrial demands.
A new set of monopolar and bipolar semiconductor based modulators, from the modular Marx generator topology, up to 20kV, 400A and 10.5kW was designed for the food industry, with flow rates from 20 t/h. Application in the mass transfer and inactivation processes will be described, as well as the associated treatment chamber.
Examples of the operation of these equipment's in several applications, such as in the apple juice, wine, and olive oil industries, as well as, the microalgae cultures, showed that the application of PEF to the industry is a valuable tool. The difficulties encountered at the industrial level and the solutions to circumvent these will be described. In addition, the requirements put by these loads to the PEF systems will be evaluated and solutions encounter shall be discussed in order to achieve the best performance.

Keywords: Pulsed Electric Fields, Food industry, Electroporation, Pulsed Power

Characterization of Portuguese pears using microsatellite high resolution melting analysis

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The Pear tree (*Pyrus* spp.) is one of the oldest and economically important fruit crops in the world. It presents a high genetic diversity, with over a thousand described species. Portugal preserves a very rich heritage of pear varieties, although currently in danger of genetic erosion.
Microsatellite (SSR) markers have been widely and successfully used in the characterization and genotyping of closely related plant species and varieties, including the pear. Traditionally performed by capillary electrophoresis (CE), a new closed-tube analytical tool has been introduced in recent years, High Resolution Melting (HRM) analysis. It relies in the evaluation of the melting curves of PCR amplified markers, a more efficient and cost-effective method than CE analysis.
In this work, the six core SSR pear markers recommended by the European Cooperative Programme for Plant Genetic Resources (ECPGR) were scored in twelve pear varieties – Bela de Junho, Bojarda, Carapinheira, D. Joaquina, Lambe os Dedos, Lanheses, Marquesinha, Pera de Inverno, Pérola Amarela, Rocha, S. Bento de Chaves and Sete Cotovelos by HRM. From the obtained melting profiles, Genotype Confidence Percentages (GCP) based on the Euclidean distance of each pair were estimated and used to assess the similarity of each tested cultivar. From this, a distance matrix was built recurring to Dice coefficient and used in a cluster analysis applying the unweighted pair-group method.
Overall, each tested microsatellite allowed the distinction of at least one pear variety. CH03g07 marker presented the highest discriminatory power, distinguishing ten out of twelve varieties (GCP<95%). Pera de Inverno and Rocha were grouped in the same genotype (GCP>95%). EMPc11 and CH05c06 were able to distinguish eight varieties, CH01f07a six and CH01d08 and EMPc117 presented the least discriminatory power, distinguishing four out of twelve varieties. The cluster analysis grouped the twelve pear varieties under study in four classes, Sete Cotovelos; Bojarda and Lambe os Dedos; Lanheses, Marquesinha, Pera de Inverno and Rocha; Bela de Junho, Carapinheira, Joaquina, Pérola Amarela and São Bento de Chaves.
To the extent of our knowledge, this is the first study to use microsatellite HRM analysis for the characterization of Portuguese pears. Moreover, it shows the suitability of this approach for the identification and discrimination of pear varieties.

Keywords: Pears, Fruit, Microsatellite, High resolution melting analysis

Efecto del tratamiento por altas presiones hidrostáticas en características organolépticas y fisicoquímicas de salchichón ibérico loncheado y envasado al vacío

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En este trabajo se ha llevado a cabo el procesado mediante altas presiones hidrostáticas (600 MPa/8 min) de salchichón loncheado y envasado al vacío elaborado de forma tradicional y procedente de cerdos ibéricos alimentados en montanera. El salchichón es un producto elaborado mediante el troceado o picado de carnes y grasas condimentadas con sal y pimienta, embutido en tripa natural o artificial, y sometido a un proceso de secado o maduración. El objetivo del trabajo ha sido evaluar los cambios a nivel organoléptico y fisicoquímicos además de comprobar la efectividad del tratamiento por altas presiones hidrostáticas en la reducción de la carga microbiana inicial. Se llevó a cabo el recuento de microorganismos aerobios mesófilos, bacterias lácticas, *S. aureus*, *Cl. Perfringens*, mohos y levaduras, coliformes totales y *E. coli*. Los resultados en los recuentos no han mostrado influencia del tratamiento con HPP en ninguno de los microorganismos estudiados, únicamente se ha obtenido una reducción de los coliformes totales en las muestras tras la aplicación del tratamiento, cuyos recuentos disminuyeron desde 3,3±0,7 a 2,1±0,5 ufc. Así mismo, un panel de cata formado por 8 catadores entrenados llevó a cabo una valoración sensorial del salchichón mediante la evaluación de 13 descriptores: color del magro, color de la grasa, intensidad del olor a chorizo, olores desagradables, dureza, jugosidad, salado, ácido, dulce, picante, intensidad de sabor a curado, aroma a curado y rancidez. No se apreciaron cambios en ninguno de los atributos sensoriales en las muestras tratadas por HHP con respecto a las muestras control. Además, el tratamiento por HHP no origina cambios significativos en los parámetros de color instrumental (CIEL*a*b*), ni tampoco en el perfil oxidativo de lípidos cuyos resultados fueron 0,6±0,2 y 0,6±0,2 mg MDA/kg en las muestras control y tratadas por HPP respectivamente, o en el perfil oxidativo de proteínas, donde los resultados obtenidos mostraron unos valores de 4,7±1,2 y 4,3±1,2 nmoles de Carbonilos/mg de proteínas en las muestras control y las tratadas por HPP respectivamente.

Keywords: Altas presiones hidrostáticas, Salchichón ibérico, Reducción carga microbiana, Oxidación lipídica, Oxidación proteica, Cambios organolépticos

Sustainable Alternative Food Processing Technologies

Non-thermal Processing and Using Less Resources

Poster Communications

Development of a turbid orange-tangerine juice blend processed by a continuous flow-through UV-C light system

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Ultraviolet light (UV-C) processing remains challenging, particularly for turbid juices, due to their medium-low light transmittance and the limitations imposed by suspended matter that can harbor microbial cells. The purpose of this study was to develop an orange-tangerine juice blend (50:50, pH: 3.9±0.1, 11.6±1.0 ^{o}Brix, 1309.3±20 NTU, absorption coefficient=0.41%v/v, $D_{3,2}$:24.0±1.4 μm, $D_{4,3}$: 330.0±27.7 μm) processed by UV-C (2 30W-UV-C lamps serially connected; 0.87m-long annular reactor; 1.6 L/min; 15 min; 17.2 kJ/m^2 ; 20^{o}C). The response of single and composited *Escherichia coli* ATCC 25922 and *Saccharomyces* cerevisiae KE162 inoculated in the blend (10^6-10^7 CFU/mL) to UV-C treatment was assessed and characterized by three conceptually different models (Weibull, modified Coroller and biphasic-plus-houlder). The background pools (10^4 CFU/mL) used for the composited inocula were a) *E. coli* (ATCC 35218, ATCC 8738, ATCC 11229), b) yeasts (*Pichia anomala* 3668, *Zygosaccharomyces bailii* NRRL 7256, *Candida parapsilosis* 22019) and c) native flora isolated from fruit skin. Additionally, uninoculated juice samples treated by UV-C were examined for native flora during 15-day storage (4 ^{o}C) and polyphenol content (PC) by Folin-Ciocalteu reaction, total an-tioxidant activity (TAA) by DPPH and ABTS, color (CIELab values), turbidity, ^{o}Brix and pH, before and after treatment. The presence of background flora in the blend did not significantly modify *E. coli* and *S. cerevisiae* inactivation to UV-C, which was highly effective achieving 4.6-5.1 and 3.7-4.2 log reductions, respectively. All inactivation curves showed shoulder with (*E. coli*) or without (*S. cerevisiae*) tail. Weibullian distributions were skewed to the right and lacked of mode. Exceptionally, the *S. cerevisiae/E.coli*-pool and *S. cerevisae*/native flora composites displayed mode. Coroller and biphasic-plus-shoulder models allowed a better fit and more accurate parameter estimation than Weibull model, thus indicating the existence of two subpopulations with different resistance to UV-C light. UV-C treatment reduced blend native flora by 4.0-5.1 logs, without any recovery except for mould and yeast population which grew up to 1 log cycle during 15-day storage (4 ^{o}C). Color parameters of UV-C processed samples (L*=35.0±0.6, a*= -0.2±0.2, b*=19.8±1.1) hardly differed from control (L*=35.8±0.4, a*=-0.2±0.2, b*=20.2±0.5), while a slight decrease in pH (C=4.25±0.01, UV-C: 4.00±0.02) and increases in ^{o}Brix (UV-C: 10.1±0.1, C: 8.1±0.3) and turbidity (UV-C: 2095±194 NTU, C: 1811±176 NTU) were recorded after treatment. No differences in PC and TAA were observed after exposure to UV-C (PC=0.6±0.1 mg GAE/mL, TAA_{DPPH} =1.5±1.5 mg Trolox/mL, TAA_{ABTS} =0.8±0.1 mg Trolox/mL) compared to the untreated blend (PC=0.6±0.1 mg GAE/mL, TAA_{DPPH} =3.7±0.1 mg Trolox/mL, TAA_{ABTS} =0.6±0.4 mg Trolox/mL). This study expands the use of UV-C obtaining promising results for the processing of turbid juices.

Keywords: UV-C light, Predictive mathematical modelling, Composited inoculum, Minimal processing, Natural juice blend

Descongelación de carnes asistida por ultrasonido

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El ultrasonido es una forma de energía que consiste en ondas de sonido que se propagan a través de un medio, en frecuencias que exceden el campo de audición del oído humano. En particular, el ultrasonido de alta intensidad se considera una tecnología emergente en procesamiento de alimentos, donde la disrupción de la estructura celular puede inducir menores tiempos de proceso. Dado los escasos antecedentes bibliográficos de aplicación de US a la descongelación de alimentos, este trabajo se propone analizar el efecto de la aplicación de US de alta potencia en la descongelación por inmersión de carne vacuna.
Experimentalmente, se trabajó con muestras de un corte comercial del músculo *Biceps Femoris*, pH promedio de 5.7. Se seccionaron muestras de 125 g de peso promedio, de dimensiones 7x4x4 cm. Las muestras fueron congeladas en un freezer doméstico a -20 ºC, almacenadas en el mismo hasta su posterior tratamiento. La descongelación se realizó por inmersión en un baño de agua destilada a temperatura ambiente (20 ºC) donde se introduce la punta sonicadora de un homogeneizador Sonics&Materials VCX750. Se realizaron ensayos a diferentes amplitudes de onda: 40, 60, 70 y 80%. En un baño equivalente, sin US se descongeló una muestra control. Los ensayos se realizaron por duplicado. Las historias térmicas durante la descongelación fueron monitoreadas empleando un adquisidor FieldLogger Novus y termocuplas J. Asimismo, en cada ensayo se registró la energía total aportada por el equipo US.
Los resultados obtenidos muestran un efecto positivo del aporte de US en cuanto a la disminución del tiempo de descongelación. Así, el tiempo de descongelación para alcanzar 0 ºC en el centro, estuvo entre 1130 y 1340 segundos en los procesos asistidos por US, en cambio la muestra control necesitó en promedio 2330 segundos. En cuanto a la energía aportada por el equipo US, varió entre 43074 J para la amplitud de 40% y 122814 J para la amplitud de 80%. Este aporte diferenciado de energía se traduce en un incremento de la temperatura del medio, en las cercanías de la sonda, que en el caso de mayor amplitud alcanza 40 ºC hacia el final del ensayo. Sin embargo, este aumento localizado de la temperatura no se manifiesta en el tiempo de descongelación de las muestras procesadas con diferentes amplitudes de onda. Estos resultados son promisorios a los efectos de aplicar la tecnología US en la descongelación por inmersión.

Keywords: Tiempos de proceso, Energía, Descongelación por inmersión

Impact of magnetic field on biomass production with a brewery's residual yeast

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Exposure of several living organisms to magnetic fields (MF) has been shown to influence cell growth, and consequently production of biomass and other biocompounds, such as glutathione (GSH). Therefore, this study aimed at evaluating biomass and GSH production with a brewery's residual yeast with MF application. The yeast (*Saccharomyces pastorianus*) was grown in 250 mL-shake flasks with 175 mL sugarcane molasses medium supplemented with $(NH_4)_2SO_4$ and KH_2PO_4. Cultivation was performed at 200 rpm, 30 °C for 24 h with samplings at regular intervals. MF of 50 mT were applied throughout the whole culture, in the first 12 h and in the final 12 h. Assays were performed in triplicate and the control assay was the cultivation without MF application. The parameters pH, cell viability, biomass, total reducing sugars and GSH concentrations were evaluated. MF application between 0 to 24 h increased biomass production in 39.1%, while MF application from 12 to 24 h increased GSH production in 10.7%. The best biomass concentrations at the end of the cultivation were between 6.26 g/L and 6.71 g/L, with no statistical difference among cultures. Regarding GSH, the best result (36.96 mg/L) was obtained with MF application from 12 to 24 h. pH values varied from 5.11 to 3.75 and cell viability was above 90% at the end of assays. Results showed that the MF application using molasses as a culture medium stimulated growth of brewery's residual yeast to produce biomass and GSH.

Keywords: Glutathione, Magnets, Molasses, *Saccharomyces pastorianus*

Food storage at room temperature under pressure – A possible alternative to refrigeration

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Data from 2002 estimated that 35–50% of the total energy consumption in super and hypermarkets is due to refrigeration (RF) equipment[1]. Hence, new food storage methodologies capable of reducing these numbers are of great interest.

Hyperbaric Storage (HS) has been studied as a new food preservation methodology for different food products (e.g., fruit juices, ready-to-eat meals, fish) allowing not only the microbial growth inhibition but also microorganisms' inactivation while overall physicochemical parameters are maintained. HS relies on food storage under pressure (50–150 MPa) at low temperatures (5-15 ºC) or at variable room temperature (RT) during days to months.

The aim of this work was to evaluate the HS feasibility for fresh raw meat, pork and bovine, both in pieces and minced. All samples were stored at different conditions: 50, 75 and 100 MPa at variable RT up to 60 days and compared to samples stored at RF (5 °C) and variable RT (both at atmospheric pressure). The HS effect on samples was evaluated by microbiological and physicochemical analyses.

During 60 days of storage it was possible to conclude that 75 and 100 MPa were capable to decrease the initial microbial load (between ≈2 and ≈5 log CFU/g) of total aerobic mesophiles (TAM), *Enterobacteriaceae* (ENT), lactic acid bacteria (LAB), and yeasts and moulds (YM) in all samples, reaching in many cases values below the detection limit (1.00 log CFU/g). Moreover, RF did not allow the microbiological safety of the products over that time period since the initial counts presented to be similar (mainly YM) to higher after 30 days of storage. Concerning physicochemical analyses, when compared to RF, HS allowed an overall equal to better maintenance of pH, and similar color differences between HS and RF were observed mainly due to samples heterogeneity.

Generally, 75 and 100 MPa presented some similarities in moisture content and drip loss when compared to RF, being observed a tendency for lower values in the former and higher values in the latter for samples stored at higher pressures.

At the end HS revealed to be a possible new food preservation methodology for these products where a shelf-life extension could be attempted while lower energetic costs and lower carbon footprint are attained since energy was only required on the compression and decompression phases. Further analyses should be carried out to assess HS impact on other parameters, such as on organoleptic characteristics.

Keywords: Hyperbaric Storage, Meat, Preservation, Refrigeration

Evaluation of combined effect of atmospheric pressure cold plasma and vaporized ethyl pyruvate for reducing *Escherichia coli* population on fresh lettuce

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Fresh produce are perishable products which are prone to microbial contamination after harvesting. Most recent decontamination methods for fresh-cut products are focused on application of different chemical agents. However, there is a lack of information related to the evaluation of the use of hurdle technology in this field. In this study, efficiency of combining atmospheric pressure cold plasma (APP) and vaporized ethyl pyruvate (EP) applications on the inactivation of *E. coli* cells on fresh-cut lettuce (*Lactuca sativa*) was studied. Varying vaporized EP concentrations [0 (control), 5, 10, 50 or 100 µL] along with different APP conditions using oxygen (O_2) and nitrogen (N_2) gases on the inactivation of *E. coli* inoculated (approximately 10^8 cfu/cm^2) on the surface of lettuce leaves (3x3 cm) stored in close-lid glass containers was tested during 3 days of storage at 6 and 25 °C and 90% relative humidity. Using APP in combination with EP treatment resulted in around 2 log more reduction in viable cell numbers when compared to EP treatment only, depending on the type of gas used. O_2 resulted in slightly greater effect (around 0,5 log difference) on inactivation than N_2. Evidence obtained in this study, suggests that the hurdle effect of vaporized EP and APP had remarkable potential to inactivate viable cells on fresh produce.

Keywords: Fresh produce, Decontamination, Hurdle technology, Microbiological quality, Atmospheric plasma

Avaliação microbiológica e nutricional de polpa de açaí (*Euterpe oleracea Mart*) do Arquipélago do Bailique-AP

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O açaizeiro (*Euterpe oleracea* Mart) é uma palmeira nativa da região norte do Brasil e tem se destacado por sua importância econômica na região do Arquipélago do Bailique-AP. Os frutos extraídos das palmeiras do arquipélago são processados e comercializados no Brasil, tendo em vista a importância da qualidade e inocuidade do produto para o consumo. Além disso, o açaí do Bailique é o único do mundo que possuí certificações FSC® e Rainforest AllianceTM (manejo florestal dos açaizais e polpa). Diante do exposto, o objetivo do trabalho foi avaliar características nutricionais e microbiológicas da polpa de açaí do Bailique e comparar a atividade biológica desta em relação a polpa comercial sem certificação. A polpa de açaí do Bailique foi avaliada quanto aos teores de umidade, cinzas, proteínas, lipídios determinados por métodos oficiais e carboidratos por diferença. Nesta polpa também foi realizada análise microbiológica de Coliformes a 45 °C e *Salmonella* sp., conforme exigido pela Legislação Brasileira. As análises de atividade antioxidante em ambas as polpas de açaí foram realizadas por 2 métodos, sendo eles: radicais hidrato 2,2-difenil-2-picrilhidrazil (DPPH) e 2,2'-azinobis (3-etilbenzotiazolina-6-sulfónico) sal de diamônio (ABTS). Os parâmetros de cor das polpas foram determinados em colorímetro. A polpa *in natura* oriunda do Bailique apresentou 80% de umidade. A polpa de açaí (em base seca) apresentou 17,9% de proteínas, 19,2% de carboidratos, 3,2% de cinzas e 54,3% de lipídios. O produto apresentou ausência de contaminação microbiológica, comprovando que o processamento é realizado de acordo com as boas práticas de fabricação. Os parâmetros de cor L* (14,5), a* (12,4) e b* (5,6) da polpa certificada apresentaram maiores valores em relação a polpa comercial (L*=10,8; a*=7,4 e b*=2,3). O potencial de inibição dos radicais DPPH e ABTS da polpa obtida do Bailique (51,1% e 11,7%, respectivamente) foram maiores em relação a polpa comercial sem certificação (29,8% e 9,6%). Sendo assim, é possível afirmar que o consumo da polpa de açaí oriunda do Arquipélago Bailique pode atender às necessidades energéticas e nutricionais de dietas sem restrições específicas.

Keywords: Açaizeiro, Atividade antioxidante, Certificação ambiental

Modeling of adsorption isotherms of milk subjected to high hydrostatic pressure

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In this work the moisture adsorption isotherms of skimmed milk subjected to high pressure were determined in the range of 200 to 600 MPa in periods of 15 and 30 minutes, at three temperatures (15, 25 and 40 ° C) for the range of aw between 0.10 and 0.90. The isotherms were modeled using the model proposed by GAB and the quality of the adjustment was evaluated with the regression coefficient (R^2).
A slow growth is observed up to water activities of 0.6 - 0.7 and from that zone a marked growth of the slope, which corresponds to the stage of water bound as mono layer and to the formation of multilayers.

GAB Equation $$\frac{Xm.C.k.aw}{(1-k.aw).(1+(C-1)k.aw)}$$

The statistical analysis shows a significant difference both for the monolayer value (Xm) and for parameters C and K, the water content in the monolayer increases with the increase in pressure and treatment time. Fourier transform infrared analysis (FTIR) shows a decrease in the amount of sheet-β and α-helix, indicating the denaturation of the protein, which increases with the level of pressure making it more hydrated because of intermolecular interactions between the water and the new amino acid residues exposed. Depending on the balance between micellar disintegration and denaturation of whey proteins, high pressure treatments result in an increase of the amount of water that can be retained by the protein.
The Guggenheim constant (C) of the GAB model showed dependence of the temperature and with the treatment pressure. While for the constant k dependence of the treatment pressure was observed. The isoteric adsorption heat (QS) was calculated using the Clausius-Clapeyron equation, obtaining a maximum of 9 kJ / mol, for a humidity of 0.40 g water / g ms, the isosteric adsorption heat decreases in the samples treated at higher pressures, indicating that the greater water retention corresponds more to a physical process associated with a greater surface area of micelles of smaller size than to an interaction on the surface of the protein. The denaturation increases the surface hydrophobicity improving the protein-protein interaction and not necessarily the protein-water interaction. The evaluation of the Z potential indicates an increase in the negative charge of the particles in the treated milk, which could be interpreted as a condition that helps the adsorption.

Keywords: GAB Equation, Isotherms, Skimmed milk, High pressure, Isosteric adsorption heat

Bioconservação de suco de maçã prensado a frio por *Lactobacillus casei*

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O suco de maçã movimentou no ano de 2014 U$ 22 milhões e é a principal base para os blends encontrados hoje no mercado, possui alta concentração de antioxidantes, baixo valor comercial e características sensoriais não marcantes. Dentre as opções disponíveis no mercado, destacam-se os sucos pasteurizados e submetidos ao tratamento UHT. Entretanto, uma categoria de produtos tem ganhado cada vez mais espaço no mercado, os chamados sucos premium. O crescimento no consumo de sucos desta categoria deve-se a percepção dos benefícios à saúde e pela aproximação do conceito de "natural", com elevadas quantidades de nutrientes, compostos bioativos e antioxidantes. Uma das formas de apresentação dos sucos premium são aqueles que são submetidos à prensagem a frio, método de extração que minimiza o efeito térmico e a exposição ao oxigênio. Por não receber nenhum tipo de tratamento ou utilização de conservantes químicos, esse tipo de suco é propício à deterioração. Desta forma, são necessárias alternativas que possibilitem a prolongação de sua vida útil. A bioconservação consiste na exploração dos benefícios proporcionados pelo metabolismo de micro-organismos, como as bactérias ácido lácticas – LAB, representadas por gêneros como Bifidobacterium, Lactococcus lactis e Lactobacillus. As LAB são consideradas QPS (Qualified Presumption of Safety) pela União Européia e GRAS (Generally Regarded as Safe) pelo FDA (Food and Drug Administration) nos Estados Unidos. O efeito conservador atribuído às LAB está relacionado à produção de ácidos orgânicos, peróxido de hidrogênio, competição por nutrientes, produção de bacteriocinas, proteínas, ácidos graxos, ácido fenólicos, peptídeos. Mediante o exposto, objetivou-se avaliar a utilização de uma LAB como agente conservador de suco de maçã. O micro-organismo utilizado foi o Lactobacillus casei (L. casei 01 – Cristhian Hansen®). O suco de maçã foi obtido a partir da prensagem das maçãs, a uma temperatura de 17 °C e submetido à fermentação por 6 horas a 37 °C e armazenado sob refrigeração (4 °C) para análises posteriores. Durante 15 dias de estocagem, o suco de maçã fermentado não apresentou desenvolvimento de bolores, leveduras, Salmonella spp., coliformes totais e termotolerantes. É possível observar o efeito benéfico do desenvolvimento do Lactobacillus casei no suco de maçã, comprovando que a combinação da fermentação e refrigeração foram suficientes para garantir a estabilidade microbiológica de um produto livre de agentes conservantes e não submetido a nenhum tratamento térmico. Também foram avaliados a viabilidade do Lactobacillus casei e as alterações de pH, acidez e sólidos solúveis durante o período supracitado.

Keywords: Bioconservação, Lactobacillus casei, bactérias ácido lácticas, LAB

Design of high pressure pasteurization processes for fruit products based on resistant molds' spores

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High pressure processing (HPP), also named high hydrostatic pressure (HHP) is a modern method of food pasteurization commercially used in many countries. It relies on the application of very high pressures (up to 600 MPa) to the food/beverage to inactivate microorganisms. Since no heat or mild heat is applied, most of the original food sensory, nutrient and functional properties are retained after processing, and fresh-like fruit products with longer shelf-life are produced. In this study, a review of the resistance to HPP and HPTP (high pressure thermal process) of key bacteria, molds and yeasts often contaminating fruit products was carried out. *Byssochlamys nivea* is a mold that spoils acid fruits and can produce mycotoxins, and as most fungi is able to grow at temperatures between 11 and 43°C, water activity between 0.892 and 0.992, over a wide range of pH (3−8), under reduced oxygen conditions inside food packs and in carbonated beverages. Studies have demonstrated that HPTP at 600 MPa at 70°C for 15 min resulted only in 1.5 to 3.2 log reductions of *B. nivea* spores in fruit products. In addition, HPP treated commercial fruit products are normally cold stored, and therefore molds are more problematic than bacteria. In view of the high resistance to HPTP and to the acidity of fruit products, we propose *B. nivea* spores to be used as reference microorganism in the design of new HPP and HPTP processes with fruit products.

Keywords: High pressure processing, Pasteurization, Fruit products, Spores, Molds

Effect of High Hydrostatic Pressure on refrigerated strored scallop (*Nodipecten nodosus* L.) muscle

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This study aimed at evaluating the effect of high hydrostatic pressure (HHP) processing on microbial safety and shelf life extension of scallop (*Nodipecten nodosus* L.) under refrigerated storage at 4 ° C for 21 days. Adductor muscles were processed at 300 MPa/2.5 min and 400 MPa/5 min and compared with non-processed control along the storage. The samples were analyzed for mesophilic, psychotropic and H2S producing bacteria, total volatile base nitrogen (N-TVB), thiobarbituric acid reactive substances (TBARS), pH, nucleotides resulting from ATP degradation and K value. Microbial counts of pressurized samples did not exceed 106 FCU/g, N-BVT levels remained below 30 mg/100 g and pH did not exceed 6.85, despite having increased during the storage. HHP accelerated lipid oxidation, resulting in increase of TBARS, but did not exceed the standard limit of 2 mg/kg. These results indicate that HHP can significantly increase the refrigerated storage time of adductor muscle of scallops.

Keywords: High hydrostatic pressure, Scallop, Shelf life, Lipid oxidation, K-value

Efeito da aplicação de extrato de erva-mate (Ilex paraguarienses) assistido por ultrassom na estabilidade oxidativa de linguiça suína

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Há tempos é estudada a erva-mate devido a sua propriedade antioxidante e princípios terapêuticos. Seus compostos fenólicos, principais agentes antioxidantes, podem ser aplicados também na indústria de alimentos para retardar as alterações bioquímicas prejudiciais ao shelf life dos produtos. Assim, objetiva-se com este trabalho demonstrar o potencial de extratos de erva-mate como conservantes para embutidos cárneos, cujo principal limitante de vida de prateleira são oxidações lipídicas. Para obtenção dos extratos foi aplicado um planejamento fatorial tipo estrela, visando as melhores condições de extração aquosa por ultrassom para uma maior atividade antioxidante em resposta aos testes de captura de radicais livres ABTS (2,2'-azinobis-(3-etilbenzotiazolina-6-ácido sulfônico)) e DPPH (1,1-difenil-2-picrilhidrazina). As variáveis testadas foram temperatura (22, 30, 50, 70 e 78°C) e tempo (6, 10, 20, 30 e 34 min.).
Nas condições deste estudo, a temperatura foi a única variável que demonstrou influência positiva significativa ($p < 0,05$) na atividade antioxidante dos extratos de erva-mate. Desta forma, utilizou-se as seguintes condições para obtenção de um extrato de erva-mate: banho de ultrassom por 10 minutos a 60°C, aplicação do extrato liofilizado em linguiça suína frescal variando as concentrações de eritorbato de sódio (0, 0,01 e 0,02% - m/m) e extrato de erva-mate (0, 0,03 e 0,06% - m/m), considerando a equivalência da capacidade antioxidante entre eles. O extrato de erva-mate demonstrou uma melhor capacidade de inibir a oxidação da linguiça suína, conforme os resultados de TBARS (substâncias reativas ao ácido tiobarbitúrico), quando aplicado em concentrações acima de 0,06% combinado com concentrações de eritorbato de sódio menores que 0,01%, nas condições deste estudo. Indicando que a ação do eritorbato de sódio como sequestrante de oxigênio combinado ao efeito do extrato de mate como estabilizante de radicais livres proporcionou melhores resultados. Uma análise sensorial de aceitação (aprovado pelo Comitê de Ética da UTFPR, sob o número 44569815.1.0000.5547) foi aplicada entre duas formulações de linguiça, ambos com a mesma concentração de eritorbato de sódio, com adição 0,06% de extrato de erva-mate em uma das formulações. O teste demonstrou que não houve diferença significativa entre a avaliação dos atributos cor, sabor e Nota Global dos provadores, com níveis de aceitação acima de 70% para estes atributos.

Keywords: Antioxidante, Extração, TBAR's, Produto cárneo

High pressure processing as a pre-treatment to increase raw ewe milk-cheese yield and safety

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Serra da Estrela protected designation of origin cheese is produced with raw milk from a specific geographical area, which has been becoming scarcer due to several reasons. High pressure (HP) milk treatment may lead to cheese yield increment as well as increase of microbial safety of raw milk cheeses. In a previous work, the application of a response surface model (100 – 300 MPa; 5 – 30 min), concluded that 121 MPa for 30 min was the optimal processing to achieve a higher cheese yield and to keep endogenous important microflora for Serra da Estrela cheese.

So, in this work, it was found a cheese yield increase of 10.4 % with milk pre-treated under 121 MPa/30 min, for cheese produced in artisanal commercial production facility, after 60 days of ripening. Furthermore, HP milk treatment led to some microbial reduction in milk: 1.30, 0.98 and 0.85 log cycle reduction ($p>0.05$) for *E. coli*, total coliforms and *Enterobacteriaceae*, respectively. While, lactococci, lactobacilli, enterococci and staphylococci were more resistant, with about < 0.67 log cycle reduction. Sensorial evaluation of cheese manufactured from HP pre-treated milk revealed a darker rind, more homogeneous and with fewer defects (yeasts and moulds) relatively to cheese manufactured from raw ewe milk, while the paste colour was maintained and showed to be more fluid. Characteristic odours of Serra da Estrela cheese were kept in HP pre-treated milk, while the texture changed, being softer and more friable/unctuous. The after–taste attribute was more intense in cheeses manufactured from HP milk treated.

In conclusion, HP pre-treatment of raw milk prior to Serra da Estrela cheese manufacture enables a higher cheese yield, important from an economical point of view and an improved microbial profile important from a safety and quality point of view and also a better sensory profile in some cases, important from a quality point of view.

Keywords: Raw ewe milk, Serra da Estrela cheese, High pressure processing, Microbiota, Cheese yield

Nannochloropsis oceanica as a sustainable source of omega-3 polyunsaturated fatty acids for hens eggs enrichment

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The regular consumption of omega-3 polyunsaturated fatty acids (n-3 PUFA), namely of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), has several health benefits as it can markedly reduce cardiovascular diseases, improve inflammatory processes besides its relevance on brain development in the fetus (1). Nevertheless, in most western countries, the recommended daily intake of these compounds is rarely achieved. Therefore, the enrichment of foods that are frequently consumed can increase the intake of these fatty acids. In this respect, eggs are an interesting target because they are prevalent in most of the diets. In the last years, special interest has been devoted to microalgae as a source of valuable compounds, namely of n-3 PUFA. Among them, the marine eustigmatophyte *Nannochloropsis oceanica*, stands out as one of the most promising microalgae due to its high yields in EPA (2).

This study aimed to evaluate the potentialities of *Nannochloropsis oceanica* as a sustainable source of omega-3 PUFA for hens eggs enrichment. It was intended to obtain eggs recognized as rich in omega 3, according to the European legislation.

During 4 weeks, hens were provided with feed supplemented with 3% (w/w) of the marine microalgae *Nannochloropsis oceanica.* Along this time, the nutritional composition of eggs was evaluated, concerning: (i) ash content, obtained after incineration in an oven, at 500°C, for 24h; (ii) total protein, following the Kjeldahl method (3); (iii) total fat, according to the Folch procedure (4) and (iv) fatty acid profile, namely the quantification of EPA, DHA and α linolenic acid (ALA), by gas chromatography analysis.

After one week of supplemented feed intake, it was noticed a remarkable increase in EPA (ranging from 2.13 ± 0.07 to 5.04 ± 0.78 mg / 100 g) and DHA (from 50.3 ± 4.0 to 111.3 ± 6.4 mg/100 g) in the eggs analyzed. These values remained unchanged along the experience. Feed supplementation didn´t lead to changes in the other nutritional parameters, being the protein content of about 12%, the total fat of 10% and ash content around 1%.

The contents of EPA and DHA in eggs, attained in this study, are clearly above the limits indicated in CE nº 1924/2006 for food labeled as source of omega-3. Therefore, it can be concluded that *Nannochloropsis oceanica* has a high potential as a sustainable source of omega-3 PUFA for hens eggs enrichment.

Keywords: DHA, EPA, Feed supplementation, Hens eggs, Microalgae, Nutritional composition

Effect of seaweed incorporation in sunflower oil stability under frying conditions

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Frying encompasses several reactions (oxidation, hydrolysis, polymerization and isomerization) promoted by the presence of oxygen, high temperature and water released by food along the process (1). The exposure to repeated frying cycles enhances edible oil degradation with negative effects on consumer health. The use of synthetic antioxidants has shown limited effects under frying, due to their high volatility and instability at elevated temperatures, besides the evidence that it can have carcinogenic effects (2). Therefore, the supplementation of edible oils with natural antioxidants has gained increasing interest (3).

This study aimed to investigate the potentiality of seaweed species, collected from the Portuguese coast, as sustainable sources of natural antioxidants for sunflower oil supplementation. For this purpose, oil enrichment was carried out by ultrasound-assisted extraction, using the oil as extracting phase and 10% (w/w) of macroalgae biomass.

Supplemented oils were characterized regarding: (i) fatty acid (FA) profile by GC-FID analysis; (ii) total phenolic content (TPC) according to Beldaa *et al*. (4) and (iii) oxidative stability by the oxidation induction period (IP) in a Rancimat apparatus at 110°C. The best results concerning TPC were obtained for *Pelvetia canaliculata* (6.0 ± 0.9 µg/g) and *Saccorhiza polyschides* (3.8 ±0.4 µg/g), being significantly higher than the control sample (1.4 ± 0.4 µg/g). Regarding oxidative stability, no significant differences in IP were observed between the control (4.99 ± 0.09 h) and supplemented oils with *P. canaliculata* (4.89 ± 0.18 h), *S. polyschides* (4.89 ± 0.22 h), *Sargassum muticum* (4.94 ± 0.12 h) and *Codium tomentosum* (4.94 ± 0.03 h). GC analysis revealed a similar FA profile for all the samples, without significant differences in saturated (11.0%), monounsaturated (29.5%) and polyunsaturated (59.5%) FA content. Linoleic acid was the most abundant FA (59.3 ± 0.1%).

Further, oil stability was evaluated under frying conditions. After 3 heating cycles of 6h each, at 180°C, the acidity of control increased from 0.207 ± 0.009 to 0.295 ± 0.014 mg KOH /g oil; the peroxide value raised from 7.7 ± 0.1 to 9.0 ± 0.4 meq O_2/ g oil; the *p*-anisidine value enhanced from 4.4 ± 0.2 to 96.4 ± 1.6, while the K232 and K270 increased from 4.0 ± 0.1 to 16.0 ± 0.2 and from 2.8 ± 0.1 to 3.8 ± 0.1, respectively. None of the supplemented oils showed better performance than the control. Therefore, no protective effect of the seaweeds against oil oxidation was observed, under the tested conditions.

Keywords: Natural antioxidants, Oil supplementation, Oxidative stability, Seaweeds

Optimization of high hydrostatic pressure assisted extraction of stinging nettle leaves using an RSM experimental design

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Stinging nettle grows wildly in the fields and is often seen as an undesirable weed and has been used for centuries as a folk medicine herb in Portugal, with its biological effects having already been reported by modern research and related to its rich content in bioactive compounds [1, 2]. Extraction is the first step to obtain natural components from herbal material with many conventional processes being traditionally used to obtain active fractions. Frequently, these methods have high organic solvent consumption and the high temperatures used are responsible for structural/chemical alterations of the extracted compounds. For so, it is of interest to develop new methods, such as high pressure extraction (HPE), which can operate at room temperature and therefore avoid compound denaturation and facilitating the extraction of heat-sensitive compounds. This work was developed in order to study the HPE effect as a new extraction method to obtain improved extracts from stinging nettle leaves. A full experimental design was applied to optimize the process, and various models were obtained by response surface methodology using a central composite face centered design. The effect of pressure level, time of extraction, and solvent concentration were evaluated on total phenolics, total flavonoids, total sugar content, chlorophylls, and carotenoids content, as also on antioxidant activity by ABTS, DPPH, and ORAC methods. The optimal conditions for maximization of total phenolics and antioxidant activity (by ABTS assay) were 200 MPa, 10.6 min, and 0% ethanol; while for total flavonoids and chlorophylls, the conditions were 200 MPa, 10.6 min, 70% ethanol. When compared to the extraction controls at atmospheric pressure, HPE allowed to increase all the studied parameters from 15% to almost 50%.

One of the most common problems of *in vitro* assays is their relative lack of biological context, since they typically disregard the molecules that the antioxidants could be protecting, such as DNA. Therefore, the antioxidant and pro-oxidant activities of the optimized extracts (in the presence/absence of Fe^{3+} and hydrogen peroxide), as well as their cytotoxicity were studied. The results indicated that aqueous extracts were not only able to protect DNA from degradation caused by hydrogen peroxide radicals (high antioxidant activity up to 5.1 mg_{DW}/mL), but also had no visible pro-oxidant activity (up to 3.8 mg_{DW}/mL), indicating that the extracts by themselves did not affect the DNA molecule. Relatively to the cytotoxicity, the extracts up to 1.0 mg_{DW}/mL did not present any significant inhibition of CaCo-2 metabolism.

Keywords: Biological activities, Bioactive compounds, High pressure extraction, Stinging nettle

Biological properties of grape by-products promoted by Ohmic Heating technology

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Vitis Vinifera (grapes) is one of the most important worldwide produced fruit with a production of 75 million tons per year. Its production is addressed towards fresh consumption as table fruit, juice and raisins, but the major use is in winemaking. During this process, significant amounts of solid wastes rich in high-value components (*e.g.* peels, seeds and stalks) are generated. Fortunately, industries and scientific community have started to play special attention to by-products in order of achieve their revalorization, keeping a better control of waste management and finding alternatives to their usage in other applications. The purpose of this work was to increase knowledge about both biological properties of grape pomace and the use of ohmic heating technology (OH) as alternative to conventional methods, allowing to revalorize this by-product as source of bioactive compounds.

The grape by-products were submitted to OH. After this pre-treatment, to obtain polyphenols extracts from grape pomace 3% of citric acid solution was added. In addition, a conventional method with Methanol acidified by 1% of HCl was performed in order to compare the extracts and to obtain a food grade ingredient. Biological activities were also analysed. The antioxidant activity was determined by ABTS and DNA assay and total polyphenols content by Folin Ciocalteu. Antihypertensive and anti-inflammatory activity were studied by angiotensin converting enzyme (ACE)-inhibitory activity and red blood cells stability methodologies, respectively. Antimicrobial and prebiotic activity were also validated.

For the total phenolic compounds of grape, three extracts, having 0.6; 0.8 and 3 mg GAE/ g FW, were obtained, being the last one, the extract performed with citric acid at 3%, clearly distinguishable. Furthermore, the same extract presented antimicrobial effect upon *Escherichia coli*, *Salmonella enteritidis*, methicillin-resistant *Staphylococcus aureus*, and methicillin-susceptible *Staphylococcus aureus.* Prebiotic and anti-inflammatory and antihypertensive effect were also confirmed. Furthermore, the ohmic heating extract has the ability to increase the potential of antihypertensive, prebiotic, and antimicrobial activity, comparatively with conventional extracts. In conclusion, the best extract obtained is promising from a functional point of view and a good source of high-value components for future food formulations.

Keywords: Grape by-products, Ohmic heating, Biological properties, High-value components, Revalorisation of by-products

Modeling the extraction process assisted by thermal treatment or pulsed electric fields in the recovery of biocompounds from peach waste

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Juice-processing industries generate wastes from fruits and vegetables, which are rich in bioactive compounds, being peach wastes a good source of phenols, flavonoids, anthocyanins, vitamins, with a prominent antioxidant activity. These compounds have an important role in preventing or retarding oxidation processes in the human body. In this regard, these compounds may be recovered by assisted extraction processes to be used as functional food ingredients.

The aim of this study was to evaluate the recovery of bioactive extracts from peach wastes by extraction processes assisted by conventional thermal treatment (CTT) or pulsed electric fields (PEF) and explain the involved phenomena through kinetic models. Peach residues were treated either by CTT (50ºC during 90 min) or PEF (1.6-10kV/cm for 16-120µs, which corresponded to a specific energy input (E_v) of 0.0014–1.61 J mL^{-1}), using 70:30 ethanol:water solvent ratio. Spectrophotometric methods were used to determine the extracts content on total phenolic compounds (TPC), total flavonoids (TF), total anthocyanins (TA), vitamin C content (Vit C) and the antioxidant activity (AA), measured by $DPPH^{\cdot+}$ assay.

A two-step mechanisms was proposed when a CTT was applied considering a first step in which the peach-waste biocompounds were released to the extraction media according to a zero order kinetic and then a second step in which the released compounds were degraded following a first order kinetic. The resulting mathematical model was $C_B=K-(K-C_{B0})\exp(-k_{CTT}\cdot t)$, where K is the relationship between the kinetic constants of both steps, and its values were 514.1 ± 60.9, 117.7 ± 30.1, 3.9 ± 1.6, and 14.5 ± 44.7 (c.u), for TPC, TF, TA, and AA, respectively, so the extraction was the prominent stage. Regarding the extraction assisted by PEF, the model $C = C_{eq}+(C_0-C_{eq})[\exp(-k_1\cdot E_v)+\exp(-k_2\cdot E_v)]$ was applied, being k_1 and k_2 the degradation kinetic constants of the biocompounds. The obtained values for TPC, TF, TA, Vit C and AA were 14.6 ± 11.8, 29.5 ± 264.2, 8.2 ± 7.8, 9.2 ± 11.7, and 22.1 ± 100.7 $mL\cdot J^{-1}$ for k_1 and 0.014 ± 0.02, 0.46 ± 1.82, 0.009 ± 0.023, 0.003 ± 0.026, and 1.47 ± 2.56 $mL\cdot J^{-1}$ for k_2, respectively. A significant relationship was found between energy input and PT degradation of biocompounds from peach wastes treated by PEF.

The results allow concluding that the recovery of biocompounds from peach wastes when extraction was assisted by CTT or PEF was adequately explained by kinetic models, which resulted to be feasible tools to understand the involved phenomena.

Keywords: Peach waste, Kinetic models, Temperature, PEF

Efecto del tratamiento con plasma frio sobre la carne de bovino Effect of cold plasma treatment on bovine meat

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OBJETIVO: Estudiar el efecto del tiempo de tratamiento (0-5 y 10 min) con plasma frío (10000V) bajo atmosfera de Helio (0,3 bar) sobre las propiedades físico químicas (Color, pH, dureza, digestibilidad enzimática), funcionales (Capacidad de emulsificación (CE), capacidad de retención de agua (CRA)), la calidad microbiológica y sensorial de la carne de bovino.
METODOLOGÍA: Para el tratamiento con plasma frio se utilizó un prototipo desarrollado en la Unipamplona. Los análisis fisicoquímicos se realizaron siguiendo la metodología de la AOAC (2016). El Color se determinó en la escala CIELab, la digestibilidad se realizó por método enzimático. Los análisis microbiológicos se reportaron de acuerdo a la Norma técnica Colombiana (NTC 4558/2007) y para la evaluación sensorial se realizó una prueba de tipo selectivo a 20 jueces sin entrenamiento previo.
RESULTADOS: Se observó que el tratamiento disminuye la Luminosidad (L) en 19 unidades independientemente del tiempo de tratamiento. Las escalas a y b disminuyeron ($p<0,05$) 14 y 5 unidades respectivamente en las muestras con mayor tiempo de tratamiento 10 min. Así mismo, la dureza disminuyó de 1,9 a 1,7 Kgf en las muestras tratadas durante 5min y aumentó a 2,05 Kgf en las muestras tratadas durante 10min. Por su parte el pH (6), la CE (0,4 ml de aceite/ g de proteína), el tamaño de la fibra muscular (83 µm), la digestibilidad enzimática (75) y la CRA (99,8%) no presentaron cambios significativos con el tratamiento. En cuanto a la calidad microbiológica se encontró que ésta disminuye 0,27 ciclos logarítmicos de Coliformes fecales y 0,16 de Coliformes totales en las muestras tratadas. La evaluación sensorial indicó que existe mayor preferencia por las muestras tratadas durante 10min en los parámetros de color (55%), olor (55%), sabor (50%) textura (40%) y aceptabilidad (50%).
CONCLUSIONES: El estudio demostró que el tratamiento conserva las principales propiedades funcionales y físico químicas de la carne de bovino, sin embargo, afecta los parámetros de color y dureza. Así mismo, disminuye la carga microbiana garantizando la calidad microbiológica y mejorando la calidad sensorial.

Keywords: Carne de bovino, Plasma frío, Propiedades fisicoquímicas, Proteínas cárnicas

Desarrollo e implementación de un reactor de plasma frío para la conservación de alimentos

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El plasma es un estado de la materia en el que una porción de las partículas se ioniza, prebendo un ambiente que genera nuevas formas de conservación de los alimentos y la destrucción de microorganismos sin afectar su calidad, cualidades prometedoras para las tecnologías emergentes. por lo cual, el principal objetivo de este trabajo fue desarrollar un reactor de plasma frío para el tratamiento de alimentos que pudiera ser usado con fines de investigación por los estudiantes de la Universidad de Pamplona (Colombia). Se aplicó la metodología STAGE-GATE llevando a cabo un estudio de las variables que intervienen en el proceso (Presión, frecuencia, campo electromagnético y tensión eléctrica). Se seleccionó un generador de plasma que implementa sistema cerrado para mejor control de variables. El equipo se formó por una cámara cilíndrica hecha en aluminio (20cm de radio y 19cm de alto) puesta a tierra, un electrodo de aluminio cilíndrico (1cm de radio y 24 cm de largo) que atraviesa el centro de la cámara. Se indujo una tensión eléctrica entre tierra y electrodo generando un campo electromagnético radial propagado en todas las direcciones. La cámara se aisló con un formato rectangular de madera (45cm de ancho, 35cm de profundidad y 40cm de alto). El control de la tensión mediante un dimmer y el de la frecuencia mediante un variador inversor controlado por Arduino. Equipo con el cual se hicieron pruebas en carne de bovino, con muestras tratadas durante 5 y 10 minutos A tensiones de 10KV, presión de vacío (0.4 bar) y atmosfera de gas Helio (0.3 bar), campo electromagnético (13µT – 15µT), y una frecuencia de 60hz, se obtuvo un ambiente de plasma con un leve tono purpura, donde se corroboro que a estas condiciones se redujo la carga microbiana del alimento, y aunque si se afectaron el color y la dureza, se conservaron las principales propiedades funcionales y físico químicas del alimento. En conclusión, el equipo permitió el control de variables y la percepción del tratamiento, así mismo, se adapta a los requerimientos de seguridad necesarios para el operario, su aplicación no afectó algunas propiedades importantes de los alimentos y mejoró la conservación de las muestras.

Keywords: Plasma frio, Generación, Tecnologías emergentes, Destrucción de microorganismos

The impact of thermosonication blanching treatments on peroxidase and color in a halophyte species (*Salicornia ramosissima*)

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Salicornia ramosissíma is a halophyte plant that grows in high-salt coastal marshes being naturally subjected to environmental pressures that stimulates the production of antioxidant compounds, such as polyphenols and vitamins A and E, which are highly valued for their nutritional and functional benefit to our health. Recently it called the attention of the chefs and was incorporated in the gourmet cuisine as a fresh plant. Nevertheless, the use of this plant as a dried or frozen product needs the application of a pre-treatment, i.e. a blanching process, to warrant its quality during storage. Non-thermal technologies with low environmental impact can be applied as pre-treatments to inactivate enzymes and microorganisms that impair the quality and extend its shelf life, such as the application of a combined blanching treatment with ultrasounds (thermosonication).

The objective of this work was to study the effect of thermosonication blanching treatments on peroxidase (POD) and color in *S. ramosissima.*

Water blanching treatments using different temperatures (75–98 °C) and times (0–7.5 min) were applied. POD activity and color were measured spectrophotometrically at 470 nm and in the Hunter *Lab* scale, respectively. Fresh samples presented POD values of 60.34±12.15 µmol.min^{-1}.mgprotein^{-1} and color *L*=35.53±3.44, *a*=-3.02±0.58 and *b*=5.74±1.33. Blanching times of 5 min/85 ºC or 0.5 min/98 ºC ($p<0.05$) reduced more than 90% of the POD activity. *L* parameter decreased for all temperatures at the beginning of each treatment evolving with time to a plateau. The *a* parameter increased by approximately 60% at 90 and 98 ^{o}C at short processing times, while the *b* parameter was maintained ($p>0.05$).

The best combination to inactivate 90% of POD was 0.5 min/98 ^{o}C which also allowed to increase the *a* parameter around 60%.

Thermosonication of *S. ramosissima* allows to reduce the time of blanching processing, resulting a product with better quality for further processing and with minimized color or flavor changes along its shelf-life.

Keywords: *Salicornia ramosissima*, Thermosonication, Peroxidase, Color, Shelf-life

Sustainable Alternative Food Processing Technologies

Physicochemical Aspects of Foods

Oral Communications

Effect of hydroxytyrosol in extra virgin olive oil submitted to frying temperatures. A study by Proton Nuclear Magnetic Resonance (^{1}H NMR) spectroscopy

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Introduction

Frying is one of the main culinary processes employed both industrially and domestically. However, this process involves the use of high temperatures, which increases the degradation rate of the oil and generates toxic compounds. To enhance its shelf-life, compounds with potential antioxidant activity have been tested. In this regard, hydroxytyrosol (OHTyr), a compound naturally present in virgin olive oil, has been described to exert an antioxidant effect. In those studies, methods based on radical scavenging, which do not give information about the nature of the compounds being generated, were mainly used. By contrast, ^{1}H NMR spectroscopy has been successfully used to study oxidation processes in oils at different conditions, providing a great deal of information about the oxidation rate and the nature of the products being formed in a simple, rapid and global way.

Objectives

The aim of this work was to study the behavior of OHTyr when added to extra virgin olive oil (EVOO) submitted at 190º C by ^{1}H NMR to elucidate if differences in the degradation rate of the oil take place under these conditions at different enrichment levels.

Materials & Methods

Two different EVOOs, with a similar acyl group composition, were used. One of them was acquired to be enriched in the laboratory (with 0.02 and 0.2% of OHTyrAcetate); the other one was already commercialized enriched with a natural extract of polyphenols (mainly OHTyr). After submitting the oils to 190ºC for 24 h, every hour samples were taken to be analyzed by ^{1}H NMR.

Results

A protective effect towards polyunsatured acyl group degradation was observed not only in the EVOO enriched with the highest concentration of OHTyrAcetate (0.2%), but also in the oil commercially enriched with the polyphenol extract. Likewise, a similar effect was noticed on the formation rate and in the concentration of secondary oxidation compounds, which was more significant in the oil enriched with the highest concentration of OHTyrAc, but also detectable at lower enrichment levels.

Conclusions

^{1}H NMR has shown that EVOO enrichment with a certain concentration of OHTyr retards the degradation rate of the oil under these conditions. Moreover, information regarding the process evolution was provided by this technique.

Keywords: Extra Virgin Olive Oil, Hydroxytyrosol, Antioxidant, Frying, ^{1}H NMR

Electronarcosis as a pre-slaughter method for rainbow trout (*Oncorhynchus mykiss*) improves meat quality

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Pre-slaughter and slaughter procedures in fish can induce acute stress disorder triggering a sequence of hormonal, biochemical and osmoregulatory responses. These responses can compromise the quality of the meat, do increase muscle activity, promoting the abrupt fall in pH after death and speeding deployment and resolution of *rigor mortis*. In Brazil, the slaughter of farmed fish is done by immersion in water and ice (Hypothermia), a method considered too stressful, and that decreases the shelf life of the fish. Rainbow trout (*Oncorhynchus mykiss*) is a species of cold water, and therefore the use of hypothermia may not be efficient. The present study evaluated the effects of electronarcosis and hypothermia as pre-slaughter stunning methods on the quality of meat of rainbow trout stored in ice during 7 days. Four treatments were used to stunning fish: Hypothermia (water and ice on 1:1), E1 - Electronarcosis 1 (1200 Hz for 3s), E2 - Electronarcosis 2 (1500 Hz for 3s) and Anesthesia/control (Eugenol previously diluted in ethanol) in which the fish were immersed for 3 minutes. After stunning, the fish were slaughtered by cutting from the gills and bled. Were evaluated *rigor mortis*, muscle pH index, dielectric properties, volatile nitrogenous bases (VNB) and thiobarbituric acid reactive substances (TBARS) at various times after the death. It took 67 minutes for the fish subjected to low temperature (hypothermia) to become apparently stunned and the complete rigor mortis (100%) was reached 3 hours after death. In other treatments, the deployment of rigor occurred 24 h after slaughter. The pH of the fish muscle stunned by eletronarcosis, independent of the frequency used, showed a gradual decline, reaching the minimum value observed (E1: 6.012; E2:5.934) at 72 h after death, while in other treatments the decline of muscle pH occurred abruptly reaching the smallest averages (Anesthesia: 6.265; Hypothermia: 6.304) only 6 h after slaughter. For trout stunned by hypothermia, the dielectric properties of the meat were higher ($P < 0.05$) at times 0 and 3h after slaughter, and there were no differences in the other samplings. Immediately after slaughter VNB concentration was higher ($P < 0.05$) in hypothermia stunned fish (14.487 mg N / 100 grams). For TBARS, there was no significant difference between the assays methods tested. We concluded that the electronarcosis with a frequency of 1200 Hz is indicated to stunned trout in an effective and fast way, preserving the quality of the meat.

Keywords: Stunning methods, Fish quality, Rigor mortis, Shelf life, Anesthesia in fish

Pasting properties of gluten-free flour mix treated with high isostatic pressure

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The rising demand for gluten-free products has led the baking industry to search for alternative ways to face the technological challenge of forming a viscoelastic dough, similar to conventional breads. The staling phenomenon happens rapidly due to the absence of gluten and high levels of starch. High isostatic pressure (HIP) processing has been identified as a potential area for food engineering. This treatment alters the structure of biopolymers such as proteins and starch. It also improves viscoelastic and elasticity properties. Given this framework, the goal of this study is to assess the pasting properties by Rapid Visco Analyser (RVA) of gluten free flour mix (41% of rice flour, 49% of cassava starch and 10% of acidified egg albumin powder) with high isostatic pressure and Untreated samples (atmospheric pressure,0.1 MPa) were used as control, for the purpose of improve the characteristics for possible application in gluten-free breads. The samples (gluten-free flour mix) were treated at 4 different conditions: T1 (200 MPa / 5 min); T2 (200 MPa / 10 min); T3 (600 MPa / 5 min) and T4 (600 MPa / 10 min). The temperature was thermostatically controlled at 20 °C throughout treatment. The RVA results indicated that Setback parameter hadn't a significant difference ($p < 0.05$). In other words, the pressure and time didn't alter the retrograde tendency of flours. Regarding the Breakdown analysis, it was observed that the subjects treated at 600 MPa showed lower values and also lower T4 than those from other treatments ($p < 0.05$). The results indicate that the 600 MPa treatment at a longer time length improved the starch resistance to shear. It was also observed that the higher-pressure treatments (T3 and T4) yielded the smaller maximum viscoelasticity parameter, suggesting that a pressure increase can help in terms of reducing the dough viscoelasticity. This research suggests that a pressure increase along with a five minutes suspension of proteins and starch in water is enough to yield a material with better capacity of making a viscoelastic pasting during the heating (maximum viscoelasticity) and a gel with smaller viscoelasticity after the cooling process (final viscoelasticity), suggesting a possible improvement on the texture of gluten-free breads.

Keywords: Retrograde tendency, RVA, Gluten-free breads

Modeling of sensorial shelf life of avocado pulp subjected to high hydrostatic pressure

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The avocado is one of the most economically relevant fruit growth in Colombia, this product also presents important losses on its post-harvest period. The objective of this research was to evaluate the kinetics of degradation of the quality parameters and sensory acceptance of avocado pulp (*Persea americana*) treated by high pressure at 6000 bars during 3 minutes.
The HHP processing conditions generally used on a commercial scale, do not completely inactivate the enzymes responsible for quality losses during storage, therefore, refrigeration (4 ◦C) is necessary to minimize quality losses induced by residual enzymatic activities and to ensure product safety.
The monitoring of sensory acceptance was accompanied by the determination of the activity of oxidative enzymes such as polyphenol oxidase (PPO) and lipoxygenase (LOX) besides a follow-up of the color evolution with the Hunter Lab color scale associated with the formation of o-quinones.
Consumers evaluated the acceptability of the avocado pastes of the descriptors (including acidity and rancid taste) using a hedonic scale (1 to 7, 1 = really disgusting, 7 = really liked).
The calculation of the cut-off point (intensity of the descriptor which induces a significant decrease in the acceptability of the product) was made by estimating the least significant difference (LSD) in the acceptability based on the data generated by the consumer panel. Subsequently, the value for the acceptability limit (S) which is the value below which the sensory acceptability of the stored product is significantly reduced.
To conclude, there is a strong correlation between sensory acceptability and color data (which produce a decrease in consumer acceptability). Based on mathematical modeling, the color delta value 4,7 ± 0. 3 as the upper acceptability limit for consumers. Other biochemical changes included a decrease in pH values and the reactivation of PPO and LOX enzymes during storage, which were only partially inactivated by the commercial processing conditions of HHP used. The sensorial shelf life of the product was established in 55 days with storage at 4 ° C, however, it may be shorter due to nutritional losses that are not considered in this study.

Keywords: Sensorial shelf life, Mathematical modelling, High hydrostatic pressure, Avocado pulp

Sustainable palm oil and its interactions on the formation of 3-MCPD, 2-MCPD and glycidyl esters in the refined oil

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Palm oil has become the leading vegetable oil for edible applications because of its unique fatty acid composition and nutritional properties. Currently, about 58.84 million tons of palm oil are produced. Given the great soil devastation and deforestation during planting, changes have occurred regarding the implementation of global standards for the production of sustainable palm oil (RSPO). This certification involves a set of actions related to compliance with local laws and regulations, economic viability, best agricultural practices, environmental responsibility and management of new plantations. Ordinarily crude palm oil follows the physical refining process which includes degumming bleaching and deodorization steps. However, the condition of high temperature (> 250 °C) commonly used during the deodorization step can also favor the formation of contaminants, such as monochloropropanediols esters (3-MCPDE and 2-MCPDE) and glycidyl esters (GE). Therefore, the main goal of this study was to evaluate the formation of 3-MCPDE, 2-MCPDE and glycidyl esters (GE) and the physicochemical characteristics (free fatty acids-FFA, color, diacylglycerols-DAG, and oxidative stability index-OSI) of sustainable palm oil (RSPO) before and after the physical refining process. The refined palm oil was submitted to the analysis of the contaminants (3-MCPD, 2-MCPD, and GE) through GC-MS. Thus, crude RSPO was subjected to dry-degumming using activated bleaching earth. Thereafter, the oil was submitted to deodorization (260°C and 2-8 mbar) during 120 minutes. The results revealed that the deodorization step was effective on reducing the FFA from 1.91% to 0.18%, and the color was reduced from 32R to 1.6R, indicating a good heat bleaching process. As the DAG have a low relative volatility their content remained practically unchanged (3.89%). The OSI value of crude oil was 24.7h and after deodorization 11.54h, hence indicating a possible reduction of the antioxidants. The content of 3-MCPDE, 2-MCPDE, and GE found in the refined palm oil was 2.71 mg/kg, 1.24 mg/kg, 0.22 mg/kg, respectively. It can be concluded that the physical refining applied to RSPO is capable to produce an oil with low FFA content and light color, which are the most relevant quality indexes evaluated in palm oil. Nonetheless, the 3-MCPDE content was 2.2 times higher than 2-MCPDE, and 12.3 times higher than GE. Although, these values are lower than those found in conventional palm oil.

Keywords: Palm oil, RSPO, Contaminants, 3-MCPD, 2-MCPD, GE

Sustainable Alternative Food Processing Technologies

Physicochemical Aspects of Foods

Poster Communications

Structural effects of ultrasound: direct and indirect evidences on potato tissue

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High power ultrasound has been widely used as a pre-treatment for improving many mass transfer processes. However, it is still rare in the literature the mechanisms description and structural changes demonstration. This work aimed to demonstrate the internal and external structural changes in potato cylinders caused by different times of ultrasound pretreatment. In addition, it was also our objectiveto associate the structural changes with the sample viscoelasticity and two mass transfer processes. Potato cylinders were immersed in distilled water and pretreated with and without ultrasound (ultrasonic bath of 91 W/L and 25 kHz) up to 120 min. Their microstructure was evaluated using a stereo microscope as a direct method. Furthermore, the microstructure modification was indirectly evaluated by sample viscoelasticity and mass transfer evaluation (pigment diffusion and drying). Formation of microchannels inside the potato tissue, as well as surface erosion caused by ultrasound were demostrated. Ultrasound process have also altered the initial product viscoelasticity, reducing their elastic behaviour. Both structural and mechanical changes could be associated. Finally, both mass transfer operations were improved by ultrasound: the pigment transfer was enhanced; and the drying process was accelerated by ultrasound, demonstrating the reduction of the internal resistance to pigment and water transfer. This work demonstrated that the structural changes caused by ultrasound can be evidenced directly and indirectly, contributing to the discussion of the associated mechanisms.

Keywords: Ultrasound, Food processing, Convective drying

A sistematic study of antifoams action in bio-based systems within microfluidic capillary channels

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Oil-in-water emulsions can be produced during fermentative genetic engineering process, hindering efficient product recovery (oil-based such as flavor and chemical compounds). Some components added along the process allow the formation of these emulsions and, specifically the antifoams could increase this stabilization. Even so, antifoams are added with a lack of knowledge about their action within the fermentative broth. In general, the formation of these emulsions is recognized as a negative step of the process since it increases both the demand for more energy for product separation and the demulsifiers use, impacting on higher costs and environmental issues. In this study, with the aid of capillary channels, the effect of two antifoams (a pluronic (A2) and a silicon agent (A1)) was analyzed triggering the formation of droplets of three different oils (hexadecane, sunflower oil and a medium chain triacylglycerol (MCT)), to understand the ability of these antifoaming agents on emulsions production and coalescence. It was observed that both antifoams improved emulsions formation, generating droplets of oil with minimum size diameter of up to 308.17 ± 14.98 µm (coefficient of variation (CV) = 4.86%), while without their addition droplets could not even be formed. However, they showed independent performances depending on the intrinsic characteristics of the oily phases, impacting on the degree of stability. In this sense, MCT with intermediate characteristics of viscosity (23.93 ± 0.01 mPa.s) and interfacial tension (22.10 ± 0.13 mN.m-1 with aqueous phase containing A1 and 7.42 ± 0.52 mN.m-1 with aqueous phase containing A2) was the oil that presented easier droplets detachment, impacting on a higher frequency of droplets formation (up to 45 s-1). On the other hand, hexadecane droplets could not be formed using A1 solution as aqueous phase, while with sunflower oil a unique phenomenon occurred and droplets were difficult to be generated with A2 aqueous phase, resulting in diameter values higher than 521.71 ± 16.07 µm (CV = 3.08%). These results allowed to understand the mechanisms of these multiphase systems formation. Moreover, aiming the reduction of emulsions formation, the results may also contribute to rational choice of antifoaming agents depending on the characteristics of the dispersed phase.

Keywords: Product oil recovery, Antifoams, Yeast cells, Capillary device, Microfluidics

Actividad antioxidante y antibacteriana de extractos supercríticos de diferentes hierbas y frutos

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Es conocido el interés en la sustitución de los antioxidantes sintéticos utilizados en la industria alimentaria por antioxidantes naturales de diferente naturaleza. Además, el control del deterioro de alimentos debido a la presencia de microorganismos y el crecimiento de bacterias patógenas se logra principalmente mediante el uso de químicos sintéticos. Sin embargo, varios tipos de hierbas pueden ser fuente de extractos con actividad antioxidante y antibacteriana.

En este trabajo se obtuvieron extractos con fluidos supercríticos, particularmente con dióxido de Carbono (SCCO2) de romero (*Rosmarinus officinalis*) y de otras hierbas y frutos nativos de Uruguay y la región: cedrón (*Aloysia citrodora*), congorosa (*Maytenus ilicifolia*), boldo (*Peumus boldus*), yerba mate (*Ilex paraguariensis*) y guayabo del país (*Acca sellowiana (Berg.) Burret*), y arazá (*Psidium cattleianum Sab.*). Para realizar las extracciones supercríticas se utilizó un extractor de laboratorio con una capacidad de 50 mL, el cual se operó a presiones de 200 a 400 bar, temperaturas de 40 a 50 °C y flujo constante de 0,5 L/min CO_2 promedio.

Para evaluar el poder antioxidante de los diferentes extractos los mismos se agregaron a un aceite de girasol purificado (P-SFO), libre de antioxidantes (comerciales o nativos), a diferentes concentraciones (500 y 1000 ppm). El P-SFO posteriormente fue sometido a un ensayo de enranciamiento acelerado (Rancimat a 100°C) determinándose el período de inducción (IP) como parámetro indicador de su estabilidad oxidativa. A los efectos de contrastar el poder antioxidante de estos extractos con el de varios antioxidantes sintéticos comunes, se realizó el mismo ensayo con el P-SFO aditivado con BHT, BHA y α-tocoferol.

Cuando el P-SFO fue aditivado en 500 ppm con los extractos de romero obtenidos a 50°C y a 300 o 400 bar, su RIP (IP relativo al del P-SFO de partida =1.7 h) fue de 7.0 o 9.4, respectivamente. Se observó que un aumento de la presión como de la temperatura durante la extracción con SCCO2 provocan un aumento del IP.

Estos extractos resultaron tanto o más efectivos que algunos antioxidantes sintéticos de uso común como el BHT y BHA (RIP= 7.9 y 8.3, respectivamente), y que él α-tocoferol (RIP= 5.2).

También, se estudió el efecto antibacteriano de los extractos obtenidos frente a bacterias Gram negativas: *Escherichia coli, Pseudomonas aeruginosa y Salmonella typhimurium*; Gram positvas: *Staphylococcus aureus, Bacillus cereus y Bacillus subtilis*. Se determinó la concentración mínima inhibitoria (CIM), para cada extracto contra los microorganismos seleccionados.

Los extractos de romero y la congorosa resultaron los de mayor poder antibacteriano. Se observó una tendencia de mayor susceptibilidad de bacterias Gram positivas.

Los extractos de hierbas prueban ser una fuente de compuestos con actividad antioxidante y antibacteriana.

Keywords: Antioxidantes naturales, Extractos de hierbas, Extracción supercrítica, Estabilidad oxidativa, Actividad antibacteriana

Overrun, color and carotenoid content in ice creams with β-carotene nanoemulsions

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Initially, nanoencapsulation of compounds was developed with the goal of improving drug release. Because of their very particular physical and chemical properties, these structures have aroused interest in the food industry. The present work aims to evaluate the effect of the addition of β-carotene nanoemulsions on ice creams and their ability to protect these compounds during storage. The β-carotene nanoemulsions were formulated with corn oil, by applying high-pressure homogenization. Three formulations of ice cream were developed: control (without carotenoid), with the addition of nanoemulsion (24 % v/v) and with free β-carotene (24 % w/v). The samples were stored at -18 °C during 28 d and the parameters overrun, β-carotene content and color were analyzed. The addition of nanoemulsions in the ice cream impacted in the overrun of the sample, with a significative ($p<0.05$) increase of 17 % and 56 % in comparisons with the samples with free β-carotene and control, respectively. This increase is caused by the elevation of the fat content that can enable a higher overrun, as more coalesced fat droplets are available to trap a more considerable amount of air bubbles in the ice cream. No significative difference ($p>0.05$) was observed in the β-carotene content in both samples after 28 d of storage. The three samples showed significative differences ($p<0.05$), control samples showed the higher values for hue angle (215.62 ± 0.44), followed by the samples with nanoemulsions (105.90°±0.60) than the samples with free β-carotene (98.95°±1.18). This values of the samples with carotenoid in the Lab system diagram indicates that the color tone of the samples closes to the yellow color while the control sample was close to the blue color. After 28 days of storage both samples with the carotenoid did not show significative ($p>0.05$) changes in the hue value. The values of chroma were significative different for the three samples, being the samples with nanoemulsion the higher value (8.70±0.11), followed by the samples with free β-carotene (3.34±0.15) and then the control sample (1.02±0.04), these values demonstrated that with the addition of the nanoemulsion color saturation increase in the samples. After 28 d of storage the saturation of the samples with nanoemulsion increased ($p<0.05$) while in the samples with free carotenoid the value decreased ($p<0.05$) in comparation with the initial values. The use of nanoemulsions β-carotene as a colorant for ice cream presented greater technological advantages, with an increase in overrun and vividness color saturation.

Keywords: Nanotechnology, Carotenoids, Food

Evaluation of the possible heavy metal and microbiological risks of watercress (*Nasturtium officinale*), lettuce (*Lactuca sativa*), lemon balm (*Melissa officinalis*), and taraxaco (*Taraxacum officinale*), sold in markets of the Metropolitan District of Quito-Ecuador

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The objective of this study was evaluating the possible health risks associated with the content of heavy metal and microorganisms in the consumption of watercress, lettuce, lemon balm and taraxaco. The products were purchased in several markets in the city of Quito. In this study, the products marketed in the north and center of the city showed better size characteristics, while the soluble solids, pH and ash showed no definite behavior. In addition, due to the volcanic origin of the soils in Ecuador, in which the samples under study were grown, they showed quantities of lead that varied between 0.02 ppm (taraxaco, lemon balm and lettuce) up to 2.60 ppm (watercress), becoming an irrigation for health in the case of watercress that exceeded the maximum limits allowed by CODEX, while cadmium varied between 0.01 and 0.07 ppm and did not imply a risk of consumption in any of the cases under study. On the other hand, the microbial quality from of the different products under study showed contamination with mesophilic aerobic microorganism and parasites, resulting in high values in both cases. These finding provide valuable information that can funding food safety decisions, and confirm that the vast majority of vegetables available on Quito markets present a problem in terms of bacteriological hazards.

Keywords: Food safety, Mesophilic aerobic, Parasites, Lead, Cadmium

Improvement of the oxidative stability of olive oil in presence of dodecyl gallate

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Introduction

Vegetable oils are widely used as cooking media and as ingredients, for this reason their oxidative stability and oxidation mechanism are subjects of great interest. It is well known that their oxidation provokes not only the reduction of their nutritional and sensorial quality but also the formation of new compounds, some of which are well-known for toxic effects on human health. To delay this process and to extend their shelf life, natural and synthetic compounds claimed to have antioxidant ability have been tested. Among these is dodecyl gallate (DG), which has been attributed antioxidant activity in some studies and in others the promotion of oxidative stress in cells.

Objectives

In this context, the aim of this work is the study of the effect of the olive oil enrichment with different levels of DG on its oxidative stability and oxidation mechanism under accelerated storage conditions.

Methods

The samples subjects of study were olive oil (a mixture of virgin and refined olive oil) and the same oil with different levels of DG enrichment (0.002, 0.02 and 0.2 % in weight). These samples were submitted to accelerated storage conditions (70ºC with aeration) until their total polymerization and daily were studied by ^{1}H Nuclear Magnetic Resonance.

Results

This technique provide simultaneously information about the concentrations of main and minor oil components throughout storage and of the identity and concentrations of primary and secondary oxidation compounds formed during the oxidation of each sample. In this way the oxidative stability of each sample and the rate of the main reactions taking place in their oxidation process are monitored.

Conclusions

Enrichment of olive oil with the three tested levels of DG significantly improves the oxidative stability of this oil. This effect is clearly dose-dependent, especially in the case of enrichment with 0.2 % DG. Taking this into account DG could be used as an effective antioxidant of edible oils, leaving aside other considerations regarding its effects on health.

Keywords: Oxidative stability, Olive oil, Dodecyl gallate, ^{1}H NMR

HOMEGREENS: Small-scaled aquaponics systems

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Aquaponic systems are based on a technique that involves fish farming and hydroponics farming techniques, producing both fish and plants (herbs, fruits or leafy greens) in the same circuit of water. The metabolism products from fish, passing through an healthy biofilter will generate natural fertilizer which is assimilated by the plantsresulting in vegetable growth and simultaneously cleaning the water that returns to the fish tank, generating a symbiotic procedure involving fish, bacteria and plants. The public awareness of aquaponics is still very low and thus the importance of developing household systems that would serve as an introduction to future sustainable production aquaponic farms. In this project several domestic unit setups were tested and evaluated according to the plant growth and fish biomass increment, granting a domestic means to see biology working applied to sustainable and economically viable production. The referred household prototypes were designed and, some, were built permitting an evaluation on how each plant stage correlates with nutrient uptake, and to assess the need for further additives to promote plant growth. Ultimately the project will offer tools to enhance and enrich the current understanding and knowledge regarding the potential of aquaponics systems in producing food in a sustainable and economic way.

Keywords: Sustainable foods, Aquaponics, Urban agriculture, Food safety

Chemical characterization, vitamins and carotenoids of red guava (*Psidium cattleyanum* Sabine): a native fruit from Brazilian atlantic forest

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Brazil is the largest holder of biological biodiversity in the world, with a large number of native plant species. Native plant resources are excellent sources of food, such fruits, which have an economic potential, but they are not yet widely used. In addition, fruit consumption has received increased attention from consumers due to their potential to improve human health. Thus, this work aims to determine the chemical composition, vitamins and the carotenoid profile of one native species of Myrtaceae family (Red Guava, *Psidium cattleianum* Sabine), produced in southern Brazil. Three independent samples of red morphotype were collected in the cities: Antônio Prado/RS, Pelotas/RS and Ipê/RS. At harvest time the fruits were fully mature and after were pulped, homogenized, lyophilized and conditioned in a freezer. All analyses were carried out according to AOAC (1997) and in triplicate: protein concentration was determined by the Kjeldahl method; lipid concentration was determined with Bligh & Dyer method; food fiber (total and insoluble) using the enzymatic-gravimetric method; ash in muffle furnace controlled to 550 ºC; and moisture contents determination by gravimetric. The carotenoids obtained by exhaustive extraction with solvents and subsequent quantification by HPLC. The B complex vitamins and vitamin C were also separated by HPLC for further quantification. The results obtained for Red Guava (expressed as dry matter) were: moisture (80.83±1.93%); ash (5.15±0.33%); lipids (0.81±0.24%); protein (4.06±0.73%); total fiber (47.81±2.28%, with 40.13±2.99% of insoluble and 7.68±4.26% of soluble fiber). The total carotenoids content was 615.00±13.21µg/100g, with 293.35±89.68 of lutein; 31.41±4.93 of zeaxanthin; 94.61±26.43 cryptoxanthin; 19.27±0.80 of α-carotene and 221.00±6.63 of β-carotene. The vitamin content found was (mg/100g): 0.05±0.01 to thiamine, 0.04±0.00 to riboflavin, 1.68±0.16 to pantothenic acid, 0.93±0.01 to pyridoxine, 0.08±0.00 to biotin, 17.39±1.44 to vitamin C and 23.73±1.58 to vitamin A. Based on these results it is concluded that Red Guava is a good choice of native fruits that can be included in a balanced diet to improve life quality of the population.

Keywords: Biodiversity, Native fruits, Bioactive compounds, Food composition

Halophytes: a treasure hidden in salt pans?

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The salt marshes in the Mondego estuary are an extremely rich ecosystem. Two of its most important vegetation components are *Salicornia ramosissima* and *Sarcocornia perennis alpini.* Both are halophytes belonging to the *Chenopodiaceae* family. *Salicornia* and *Sarcocornia* differ mainly on their growth habits, since the latter are perennial, and woody, whereas the former are annual, and herbaceous. Both genera produce succulent shoots greatly appreciated in modern European cuisine for their pleasant salty taste and crunchy texture. Typically, they are consumed together, owing to, on the one hand, the difficulty in distinguishing them, and, on the other hand, consumer preference for *Salicornia*, against producer preference for *Sarcocornia* due to its higher yield. Notwithstanding, in Portugal the exploitation of these plants is still scant, since the majority of salt pan owners regard these as a plague, wherefore large amounts are disposed of every year. Thus, it is crucial to find ways to make better use of this resource. Hence this study, which aims to assess the nutritional and mineral profile of *S. ramosissima* and *S. perennis alpini*, collected from a salt marsh on Morraceira Island (Figueira da Foz, Portugal). Proximate composition was determined according to the AOAC official methods. Mineral profile was analysed by ultrasound-assisted extraction, followed by potentiometry for Na and K, and colorimetry for Mg, Ca, P and Fe. The results showed that moisture is the major component of both plants (*S. ramosissima* 89.72% vs. *S. perennis alpini* 87.83%). None of them exhibits a high protein content, but *S. ramosissima* was richer (6.61% vs. *S. perennis alpini* 4.28%). Both samples had a low amount of lipids (*S. ramosissima* 1.32% vs. *S. perennis alpini* 1.52%) and a high amount of carbohydrates (*S. ramosissima* 40.03% vs. *S. perennis alpini* 36.93%). Important fibre levels were detected, especially in *S. perennis alpini,* 15.34% (*S. ramosissima* 11.26%). The ash content found is remarkable, namely 39.46% and 40.41% for *S. ramosissima* and *S. perennis alpini,* respectively. The most abundant minerals found in both plants were Na, Mg, K, and Ca. All values are expressed on a dry matter basis, except for moisture. These data are expected to contribute to the sustainable exploitation of the Portuguese coast halophytes, particularly those in the Figueira da Foz region, especially for both high added-value markets — such as functional foods — and the traditional food industry as well.

Keywords: Halophytes, *Salicornia ramosissima*, *Sarcocornia perennis alpini*, Proximate composition, Minerals, Functional food

Effects of high pressure on properties of soy protein isolates

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Studies with vegetable proteins have shown that high pressure (HP) processing allows to modify proteins' supramolecular organization, destabilizing tertiary and quaternary structures, resulting in the eventual unfolding of proteins. This originates structures different from the native ones, which may change proteins' functionality.

In this work, the effects of HP (200-600 MPa; holding time: 5-15 min) on solubility, surface hydrophobicity and emulsifying properties of a readily dispersible soy protein isolate (SPI) (1 $g \cdot dL^{-1}$) were evaluated.

The initial % of the soluble protein was 43.8 ± 1.7 %. Overall, it increased with increasing pressure and processing time, reaching a maximum of 92.9 ± 0.3 % at 600 MPa and 15 min. Still, no significant ($p > 0.05$) increase in the solubility of the proteins was observed above 400 MPa and 10 minutes. The maximum obtained surface hydrophobicity was 156 % (P = 600 MPa; t = 15 min) of the initial value (H_0 = 2209 ± 51). Most treatments increased H_0, still, less intense treatments (200 MPa; 5 and 10 min and 400 MPa; 5 min) led to no significant differences ($p > 0.05$) comparatively to the untreated samples.

The emulsifying activity index (EAI) of the total fraction of the untreated SPI was 66.1 ± 0.8 $m^2 \cdot g^{-1}$. No trend was observed with pressure or processing time and no significant differences ($p > 0.05$) with most of the conditions tested, although a decrease of 9 % was verified for 10 min at 200 MPa. Considering only the soluble fraction, the EAI of the untreated SPI was 45.9 ± 2.6 $m^2 \cdot g^{-1}$. It was generally observed an increase of EAI with increasing pressure and holding time, reaching an increase of about 33 % at 600 MPa and 15 min. The observed increase of H_0, may promote interactions between the hydrophobic groups of the proteins and the oil droplets, especially when only the soluble fraction is used in the formation of the emulsion. The emulsifying stability index (ESI) of the untreated SPI total and soluble fraction was 47.3 ± 4.5 and 44.1 ± 4.5 min, respectively, and the ESI generally decreased with HP. A trend was observed in the soluble fraction, where the ESI decreased with increasing pressure and holding time.

In conclusion, HP can be used to increase some techno-functional properties of SPI, particularly the solubility and surface hydrophobicity.

Keywords: HPP, Soy protein isolate, Protein solubility, Protein surface hydrophobicity

Effect of the UV-C irradiation doses on strawberries quality

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Effect of the UV-C irradiation doses on strawberries quality have been shown a good alternative for reducing and or inactivating the microbial load and maintaining the quality of fruits and vegetables. Among the emerging technologies, there is ultraviolet light radiation, inserted in the wavelength between 200 and 280 nm called ultraviolet shortwave radiation (UV-C). In this context, the present work aimed to study the effect of the UV-C radiation on strawberries physicochemical qualities. 1.44 and 2.8 kJ.m-2 UV-C radiation doses were used at 10 and 20 °C using an apparatus developed in the Lab. After that, treated fruits were stored at 10 °C for five days. During this period, physical-chemical parameters and mold and yeast counts of the strawberry were evaluated. Color, firmness, pH and total soluble solids (TSS) of the strawberries submitted to UV-C treatment showed better results at 10 ºC in the doses 1.44 kJ.m-2 and 2.8 kJ.m-2 when compared to control (C) and at 20 °C in end of five days of storage. The production of phenolic compounds and antioxidant activity was induced by UV-C light, mainly at 10 °C and doses of 1.44 kJ.m2 . Strawberries irradiated with UV-C at both temperatures presented reductions in the counts of molds and yeasts in relation to the control sample. The results obtained demonstrate that both the UV-C radiation technology and the food irradiation system developed in the present work can be used successfully in prolonging the shelf life of strawberries.

Keywords: UV-C radiation, Strawberry, Quality

Application of melon seeds (*Cucumis melo* var. *reticulatus*) in the development of new foods

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Melon by-products present different biological activities including antioxidant, anti-inflamatory, antidiabetic, antiulcer, antibacterial and anti-angiogenic, fully justified by the presence of bioactive compounds. Therefore, some of these by-products can be good candidates for the development of novel functional foods, contributing to promote sustainability across food chain.
The change in consumer preferences has been mainly related to the increasing demand of food products combining a pleasant flavor with nutritional benefits, and to the concomitante availability of different sources of vegetable oils as well.
The aim of this study was to study the application of melon seeds (*Cucumis melo* var. *reticulatus*). Melon seeds were found to contain good source of, protein (28.2%) and fibers (26.1%).
Conventional oil extraction was performed using petroleum ether in a Soxhlet apparatus. The oil extraction yield obtained from seeds of melon was 31.5 % and showed that melon seeds are very interesting for oil extraction. The fatty acid profile demonstrated that linoleic, oleic, palmitic and stearic acids were the principal fatty acids and the extracted oil presented a high percentage of unsaturated fatty acids. Melon seed oil has an interesting fatty acid profile, very similar to soybean and sunflower oils.
The obtained results revealed that melon seeds presented an alternative source of plant oil which may serve as raw material for new food applications.

Keywords: Seeds, Oil, Melon, *Cucumis melo*, Fatty acids profile

Rheological and chemical characterization of ozonized quinoa starch

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Modification of starch can lead to newer product with desirable properties and functionality. Quinoa (*Chenopodium quinoa*) is a non-conventional source of starch (47-60 g starch/100 g grains), with extraction yields of 25-50% (dry basis). Quinoa starch has small granules, low amylose content and low gelatinization temperature. Ozone is known to have powerful oxidative potential, decomposing into oxygen, reacting with most substances at ambient temperatures and generating minimum toxic byproducts whereby simplifying the waste disposal process. Quinoa starch samples modified by ozone were prepared as a 10% (w/w) suspension and exposed to different ozone generation times (OGTs) of 10, 20 and 30 minutes. The reference was native quinoa starch. After modification, the effect of ozonitation was evalued by estimating the amylose, carbonyl and carboxyl contents and rheological properties of quinoa starch. The amylose content reduced from 19.7% to 17.4% as OGT was increased, which is probably due to the depolymerization of the starch chains. The carbonyl and carboxyl group contents ranged from 0.010 to 0.024%, and from 0.000 to 0.030%, respectively, as OGT was increased, indicating the occurrence of chains oxidation, forming such groups in place of hydroxyl groups. From this analysis statistically significant differences were obtained for native starch with treatment times of 20 and 30 minutes were observed ($p<0.05$). The gelatinization temperature of starch was determined by temperature sweep analysis (oscillatory shear). Significant difference was observed between the native starch and the sample with 30 minutes of treatment ($p <0.05$), at gelatinization temperatures of (57.9 and 55.7) ºC, respectively. For frequency sweep analysis in the linear viscoelasticity region, the modified starch gels was more elastic when comparate to native. Dispersions with 5% starch were gelatinized at 95°C/30min and flow curves were obtained at 25°C. The experimental data were modeled by the Power Law model, with good determination coefficients ($R^2>0.998$). All samples presented pseudoplastic behavior with n (flow behaviour indice) ranging from 0.74 to 0.58 and an increase of K (consistency coefficient) was observed, ranging from 308.5 to 1175.3 mPa.s. The apparent viscosity (in the range to 0 from 300 s^{-1}) increased as OGT was increased, and this can be attributed to a cross-linking effect. It can be concluded that the ozone treatment was effective in altering rheological properties which may be attributed to changes at the molecular level for quinoa starch.

Keywords: Ozone, Modified starch, Viscosity

Free amino acids profile of locally occurring mango varieties from Northeastern Brazil

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Mango (*Mangifera indica* L.) is one of the most exported fruit in Brazil and its production is especially concentrated in the northeast region. Apart from the exported cultivars, this region produces a large number of high valued varieties of regional occurrence and most of those have never been studied for nutritional and functional value. Therefore, the objective of this work was, for the first time, to characterize the free amino acids profile of seven regionally mango varieties produced in the Paraíba state, northeast of Brazil, compared with two commercial varieties. The varieties were the locally occurring 'Cunha', 'Espada', 'Extrema', 'Jasmim', 'Manguita', 'Maranhão' and 'Rosa', and the commercials 'Alphonso' and 'Tommy Atkins'. Fruits were manually harvested at the physiological maturity and after harvest were allowed to reach the full (consumption) maturity at room conditions (24±2°C, RH 78%). The pulps replicated by variety were homogenized and freeze-dried for evaluations. The evaluation of the free amino acids of pulp was performed by pre-column derivatization using orthophthalaldehyde (OPA) methodology. Isoindole-type fluorescent derivatives were formed in an alkaline solution (borate buffer pH 10.4) from OPA, 2-sulfanylethanol and the primary amine group of the amino acid. The derivatives were separated by HPLC coupled to a fluorescence detector. 100 µL of each sample, at concentration of 50 mg/mL was derivatized according to the OPA method and injection volume of derivatives was of 20 µL. The amino acids aspartic acid, glutamic acid, alanine, asparagine, glutamine, serine, tyrosine, and threonine were detected in all varieties. Alanine was the most abundant free amino acid in the pulps, mostly in the commercials 'Alphonso' and 'Tommy Atkins'. Notably, the essential amino acid methionine and threonine appeared in highest contents in the local varieties, as well as the non-essentials tyrosine, arginine and glutamic acid. 'Jasmim' was highlighted with the higher contents of leucine. The 'Maranhão' was the only one in which isoleucine and methionine were detected. However, it was not found valine, tryptophan and phenylalanine in this variety. Thus, the local varieties are positively differentiated from the commercial ones by presenting much higher contents of free essential amino acids such as isoleucine, methionine and tryptophan.

Keywords: *Mangifera indica* L., Varieties, Regional, Composition, Amino acids

Food Digestion Engineering

Plenary lectures

Advances in Improved Understanding of Food Digestion

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Recent advances to improve our understanding of food digestion in the human gastrointestinal (GI) tract have relied on novel approaches in vivo, in vitro and in silico. In vivo studies have used animal models to study gastric and intestinal digestion. These studies have yielded new and useful information about the digesta such as changes in its material and rheological properties, flow behavior, and mixing as influenced by peristaltic movement and contraction of the stomach walls. These studies demonstrate the role of food structure during digestion. In-vitro studies have involved design and development of novel simulators for oral, gastric and intestinal sections of the GI tract. Dynamic in-vitro systems allow determining the influence of peristaltic movement of gastric and intestinal walls on food breakdown and mixing. New generation of simulators are aimed at improved mimicking of the functions of the human GI tract. In silico studies have used computational fluid dynamics to describe flow behavior, and spatial and temporal distribution of forces causing food breakdown in gastric environment. These studies suggest the need for a food breakdown classification system for future development of foods for health with desirable functional properties.

Food Digestion Engineering

Food Digestion Engineering

Oral Communications

Simulated gastrointestinal digestion of amaranth flour and protein isolate: comparison of methodologies and antioxidant peptides release

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Diverse methodologies for the simulated gastrointestinal digestion are used in order to study bioactivity. In our laboratory, we have applied a simplified protocol focused in protein digestion of amaranth protein isolate (***I***) to release antioxidant peptides. The aim of the present work was to compare this protocol with other ones based on an international consensus (COST-INFOGEST) in order to evaluate the effect of digestion conditions and matrix in the protein hydrolysis and the generation of antioxidant peptides. The in-house protocol was applied to the ***I*** digestion obtaining ***Id1***, the standardized method was applied to digest ***I*** and amaranth flour (***F***) obtaining ***Id3*** and ***Fd3***, as well as a modified version using the same enzyme/substrate ratio than in our lab method (***Id2*** and ***Fd2***). Protein hydrolysis degree (HD, TNBS method) was similar for the three digests from ***I*** (about 60%), but lower for ***F*** digests (45% for ***Fd2*** and 34% for ***Fd3***). All digests presented comparable protein solubility values (about 70%). Polypeptide composition was analyzed (SDS-PAGE and tricine-SDS-PAGE, gel filtration chromatography FPLC); low molecular mass molecules (< 6.5 kDa) appeared in all cases, and only small differences in non-hydrolyzed and released peptides proportions among the digests were registered. Antioxidant activity was evaluated by the ORAC and HORAC methods. In the case of ORAC, soluble fractions from ***Id1***, ***Id2***, ***Id3*** and ***Fd3*** presented similar activity (IC_{50} = 0.020-0.024 mg protein/ml, respectively), while activity was greater for ***Fd2*** (IC_{50} = 0.012 mg/ml). For HORAC assay, only small differences among digests were registered (IC_{50} = 1.13-1.61 mg protein/ml). All FPLC fractions showed some level of ORAC activity, but those in the 0.2-0.6 kDa range presented the greater potency. Active HORAC fractions were in the range of 0.55-3.5 kDa. Results evidenced that the modification of the digestion conditions (phases, kind and concentration of salts, pH, enzyme activities) on ***I*** digestion produced only small differences in the molecular composition of digests but did not have effect neither on HD nor antioxidant activity, while the presence of other food components (***F***) had incidence on HD.

Keywords: Amaranth, Flour, Protein isolate, Simulated gastrointestinal digestion, Antioxidant activity

Study of bioaccessibility and bioavailability of phenolic content of sweet cherry (*Prunus avium* L.) by *in vitro* digestion and cellular model

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Objective: This study aims to determine the *in vitro* bioavailability and bioactivity of phenolic compounds present in sweet cherries.

Methods: A cell line derived from the gastrointestinal tumor (Caco-2) was used, and the permeability and integrity of the monolayer formed by this cell line was firstly investigated using the TEER and Lucifer yellow tests. After this, the permeability to the phenolic compounds present in the cherry extract of the cultivar Saco, digested and undigested, was evaluated. After incubation, the phenolic compounds that permeabilized the simulated membrane were quantified using the HPLC-DAD technique. At the same time, the antioxidant activity of that compounds present in the extracts was evaluated by 2,2-diphenyl-1-picrylidrazyl (DPPH) method.

Results: The results obtained demonstrated that the phenolic compounds of the fruit of *Prunus avium* L. after undergoing a simulated digestion process were absorbed by the cellular barrier, becoming bioavailable, however, in lower concentrations. Nevertheless, when the same cherry extract not subjected to digestion was placed in contact with the same cell layer, only quercetin-3,4'-di-*O*-glycoside was able to become bioavailable. Also, the antioxidant activity was increased before passage through the cell monolayer, and the percentage of DPPH inhibition was 0% after this process. Contrary to what was found after incubation with the *in vitro* digested extract, the integrity of the cell monolayer was altered, and the permeability of the monolayer increased after incubation with the crude extract.

Conclusion: This study suggests that digestion is an indispensable process for absorption, since without it, the phenolic content of the food matrix does not become bioaccessible.

Keywords: Antioxidant activity, Bioaccessibility, Bioavailability, Phenolic compounds, *Prunus avium* L.

Optimization of an *in vitro* method to measure the bioaccessibility of proteins in seaweeds using response surface methodology

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Seaweeds are well-known as an excellent source of biologically active compounds such as dietary fibres, essential fatty acids, minerals, vitamins and phenolic compounds, which gives them a huge potential for application in the food industry as new ingredients for the development of food products. However, high concentrations of some nutrient/contaminants need to be addressed when evaluating seaweed consumption, to assess whether a benefit or a hazard/risk effect is brought upon the consumer health. Therefore, knowledge about the total amount of nutrient/contaminant present in this marine resource, as well as, the amount that is bioaccessible is of utmost importance. Bioaccessibility indicates the maximum fraction of a compound that is released from the food matrix into the gastrointestinal tract, thus being absorbable in the intestine and bioavailable. During the last years, a huge range of gastrointestinal models has been designed to simulate the food digestion process, ranging from single static systems to multi-compartmental and dynamic systems. However, optimization of an *in vitro* human digestion process has lack of consensus concerning the physiological conditions applied. Differences in pH, mineral type, ionic strength and digestion time, which alter enzyme activity and other phenomena, may alter results.
In this work, an *in vitro* gastrointestinal model applicable to the evaluation of bioaccessibility in *Fucus spiralis* collected in Marques Neves beach (39°22'11.3"N 9°23'09.9"W) Portugal, were demonstrated and optimized. Response surface methodology (RSM) considering a central composite rotatable design (CCDR) was carried out to optimize the digestion conditions including saliva enzymatic constitution (α-amilase quantity), enzymatic constitution of gastric and enzymatic constitution of intestinal solution. Additionally, a second-order polynomial fit was performed to fit the experimental data used to determine optimal digestion conditions. The hydrolyzed proteins levels (evaluated by amino-acids quantity with Ninhydrin reaction) was used as response criteria. The developed models were successfully fitted to the experimental data and used to determine optimal digestion conditions. In process optimization, maximum values of hydrolyzed proteins were achieved as 70%, with a saliva solution with α-amilase (70U/ml), gastric solution with pepsin (3.0U/ml) and intestinal solution with pancreatin (120U/ml) and chymotrypsin (30U/ml). Additionaslly, results suggest the system can be a very suitable model for evaluation of bioaccessibility in seaweed.

Keywords: Seaweed, *in vitro* method, Bioaccessibility

Total phenolic and flavonoid contents and antioxidant capacity of carob liqueurs obtained by different extraction methods and subjected to *in vitro* digestion

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Maceration (M), hydro-alcoholic (HAI) and aqueous (AI) infusions, percolation (P) and distillation (D) are among the most used liqueur production methods. Different temperatures, solvents and procedures are used in these extraction techniques and each technique confers distinctive chemical characteristics to the final drink. In this work, the total phenolic (TPC) and flavonoid (TFC) contents, as well as the antioxidant capacity (AC) assessed by the Trolox equivalent (TE) antioxidant capacity (TEAC) and oxygen radical absorbance capacity (ORAC) assays were studied in carob liqueurs. In addition, these parameters were also studied after simulated *in vitro* gastrointestinal digestion of liqueurs to evaluate their stability after this hydrolytic process. Carob pod flour was extracted in deodorized fig spirit (45 % v/v) by M and P (room temperature), HAI (approx. 50°C), and D (approx. 90°C), or soft water by AI (approx. 90°C). Then, they were mixed with sugar syrup and analysed for TPC, TFC and AC by TEAC and ORAC assays before and after *in vitro* digestion.

The results showed great differences in the chemical composition among the obtained liqueurs by the different methods used. Liqueurs prepared by HAI and M presented greater levels of TPC [434 and 420 mg gallic acid equivalents (GAE)/L, respectively), TFC [216 and 189 mM quercetin equivalents (QE), respectively], as well as AC (TEAC: 5.1 and 5.0 mM TE, respectively; ORAC: both 6.4 mM TE). The use of ethanol-water, and the continuous contact between spirit and carob pod allowed the maximum extraction of chemicals. The higher temperature of HAI did not induce significant alterations in the parameters studied comparing to M. Also, the composition of liqueurs obtained by HAI and AI seems to be more dependent on the solvent than on the temperature applied. Therefore, according to these results, water is a poor solvent in the extraction of these compounds. In relation to the gastrointestinal digestion, in general, small differences were observed among digested liqueurs. The TPC and AC decreased, while TFC increased. The most important differentiating method was D, and it is noteworthy the increase in TPC (1.5 to 110 mg GAE/L) and TFC (3.7 to 447 mM QE) in the digested liqueur.

Despite being one of the oldest and simplest methods used in the elaboration of liqueurs, according to the chemical parameters studied, maceration continues to be one of the most suitable techniques. In general, the digestion process provided greater bioavailability of flavonoids but decreased TPC and AC.

Keywords: Antioxidant capacity, Fruit liqueur, Gastrointestinal digestion, Total flavonoid content, Total phenolic content.

Food Digestion Engineering

Food Digestion Engineering

Poster Communications

Relação dos fatores que influenciam a escolha alimentar com risco cardiovascular, estado ponderal e risco nutricional em idosos a viver na comunidade. Resultados do projeto PRONUTRISENIOR*

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Estudos mostram que os consumidores veem os alimentos com uma forma de melhorar a sua saúde e bem-estar, ao que a indústria alimentar responde proactivamente através de novos produtos que correspondam a estas expectativas. Assim, é importante conhecer os fatores que influenciam a escolha alimentar dos consumidores para o desenvolvimento de produtos alimentares que, não só atendam às suas necessidades, mas também vão de encontro à forma como estes os procuram, especialmente numa população envelhecida com mais doenças e restrições. Este trabalho tem o objetivo de relacionar os fatores que influenciam a escolha alimentar de idosos a viver em comunidade com o seu risco cardiovascular, estado ponderal e risco nutricional. O projeto PRONUTRISENIOR teve lugar na Unidade de Saúde Familiar "Nova Via", (Vila Nova de Gaia, Portugal). Uma amostra de 602 idosos (≥ 65 anos) foi avaliada presencialmente por nutricionistas treinados. Neste trabalho analisaram-se dados referentes aos fatores que influenciam a escolha alimentar (lista de 18 factores, classificados de 1 = Nada importante a 5 = Extremamente importante), risco cardiovascular (avaliado pelo perímetro da cintura), estado ponderal (Índice de Massa Corporal) e risco nutricional.

Os participantes tinham uma média de 74 anos (dp = 6), sendo a maioria do sexo feminino (64,0%), casados (67,8%) e a viver em casa própria (80,2%). Quanto maior o risco cardiovascular mais importância os idosos atribuíam às suas raízes culturais, religiosas ou étnicas como determinantes da escolha alimentar, e menos importância ao conteúdo em aditivos, corantes e conservantes, bem como à alimentação vegetariana ou outros hábitos especiais. Em relação ao estado ponderal, observou-se uma associação positiva com a importância atribuída à disponibilidade dos alimentos e uma associação negativa com a facilidade de mastigação. Por fim, verificou-que que os idosos em risco de desnutrição ou desnutridos atribuem uma menor importância ao conteúdo em aditivos, corantes e conservantes, mas maior importância à facilidade de mastigação. O conhecimento dos fatores que influenciam a escolha de alimentos em idosos não só fornece informações úteis para o desenvolvimento de produtos “à medida” do consumidor, mas também na área do *marketing* alimentar criando uma relação de maior proximidade entre a indústria alimentar e o consumidor.

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Keywords: Escolha Alimentar, Idosos, Alimentação, Estado Nutricional, Risco Cardiovascular, PRONUTRISENIOR.

Study of the viability of probiotic strains for application in fermented meat sausage: *in vitro* evaluation

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The incorporation of probiotic strains during the processing of fermented meat sausages has been associated with healthy body. Fermented meat products have favorable conditions for transporting probiotic microorganisms as a function of lipid protection in bacterial cells during passage through the gastrointestinal tract. However, it is necessary to carry out an initial screening for the selection of the most resistant strains for the specific process. The use of lactic acid bacteria in the fermentation of meat sausages is justified by the rapid acidification, which favors the development of their sensorial characteristics, besides guaranteeing microbiological safety against pathogens. The aim of this study was to evaluated the growth kinetics of 4 probiotic strains of *Lactobacillus* strains, previously isolated and identified using the 16S rRNA gene sequencing as *Lactobacillus casei* (SJRP38, SJRP66, SJRP146, and SJRP169) in similar conditions to manufactured of fermented sausage: pH values (6.0, 5.5, 5.0 and 4.5) and incubation temperatures (15 and 25 ºC). All test was conducted in a sterile flat-bottom 96-well microtiter plates. Optical density was recorded at 600 nm after 2, 4, 6, 8, 10 and 24 h, using a microtiter plate reader. This experiment was performed in triplicate. All the strains tested showed high growth rate at pH values of 6.0 and 5.5 and 25 ºC. This temperature is used in the fermentation process of meat product, which indicated that this probiotics strains could be used to decrease the pH values. At 15 °C and pH values of 5.0 only SJRP38 and SJRP66 presented a good growth rate. However, the strains SJRP66 and SJRP169 displayed a high viability at pH of 4.5. The SJRP38, SJRP66 and SJRP146 could represents a good alternative for a LAB to manufacture fermented sausage.

Keywords: *Lactobacillus* strains, LAB, fermented meat, optical density, temperature, pH values

Perfil de ácidos graxos em bebida láctea probiótica com extrato hidrossolúvel de aveia

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A produção de alimentos funcionais utilizando a combinação de cereais como a aveia e de microrganismos probióticos, pode ser considerada como uma opção, a fim de agregar valor nutricional ao mesmo e trazer benefícios à saúde do consumidor. Além disso, adição de aveia no produto pode aumentar o aspecto funcional de bebida láctea, uma vez que aumentaria o teor de ácidos graxos mono e poli-insaturados de cadeia longa. Por isso, o objetivo do presente estudo foi avaliar o perfil de ácidos graxos em bebida láctea probiótica com adição de extrato hidrossolúvel de aveia. Os lipídios foram extraídos a partir de duas formulações de bebida láctea probiótica (*Lactobacillus casei*), com extrato hidrossolúvel de aveia, de acordo com o método ISO 14156 (2001), com adaptações. Os ácidos graxos metil ésteres (FAMEs) foram preparados por esterificação de acordo com ISO 15884 (2002). A composição dos ácidos graxos foi determinada utilizando um cromatógrafo gasoso acoplado a um espectrômetro de massas (GC/MS), a identificação e quantificação foi realizada por comparação dos tempos de retenção dos picos dos padrões com os picos produzidos pelas amostras após metilação, sendo expressa em percentagem. A classificação de ácidos graxos, em relação ao número de cadeia de átomos de carbono, foi determinada de acordo com Ackman (2007). Foram detectados os seguintes ácidos graxos saturados: Cáprico (C10:0), Láurico (C12:0), Mirístico (C14:0), Palmítico (C16:0), Esteárico (C18:0), além dos ácidos graxos insaturados: Linoleico (C18:2n6) e oleico (C18:1n9). Observa-se que a concentração percentual dos ácidos graxos saturados vaiou de 67,28 a 79,52 %, enquanto, que os insaturados variaram de 21,35 a 32,72 %. Com isso, conclui-se que na bebiba láctea probiótica com extrato hidrossolúvel de aveia o ácido graxo saturado majoritário foi o Palmítico (C16:0) e entre os insaturados foi o oleico (C18:1n9), sendo, portanto, um produto recomendável para o consumidor.

Keywords: *Lactobacillus casei*, Aveia, Ácidos graxos

Atividade antioxidante em bebida láctea probiótica elaborada com extrato de farelo de aveia

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O desenvolvimento de bebidas lácteas adicionadas de extrato de cereais além de diversificar o mercado de lácteos, melhora sua qualidade nutricional e funcional. A tendência na comercialização de produtos lácteos probióticos é um contínuo crescimento no consumo desses produtos, pelo fato do consumidor aceitar que produtos lácteos contenham micro-organismos viáveis e os reconhecem como benéficos à saúde. A aveia, além de ser uma fonte importante de fibra alimentar e nutrientes necessários para uma dieta equilibrada, é também rica em uma vasta variedade de compostos fenólicos com atividade antioxidante comprovada *in vitro* e *in vivo*, por isso sua adição em um produto de consumo habitual de grande aceitação, como a bebida láctea pode promover melhoria dos aspectos nutricional e funcional da bebida láctea probiótica. O objetivo deste trabalho foi avaliar o teor de compostos fenólicos com atividade antioxidante em bebida láctea probiótica elaborada com adição de extrato hidrossolúvel de farelo de aveia e compará-la com uma formulação controle, sem aveia. Neste estudo foi elaborada uma bebida láctea formulada com 70% de leite reconstituído e 30% de extrato hidrossolúvel de farelo de aveia. Aplicou-se à mistura um tratamento térmico de 85 °C durante 5 minutos. Posteriormente a temperatura foi reduzida para 37 °C, quando se inoculou 0,1% de culturas iniciadoras + *Bifidobacterium* BB-12. Após, incubou-se a formulação em iogurteira, até atingir pH 4,6, interrompendo-se o processo de fermentação. Em seguida, homogeneizou-se lentamente, ocorrendo quebra do coágulo. A bebida foi envasada e mantida sob refrigeração (5 °C). Na formulação controle o extrato de aveia foi substituído por soro de leite. A quantificação dos compostos fenólicos solúveis totais (CFST) seguiu o método de Folin-Ciocalteau, com leitura na absorbância em 764 nm e a atividade antioxidante total foi determinada em função da reação de redução do radical livre 1,1-difenil-2-(2,4,6-trinitrofenil) hidrazila (DPPH), com adaptações metodológicas e leitura em 515 nm. Concluiu-se que a formulação elaborada com extrato hidrossolúvel de farelo de aveia apresentou maior conteúdo de compostos fenólicos solúveis totais e atividade antioxidante, quando comparada à formulação controle, indicando que a presença da aveia promoveu um incremento de 30% de compostos fenólicos com atividade antioxidante na formulação estudada.

Keywords: *Avena sativa* L., Polifenol, Avenantramida

Estabilidade de probióticos encapsulados em suco de maçã armazenado sob refrigeração

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Atualmente, o desenvolvimento de novos alimentos que promovem a saúde para os consumidores é uma das prioridades de pesquisa da indústria de alimentos (CHAIKHAM, 2015). A procura por alimentos com probióticos está aumentando entre os consumidores. Os produtos lácteos são mais adequados para o desenvolvimento de alimentos probióticos. No entanto, devido à alta prevalência de intolerância à lactose, produtos probióticos não lácteos, como sucos de frutas, foram desenvolvidos. Os produtos devem fornecer entre 10^7-10^9 células viáveis para o intestino, consumindo aproximadamente 100g/dia do produto (CALABUIG-JIMENEZ *et al.,* 2019). A formulação do produto deve ser direcionada para aumentar a resistência probiótica às condições de estresse e melhorar a viabilidade e outras funcionalidades dos probióticos que determinam sua eficácia no trato gastrointestinal (CALABUIG-JIMENEZ *et al.,* 2019).

A microencapsulação com alginato de sódio é uma das estratégias que tem sido considerada para proteger as células probióticas da degradação por condições adversas e controlar sua liberação sob condições específicas (CALABUIG-JIMENEZ *et al.,* 2019). O alginato é utilizado devido ao seu baixo custo, simplicidade e biocompatibilidade podendo ser incorporado com outros materiais, por exemplo, gelatina, galactooligossacarídeos, e, pode ser usado para aumentar a sobrevivência de várias cepas probióticas em produtos alimentícios durante o armazenamento e em ambientes gastrintestinais (CHAIKHAM, 2015).

Assim, o objetivo desta pesquisa foi descobrir o impacto do encapsulamento sobre a estabilidade de bactérias probióticas, *L. acidophilus* (LA5) e *B. lactis* (Bb-12) em sucos de maçã durante armazenamento sob refrigeração (7°C) por 30 dias. Os probióticos foram encapsulados através do processo de gelificação iônica, com a produção de uma solução contendo gelatina, alginato e oligofrutose, sendo posteriormente atomizada diretamente em cloreto de cálcio para produção das micropartículas.

O conteúdo de LA-5 e Bb12 foi determinado em suco de maçã após 0, 7, 14, 21 e 28 dias de armazenamento. Após 30 dias, o conteúdo probiótico encapsulado foi compatível com o exigido pela legislação (2,5 x 10^7 log UFC/L para ambas as cepas). A microcápsula formada com alginato como revestimento é suficiente para proteger os microrganismos para resistir a condições desfavoráveis durante o processo de digestão e durante o tempo de armazenamento (CALABUIG-JIMENEZ *et al.,* 2019).

A viabilidade das bactérias probióticas no suco foi mantida dentro dos limites exigidos para exercer benefícios até 30 dias de armazenamento. Assim, o suco de maçã é uma matriz viável para o suco com adição de probióticos, permitindo a manutenção da viabilidade microbiana durante a vida de prateleira.

Keywords: Microencapsulação, Probióticos não lácteos, Alginato de sódio, Aelificação iônica, Viabilidade

Evaluation of three agroindustrial by-products for the production of proteolytic enzymes with "*Bacillus subtilis*" as a culture medium

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Proteolytic enzymes have numerous applications in analytical, physiological and industrial processes, so their demand is in continuous growth. The objective of this research was to evaluate the effect of different culture medium of animal origin to obtain an extract with proteolytic activity from Bacillus subtilis. In order to establish the best conditions to obtain the enzymatic extract; 3 nutritive medium of animal origin (feather meal, blood meal, and fish meal) were used at concentrations of 1, 2, 3 and 4%; the proteolytic activity was evaluated with azocasein and casein as substrate. The time for maximum generation of the enzymatic extract was determined and semi-purified through a Sephadex G-25 column. The nutritive medium used was the one where the highest proteolytic activity was achieved. Finally, the molecular sizes of the components of the semi-purified extract which presented the highest enzymatic activity were identified. The results indicated that the animal medium that provided the highest proteolytic activity was feather meal at a concentration of 1%; an activity of 6.75 ± 0.38 U / mL was determined with the azocasein method, and 81.63 ± 0.96 U / mL with the casein method. The maximum production of proteases in feather meal was obtained on the fourth day. The electrophoresis gel, from the molecular size determination, presented different bands; this suggests the presence of different enzymes in the sample. The enzymes produced were related to the enzymes registered in the BRENDA database which correspond to the ones obtained form of Bacillus subtilis. It was concluded that the microorganism completely metabolized the feather meal at a concentration of 1%. In the production of proteolytic enzymes, the maximum production of proteases in the feather meal was reached after four days; this was verified by the azocasein and casein methods. After processing the enzyme extract obtained from B. subtilis in feather meal through the column with sephadex G-25; its azocaseinolytic and caseinolytic activity increased.

Keywords: Enzyme, Protease, Electrophoresis

Isolation and identification of a bacteria from shrimp intestines (*Penaeus vannamei*), to obtain proteolytic enzymes

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Proteolytic enzymes are very important since they are used both in the field of textile, food and pharmaceutical (among others), as well as in the field of research.
The aim of this research was the production of proteolytic enzymes produced by a bacterium isolated from the intestines of shrimp (*Penaeus vannamei*)
To obtain the microorganism, shrimp intestines were used, from which the excrement was extracted.It was placed in a Petri dish with BHI agar to make a culture. Finally, the majority colony was isolated for evaluation as an enzyme producer. For the identification and characterization of the microorganism, two techniques were performed, a Maldi-tof analysis and a PCR analysis. After identifying the bacteria, a culture was carried out using chicken heads as a substrate for the growth of the microorganism and the enzymatic production, where the proteolytic activity was determined.
The bacteria from the shrimp intestines was identified as Bacillus cereus by both methodspreviously cited. The best pH conditions and substrate concentration for the growth of B. cereus bacteria were 8 and 1.5 g / L, respectively. The growth of the bacterium reached a maximum level at the 96th hour of experimentation and a directly proportional relationship was observed between the growth of the bacteria and the generation of proteolytic enzyme. The enzymatic activity obtained after purification was 55.01 U / mL.
The results of this investigation determined that the bacterium Bacillus cereus can be isolated from shrimp intestines. In addition, proteolytic enzymes can be obtained from B. cereus, using heads and chicken necks as a substrate.

Keywords: Shrimp, Enzyme, Protease, Maldi-Tof, PCR

Diseño ingenieril de micropartículas: una alternativa efectiva para la fortificación con micronutrientes de alimentos para el adulto mayor

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La fortificación con micronutrientes (MN) de bebidas lácteas y cremas de legumbres en polvo ha sido implementada como estrategia para mejorar el estado nutricional del adulto mayor chileno (AM). Sin embargo, estudios recientes indicarían que estas matrices alimentarias carecen de efectividad en términos de la bio-absorción de sus MN, identificándose déficits de vitaminas D y B_{12}, Ca y Zn. En este sentido, el diseño ingenieril de micropartículas biopoliméricas que encapsulen los MN de los alimentos fortificados podría modular las interacciones competitivas de absorción de estos compuestos durante el proceso de digestión, mejorando así su biodisponibilidad.

El objetivo de este trabajo fue desarrollar micropartículas cargadas con vitaminas D y/o Ca, a partir de emulsiones de mezclas poliméricas mediante secado por aspersión; que permitan aumentar la bioaccesibilidad de estos MN tras el proceso de digestión.

Para cumplir este fin, se prepararon emulsiones (aceite vegetal, emulsificante tween-80 y agua) estabilizadas a alta presión (300 bar y 3 ciclos de homogenización) de maltodextrina/inulina y maltodextrina/caseinato (1:1 y 3:1) a las cuales se incorporó el MN (calcio y/o vitamina D), en una concentración de 50% respecto de los sólidos totales. La obtención de las micropartículas se realizó mediante secado por atomización (130°C, flujo de alimentación: 16 mL/min, velocidad de ventilación: 4,0 m/s). Las micropartículas obtenidas fueron evaluadas en términos de rendimiento del proceso, tasa de carga, eficiencia de encapsulación e índice de solubilidad en agua (IS). Posteriormente, se sometieron a un proceso de digestión gastrointestinal simulado en condiciones estáticas.

El rendimiento de secado (~ 71%) fue similar para todos los encapsulantes evaluados ($p \geq 0,05$). Las tasas de carga (~0,096% y ~4,8% para vitamina D y Ca, respectivamente) y la eficiencia de encapsulación (68%) no se vieron afectadas ni por tipo de encapsulante ni por las proporciones de estos y resultaron ser muy similares a los valores teóricos ($p \geq 0,05$). Las micropartículas en base a maltodextrina/caseinato (IS: 58,5%), fueron significativamente ($p \leq 0,05$) menos solubles que las micropartículas con maltodextrina/inulina (IS: 76,4%). Además, una mayor proporción de caseinato (1:1) disminuyó la solubilidad de la microcápsula en un 10%. La encapsulación conjunta de Ca y vitamina D en micropartículas de maltodextrina/caseinato (1:1) permitió aumentar en un ~18,5%y 23, 4%, respectivamente, la bioaccesibilidad de estos MN en comparación a sus pares no encapsulados tras el proceso simulado de digestión. Este trabajo fue financiado con proyecto FONDEF ID17AM0018

Keywords: Micronutrientes, Micropartículas, Bioaccesibilidad, Alimentos deshidratados, Adulto mayor

Interfacing Food Engineering and Food Security

Plenary lectures

Authenticity: an alternative to deal with emerging risks

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The complexity of the food chain makes it vulnerable to fraud; and, as the horsemeat scandal demonstrated, compliance with certifications and labelling is insufficient to eliminate risks. At SONAE MC, the largest food retailer in Portugal, we are developing new technologies to deal with emerging risks via collaborative research such as MobFood – Mobilization of Food Knowledge, a research project with 47 partners working on new methodologies to assess the origin and key authentic characteristics of fresh products, including experimenting with reflective near-infrared spectroscopy on mobile devices. This technology will support us in our work to inspect, on time and onsite, the quality and origin of fresh products as well as to share with consumers more information related with traceability and authenticity.

Interfacing Food Engineering and Food Security

Extending Shelf-life of Food Products

Oral Communications

Avaliação da estabilidade ao armazenamento de sopa de palmito de Pupunha (*Bactris gasipae*)

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Este estudo de pesquisa teve por objetivo avaliar a estabilidade ao armazenamento de sopa de palmito Pupunha elaborada a partir de resíduos do processamento industrial de palmito em conserva, acondicionada em embalagens flexíveis *retort pouch* (P) e latas metálicas (L) e submetida a esterilização. A matéria-prima, polpa proveniente do resíduo do processamento industrial do palmito Pupunha em conserva, assim como as sopas de palmito foram avaliadas quanto aos teores de sólidos totais e solúveis, acidez total titulável, pH e análise objetiva de cor (L*, a, b). A sopa continha polpa de palmito (40%), farinha de arroz (3%), água (54%), óleo de milho (2%), NaCl (0,75%), alho (0,03%) e cebola (0,18%) em pó. O tratamento térmico seguiu os parâmetros de $D_{121,1ºC}$, z=10°C e os resultados indicaram que os valores de letalidade obtidos foram suficientes para reduções mínimas de 12D para *C. botulinum* e 5D para *C. sporogenese* e superiores à letalidade mínima estipulada para esterilização comercial, F0 de 5 minutos. As amostras foram consideradas comercialmente estéreis, armazenadas por 120 dias nas temperaturas de 25°C e 35°C e avaliadas periodicamente a cada 30 dias, quanto ao pH, sólidos solúveis, acidez total titulável, análise objetiva de cor e avaliação sensorial quanto a cor, aparência, consistência, sabor, modo global e qualidade. O acompanhamento dos parâmetros L* e da diferença total de cor (ΔE) foi ajustado em primeira ordem. Com base nas velocidades de reação (k), ou seja, nas inclinações de reta obtidas para cada temperatura e com o auxílio da equação de Arrhenius, foram determinados os valores de energia de ativação (Ea) e Q_{10} para os dois parâmetros de cor. Os valores médios da energia de ativação para a embalagem metálica e embalagem flexível, mostraram que ambas apresentaram o mesmo comportamento em relação a variação de cor no tempo de estocagem, com valores de Q_{10} médios de 2. Quanto a avaliação sensorial, a partir da extrapolação das regressões lineares, considerando o atributo de modo global, os provadores classificaram as amostras com nota 6 (gostei ligeiramente) para L25°C - 95 dias, L35°C – 72 dias, P25°C – 240 dias e P35°C 168 dias. Estes resultados demonstram que a embalagem flexível obteve um melhor desempenho na preservação das características sensoriais da sopa creme de palmito Pupunha. O valor de Q_{10} encontrado através do atributo modo global foi de 1,06 para latas e 1,34 para *retort pouch*.

Keywords: Palmito Pupunha, Resíduo, Sopa, Esterilização, Retort pouch, Latas metálicas, Vida de prateleira

Estimacion comparativa de la vida util de galletas libres de gluten (*GLG*) con adicion de un ingrediente rico en fibra

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Los productos libres de gluten deben garantizar su seguridad respecto a la presencia de gluten y ser evaluados en su vida útil (VU). **El objetivo del estudio** fue evaluar la adición de un bioingrediente de fibra dietaria de vegetales tropicales (IFD) en la vida útil de galletas libres de gluten. **La metodología** comprendió; dos tipos de galletas, formula control (F1C) y formula con bioingrediente al 8% (F2EF) elaboradas con harina compuesta libre de gluten (HBi-Noarroz-Nomaíz), fueron empacadas en bolsa polipropileno biorientado-PPBO, luego evaluadas en composición según métodos Association of Official Analytical Chemists-AOAC 2006 en *(g/100g)*, en cuantificación de gluten *(ppm)* según CODEX-STAN 118–1979. La selección del indicador critico de VU según Calligaris y Menzocco, 2012, por correlación entre crocancia, sabor rancio y actividad acuosa-aw, mediante análisis sensorial según Lawless et al, 2010 y norma relacionadas, aw fue determinada por punto de rocío con analizador aw. Determinación de isotermas entre 0,2 a 0,8 de aw y medición de humedad *(g/100g),* por gravimetría a 28°C. Se condujo un estudio comparativo de vida útil, entre un modelo teórico basado en el contenido de humedad del producto y propiedades del empaque según Robertson GL, 2016 y el modelo probabilístico de tiempos de fallo según Gacula y Sing 1984 y Cantillo et al, 1994. Se utilizó Statgrafics Centurión XVII para tratamiento de datos y relaciones estadísticas significativas. **Los resultados** muestran una composición similar en ambas formulaciones, proteína mayor a 8,8±0,6 (con humedad baja de 5,0±0,8 y el contenido de grasa de 21±2. En el contenido de fibra dietaria, F1C presentó 8,45±0,7 y F2EF 13,75±1,2, consideradas como buena fuente de fibra según Codex CAC/GL 23-1997. En la cuantificación de gluten, F1C y F2EF, mostraron 12,62 y 12,24 ppm respectivamente, categorizados como exentos de gluten. Las isotermas de F1C y F2EF muestran comportamiento tipo II, con humedad crítica *mc* de *10 y 8,3* y*,* humedad inicial *mi de 4,9 y 4,2* y humedad en equilibrio *me de 22 y 17*, respectivamente, evidenciando el efecto del bioingrediente rico en fibra. El estudio comparativo de VU mostró que el modelo teórico estimó la vida útil de F1C en *42,05±3,7 días* y F2EF en *85,51±2,2 días*, el modelo experimental probabilístico, aplicado en F2EF, estimó *77,60±3,57 días*, observando valores cercanos en ambos métodos. Los hallazgos muestran el potencial del modelo teórico aplicado y como la adición de un ingrediente puede promover la vida útil de productos libres de gluten seguros.

Keywords: Galletas libres de gluten, Fibra alimentaria, Estudios de vida útil, Modelo probabilístico de tiempos de fallo

Effects of depuration on subsequent deterioration and shelf life of cultured grooved carpet shell clam Ruditapes decussatus during chilled storage

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The grooved carpet shell clam *Ruditapes decussatus* is one of the most consumed and valuable bivalves in the Mediterranean in terms of both nutrition and market. As with other filter-feeding species there are health risks associated with its consumption and specimens have to be depurated pending assessment of water quality of the environment where they originate. The aim of this study was to examine the effects of depuration on parameters of biological (mortality), commercial/physiological (condition index, CI, and percent edibility, PE), physicochemical (pH and TVB-N content), microbiological (TVC, Enterobacteriaceae and psychrotrophic bacteria) and sensory quality of commercially-sized clams from Ria Formosa (Algarve, south Portugal) stored at chill temperatures.

In Summer, the season of peak clam's consumption, the 'median time to death' t_{50} estimated in the two-parameter logistic model fitted to proportion data of alive depurated and non-depurated clams stored chilled (5ºC) for up to 24 days was similar (13±0.12 vs. 12.1±0.06 days). Moreover, t_{50} of non-depurated, 'natural' clams was found to be much lower in Summer compared to Winter (12.1±0.05 vs. 20.1±0.22 days). In depurated clams, CI decreased, and PE increased steadily during storage, whereas CI and PE of non-depurated clams remained constant (55-61% and 18-20% respectively). pH decreased in the first 1-2 days, markedly in non-depurated clams (from ca. 6 to 5) and then gradually increased to values >7 on days 23-24. Concurrently, TVB-N increased exponentially in both depurated and non-depurated clams, exceeding EU limits by day 20. Initial microbial load was fairly low, 2 to 4 log cfu/g. Expectedly, after depuration microorganisms' abundance decreased, more pronounced (1-2 log cfu/g) in TVC and psychrotrophic bacteria. Subsequently, abundances grew substantially to 5 log cfu/g at day 24. Enterobacteriaceae abundance remained constant till day 20 and then increased sharply. Similar dynamics were found for non-depurated clams but at comparatively higher abundances. In terms of sensory quality, 50% of the panelists rejected the samples (raw and cooked), t_{50}, on days 7-8 of chill storage. Rejection was elicited by marked changes in appearance and odor.

Depuration affected in different ways the level but not the general dynamics of the quality parameters assessed during chilled storage of clams. However, eventual safety issues emerge long after habitual storage time and panelists' sensory rejection.

Keywords: R. decussatus, Depuration, Food quality, Chill storage

Effect of C*innamomum zeylanicum* extract as antioxidant in frozen fillet and mechanically separated meat of *Sardinella* sp.

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Freezing is a process that increases the shelf life of fish, however, lipid oxidation reactions continue to occur even at low temperatures. Sardine (*Sardinella sp.*) is susceptible to lipid oxidation due to its high content of polyunsaturated fatty acids. *Cinnamomum zeylanicum* extract, rich in proantocyanidins, may be an alternative as a natural antioxidant for restricting lipid oxidation. This study aimed to evaluate the antioxidant effect of cinnamon extract on fillets and mechanically separated meat (MSM) of sardine stored at -18 °C. The dry extract of cinnamon (DEC) was obtained by hydro-alcoholic extraction followed by drying in spray dryer. The antioxidant capacity of DEC was evaluated by both DPPH• and ABTS+ radical scavenging activity methods. The sardines were beheaded, gutted and washed. Part of the batch was filleted and the other part was processed in a deboning machine to obtain the MSM. Half of MSM was washed with 5 oC water. Both washed and unwashed MSM were added with 0.25% DEC. An aqueous solution of 0.1% DEC was applied on sardine fillets by three methods: soaking (2h at 5°C) before freezing, glazing of frozen fillets and soaking plus glazing. Positive controls added with 0.25% sodium erythorbate and negative controls without antioxidant were carried out for fillets and MSM. All samples were packed in LDPE bags and stored at -18 °C. Lipid oxidation was evaluated measuring malondialdehyde, referred to as the thiobarbituric-acid-reactive-substances (TBARS) assay. Sampling occurred every 30 days for a period of 120 days. The DEC (100 µg/mL) presented antioxidant capacity of 43.43% for ABTS+ and 90.7% for DPPH•. The average concentration of malondialdehyde at the beginning of storage was 13.7 ± 1.45 mg/kg and 4.2 ± 1.21 mg/kg in unwashed and washed MSM, respectively, showing the effect of the washing process in removing soluble compounds. The washed MSM presented lower levels of lipid oxidation compared to unwashed MSM during the storage period possibly because the washing process reduced its lipid content. For both washed and unwashed mince, the DEC was efficient in restricting lipid oxidation ($p < 0.05$) after 120 days of frozen storage. Sardine fillets had 1.4 ± 0.6 mg malondialdehyde /kg at the beginning of the storage. The combination of soaking plus glazing with sodium erythorbate had a greater effect in restricting lipid oxidation that remained low during 120 days of storage. DEC was only efficient in reducing lipid oxidation when applied by soaking of fillets before freezing.

Keywords: Fish, Lipid oxidation, Glazing, Mechanically separated meat

Effects of *Zingiber officinale* on quality traits of minced beef stored in Modified Atmosphere Packaging (MAP)

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Burgers are one of the most consumed meat foodstuffs due to their easily to be cooked and consumption. As the increase of consumer's awareness for healthier and sustainable food, it became favourable the use of natural ingredients in the preparation of meat products. *Zingiber officinale* is a specie of the *Zingiberaceae* family, and it is one of the most common spice used worldwide as a condiment for food. Ginger rhizome is generally consumed fresh or dried powder. The aim of this study was to evaluate the effects of *Zingiber officinale* in fresh beef burgers packed in modified atmosphere packaging (MAP) on the physical-chemical and sensorial characteristics during the time of storage. The fresh beef (semitendinosus and semimembranosus muscles) of DOP-Mertolenga breed (males; n=3) were obtained from a local slaughterhouse and transported to laboratory under refrigeration. Then, beef was cut and minced in amounts with 20g in triplicate and added with different concentrations of ginger (1 and 2 %). Samples were packed in MAP with 70% O_2/30% CO_2, stored at 2ºC and analysed immediately at 1, 3, 5, 7 and 10 days for colour (L*, a*, b*), pH, aw, and TBARs evaluation. The determination of pH and aw were performed 30 min after each end storage time, in triplicate. The colour measurement was done after 60 min of end time of storage in triplicate, with the assistance of a reflectometer using the colour system CIELAB (L*, a*, b*). The determination of TBARs was done according to Raharjo *et al* (1992). Sensory analysis were performed, at each time of storage, for colour, fresh or spoiled odours, and for overall assessment of freshness. It was observed that *Zingiber officinale* added to fresh beef burgers improved the sensorial attributes of beef burgers, showing a positive and significant effect on attractive red colour of samples. Spoiled odour were most evident in samples untreated with ginger, compared to control samples. High values of L* and a* parameters were also more frequent in samples treated with *Zingiber officinale*. This study allows to conclude that *Zingiber officinale* has a significant effect in maintaining fresh burgers colour and can be used as food preservatives, enhancing shelflife of beef burgers.

Keywords: Shelf-life, Burgers, *Zingiber officinale*, Beef quality, Sensory analysis

Interfacing Food Engineering and Food Security

Extending Shelf-life of Food Products

Poster Communications

Pitangueira leaf extracts as alternative to traditional additives in fresh pork sausage

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The use of natural additives with antioxidant and antimicrobial activity in meat products has been reviewed by many research papers. Studies on the use of Brazilian native plant extracts are still very scarce. Thus, the objective of this study was to apply pitangueira leaf extracts (PLE) in fresh pork sausage. Different extraction conditions were tested: 4 hydroethanolic solvent ratios (80:20, 60:40, 40:60 and 20:80) in an ultrasound bath (US) extraction at 15, 30 or 45min, at room temperature, followed by magnetic stirring at 60 or 80^{o}C/30 min; which were conveniently characterized. The best PLE extraction condition was chosen according to its antioxidant and antibacterial activities. Four formulations of fresh pork sausages were prepared: positive control (150ppm nitrite+500ppm sodium erythorbate), erythorbate control (50ppm nitrite+500ppm erythorbate), negative control and extract (50ppm nitrite+1600ppm PLE). For the stability study of pork sausages, refrigerated (4^{o}C/12 days) storage was carried out, in which color, pH, a_W, and lipid oxidation (TBARS) and sensory analyzes (approved by the Ethic Committee) were performed. During storage, microbiological counts of Pseudomonas spp, aerobic psychrotrophs and thermotolerant coliforms were carried out, as well as Staphylococcus aureus detection. The highest total phenolic compounds content (2.93g GAE/g DM) was obtained for PLE at 40:60 hydroethanolic proportion, 45min US bath and 80^{o}C during magnetic stirring. PLE presented high antioxidant (EC50=0.242±0.014mg/mL and 93.73±7.9mg Trolox/g DM) and antibacterial (IZ=2.9 cm) power. The intermediate and polar fractions of PLE were the only fractions with antioxidant activity, where the phenolic compounds myricitrin and quercetin 3-α-fucopyranoside, as well as quinic acid were identified by UPLC-DAD-MS, respectively. Sausages from the extract treatment presented lower L* and a* values ($p<0.05$), probably due to the dark green coloration of PLE. Negative control samples showed pH with an exponential increasing tendency, attributed to microbial growth. Extract treatment was the only one able to maintain lipid oxidation at the initial levels (0.68±0.73mg MDA/kg), promoting better lipid protection of fresh pork sausages than the other treatments. No antibacterial action was observed with the inclusion of PLE in the sausages. Results from sensory analyzes of pork sausages showed good overall acceptance of the formulations (>grade 6), however extract treatment presented the lowest grade ($p<0.05$) for color and global acceptance, probably due to PLE color. It can be concluded that even though PLE dark green color seems an issue, it is a suitable natural additive capable of protecting lipid oxidation of pork fresh sausages during 12-day cold storage.

Keywords: Meat Preservation, Bioactivity, Phenolic Compounds

Aplicación conjunta de agentes físicos y aditivos naturales para inhibir el desarrollo de la flora microbiana de carnes bovinas

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El desarrollo tecnológico en el procesamiento y conservación de las carnes ha permitido consecuentemente, que los consumidores sean cada vez más selectivos buscando la mejor calidad. Para asegurar la preservación de este tipo de alimento es necesario el empleo de diferentes métodos que impidan el desarrollo de microorganismos patógenos y alteradores, prolongando la vida útil y manteniendo la calidad tanto como sea posible.
La irradiación con luz ultravioleta, las temperaturas de refrigeración, el pH, y el agregado de aditivos naturales como los aceites esenciales, son algunas de las tecnologías que pueden considerarse para extender la vida útil microbiológica, las que al accionar en forma conjunta tendrán una mayor actividad que al hacerlo por separado.
El objetivo de este trabajo fue determinar la acción inhibitoria de estos obstáculos actuando en forma conjunta sobre la flora microbiana alteradora de carnes bovinas.
Se trabajó con dos músculos cárnicos (*Longissimus dorsi*, pH 5.8 y *Cuadriceps femoris,* pH 5.6) comprados en el comercio local, los cuales se cortaron en muestras circulares de 19.625cm^2 (n=60). Las experiencias se realizaron por cuadruplicado. Para cada músculo, las muestras se separaron en dos lotes, unas consideradas control (sin tratar) y otras tratadas, las que fueron irradiadas con luz UVC (dosis 0.5567 J.cm^{-2}) y rociadas con 1ml de solución de ácido láctico y aceite esencial de romero (1:1). Luego, todas las muestras fueron envasadas individualmente en bolsas de polietileno y almacenadas en cámaras de refrigeración controlada a 0, 4 y 8ºC, durante 20 días. A diferentes tiempos de almacenamiento, se realizaron recuentos de Microorganismos Aerobios Totales, *Pseudomonas sp* y Enterobacterias sembrando en medios de cultivo específicos. Las cinéticas microbianas se analizaron utilizando el modelo matemático de Gompertz y cuando el efecto fue bactericida, el de regresión lineal. Se calcularon los parámetros derivados: velocidad específica de crecimiento (μ); fase de latencia (LPD) y máxima densidad poblacional (MPD).
Se observó un buen ajuste de los datos experimentales a los modelos. En todos los casos, los recuentos finales fueron menores en las muestras tratadas que en las sin tratar, presentando las mayores diferencias entre ellas en *Cuadriceps femoris* a 4ºC (2.13 log UFC.cm^{-2}), debido a una mayor influencia del pH; por otro lado, a 0°C, la acción fue mayormente bactericida debiendo utilizar el modelo de regresión lineal.
Como conclusión podemos afirmar que la aplicación conjunta de estos agentes fue eficaz para inhibir el desarrollo bacteriano prolongando así la vida útil del producto.

Keywords: Luz ultravioleta, Aceite de romero, Modelos matemáticos, Flora microbiana, Carnes bovinas

Ação antioxidante de óleo essencial de diferentes pimentas em linguiça toscana refrigerada

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A carne suína é amplamente consumida no mundo, principalmente na forma de produto processado. Esses produtos, como a linguiça toscana, podem sofrer alterações devido a reações de oxidação lipídica. Antioxidantes são utilizados para reduzir ou evitar tais reações. Há uma forte tendência em utilizar extratos vegetais como fonte de compostos que apresentam efeito antioxidante visando atender consumidores que buscam produtos com ingredientes naturais e com menor adição de aditivos. Os óleos essenciais extraídos de fontes vegetais são amplamente utilizados na indústria de alimentos e estudos mostram sua ação antioxidante. O objetivo desse trabalho foi avaliar a capacidade antioxidante de óleos essenciais de pimenta rosa (*Schinus terebinthifolius* Raddi) e pimenta preta (*Piper nigrum*) em linguiça toscana armazenada sob refrigeração por 14 dias. Foram elaborados quatro tratamentos: FC - controle, sem adição de antioxidante, FE - com adição de 0,5 g/100g de eritorbato de sódio, FPR - com adição de 0,5 g/100g de óleo essencial de pimenta rosa e FPP - com adição de 0,5 g/100g de óleo essencial de pimenta preta. Análise de cor instrumental (L*, a* e b*) e oxidação lipídica pelo método de TBARS - substâncias que reagem ao ácido tiobarbitúrico - foram realizadas em 0 e 14 dias durante armazenamento refrigerado a 4 ± 1 °C. Para L*, não houve diferença entre os tratamentos nos períodos analisados, apresentado valores entre 53,60 e 55,09 em zero dia e 51,59 e 54,62 em 14 dias. O maior valor de a* em zero dia foi obtido por FE, devido ao eritorbato de sódio ser um composto que acelera a reação de formação de cor no processo de cura. Em 14 dias, o maior valor de a* foi apresentado por FE, seguido de FPR e se diferiram de FC, que apresentou o menor valor a*, pois, sem a adição de antioxidantes, não foi possível prevenir a oxidação dos pigmentos no produto. O tratamento FPP apresentou os menores valores de oxidação lipídica em 7 e 14 dias de estocagem (0,185 e 0,149 mg de malonaldeído/kg de amostra) seguidos de FPR e FE, que não diferiram entre si durante o armazenamento. Como esperado, os maiores valores de oxidação lipídica foram apresentados por FC (0,417 e 0,412 mg de malonaldeído/kg de amostra), sem adição de antioxidantes. Os óleos essenciais de pimenta preta e pimenta rosa nas concentrações utilizadas mostraram um efeito antioxidante em linguiça toscana refrigerada.

Keywords: Antioxidante natural, Produto cárneo, Oxidação lipídica, Óleo essencial de pimenta rosa, Óleo essencial de pimenta preta

Storage behaviour of 'Rocha' pear coated with nanoemulsions enriched with essential oils

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One of the main problems of 'Rocha' pear long-term cold storage is the development of the physiological disorder superficial scald. The objective of this work was to study the effect of coating 'Rocha' pears with alginate-based nanoemulsions enriched with essential oils to reduce this problem and improve quality. Four formulations of nanoemulsions were used: sodium alginate (AL) 2% (w/w) with incorporation of lemongrass essential oil and citral at 5 and 10 times their, respective, MIC. 'Rocha' pears were dipped in those solutions for 2 min, and then stored at 0 ◦C. Uncoated fruit were used as control. Periodically, through storage, fruits were removed from storage and were transferred to shelf-life at approximately 22 ºC. Then fruit were assessed for the quality parameters colour CIELab, firmness, soluble solids content (SSC), weight loss, microbial growth, taste panels and symptoms of superficial scald, after 0 and 7 days. Results showed that edible coating incorporating LG at 1.25% and 2.5% were the best to maintain most quality attributes of the commodity through storage at 0 ◦C. Pears coated with LG 1.25% and 2.5% nanoemulsions maintained higher firmness through shelf-life, without scald symptoms and LG-1.25% coated fruit had the best classification in overall taste at the end of the storage period. Thus, these coatings may be useful for improving postharvest quality and long storage life of ´Rocha´ pear.

Keywords: Superficial scald, Internal disorders, Firmness, Taste, Lemongrass, Citral

Cinnamomum zeylanicum extracts reduces lipid oxidation in mechanically separated meat of broadband anchovy (*Anchoviella lepindentostole*)

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Fish and fish products are susceptible to lipid oxidation due to the high content of polyunsaturated fatty acids. Therefore, preservation technics to prevent the oxidative process and to prolong the shelf life of fish and fish products have been used in food industries. Due to the high content of phenolic compounds, such as proanthocyanidin, *Cinnamomum zeylanicum* is known as a natural antioxidant. The present study evaluated the antioxidant activity of *Ceylon cinnamon* bark extracts and their ability to slow up the lipid oxidation on mechanically separated meat (MSM) of broadband anchovy (*Anchoviella lepidentostole*) during storage at -18 ^{o}C for 150 days. Fresh fish were purchased, beheaded, gutted and processed in a deboning machine to obtain MSM. Physicochemical characteristics (proteins, moisture, ash, lipids) were determined in washed (WMSM) and unwashed MSM (UWMSM). Spray-dried cinnamon extract (DC) and spray-dried cinnamon extract using maltodextrin 10DE (DCM) as a carrier were obtained after hydroalcoholic extraction. The antioxidant capacity *in vitro* of the extracts was measured by Total polyphenolic content (*TPC*), Ferric reducing antioxidant power (*FRAP*), DPPH• radical scavenging activity, $ABTS^{+}$ radical scavenging activity, and oxygen radical absorbance capacity (*ORAC*). To evaluate the effect of the cinnamon extracts on MSM of broadband anchovy, eight treatments were conducted in triplicate using W or UW MSM: negative controls (CW and CUW), positive controls 0.25% sodium erythorbate added (SEW and SEUW), 0.25% DC added (DCW and DCUW) and 0.25% DCM added (DCMW and DCMUW). Periodic analysis of lipid oxidation (2-thiobarbituric acid reactive substances-TBARS) was performed. The washing process caused a significant loss of lipid content from 5.07 in UWMSM to 2.22% in WMSM ($p<0.05$). The DC extract had the higher antioxidant activity *in vitro*: 4045.30 umol/g for *FRAP*, 3782.31 umol/g for *ORAC*, 4393.46 umol/g for $ABTS^{+}$, 424.00 AGE/g for TPC and 250.40 mg procyanidin B2/g, and the lower *DPPH*• EC_{50} (105.70 µg/ml) ($p<0.05$) compared to DCM extract. The reduction of lipids resulted in lower oxidation levels because the treatments UWMSM showed significantly higher values of TBARS. The negative controls had the highest TBARS (0.60 and 3.16 mg malondialdehide/kg for CW and CUW, respectively). Compared with the controls, both cinnamon extracts treatments significantly decreased the TBARS values in W (0.49 and 0.49 mg malondialdehide/kg for CDW and DCMW, respectively) and UW MSM (2.71 and 2.63 mg malondialdehide/kg for CDUW and DCMUW, respectively). Results revealed that *C. zeylanicum* bark extracts can be used to prevent lipid oxidation in fish products.

Keywords: Natural antioxidant, Spray drying, *Minced fish*, Oxidative stability

Effect of vacuum packaging on shelf life of octopus (O. insularis) under refrigeration

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In Brazil, the State of Ceará has great prospects for increasing capture of octopus, due to the vast coastline and the search for exotic and healthy dishes by population. Besides, it comes the need to further expand this product to distant markets from local production, promoting the increase of shelf life in order to meet the demands from consumers in a convenient and safe way. Thus, the aim of this work was to evaluate the effect of vacuum packaging on the shelf life of *Octopus insularis* stored under refrigeration (2±2°C). There were three treatments, octopus not gutted (NG), gutted and packed without vacuum (GWVP) and, gutted and vacuum packed (GVP), which were evaluated every 5 days for 20 days at refrigerated storage (2±2ºC) for microbiological (pathogenic and spoilage), physicochemical (pH, TVB-N and TMA-N) and sensory characteristics (freshness evaluation). For this, the Quality Index Method (QIM) proposed by Barbosa and Vaz-Pires (2004) has to be adapted. For this, the help of five trained judges was accounted. The adapted QIM has eight sensory attributes used to evaluate the freshness of *O. insularis.* The results showed that the vacuum packaging has not been effective in maintaining the quality characteristics of *O. insularis* stored under refrigeration, as the values of physicochemical parameters at the end of the experiment were 23.39 mg TVB-N/100g, 14.84 mg TMA-N/100g and 6.11 for pH. For the NG samples, the values obtained for TVB-N, N-TMA and pH were 24.82 mg TVB-N/100g, 7.27 mg TMA-N/100g and 5.99, respectively, and for the GWVP samples were 14.93 TVB-N mg/100g, 2.62 mg TMA-N/100g and 6.00 for pH. It can be observed that the GVP samples were the ones with the highest values for the N-TMA and pH parameters. The vacuum packaging was also not effective against spoilage microorganisms analyzed, since at the end of the experiment showed the highest values, which were 7.13 log CFU/g for lactic acid bacteria, 6.33 log CFU/g for bacteria producing H_2S and 7.48 log CFU/g for psychotropic bacteria. There was no growth of pathogenic bacteria. The sensory evaluation showed that vacuum packed samples did not differ significantly from non-vacuum packed ones. It can be concluded that vacuum packaging was not effective in extending the shelf life of octopus stored under refrigeration. It was not observed a beneficial effect of this type of packaging on microbiological, sensory and physicochemical quality of octopus when compared to the other treatments.

Keywords: *Octopus insularis,* Quality Index Method (QIM), Vacuum packaging, Shelf life

Postharvest disinfestation treatments of *Callosobruchus maculatus* in stored cowpea (*Vigna unguiculata*)

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Grains and cereals are extensively degraded by pests during storage. Insects are the precursors that allow the growth of microorganisms. Insects activity causes chemical and physical degradation of grains, leading to a huge loss of agricultural products. The beetle *Callosobruchus maculatus*, also known as "weevil," is the main pest of cowpea (*Vigna unguiculata*) and other legumes such as peas and chickpeas. The most widely used method for grains disinfestation is based on the fumigation of chemical agents. Because of the accumulation of chemical residues and their high toxicity, alternative and safer methods are needed. Heat treatment has been applied for grain disinfestation. In this study, the application of vacuum was also reported as an alternative for grain disinfestation. Thus, the present study aims to evaluate the death of the insect *C. maculatus* in the adult phase, submitted to vacuum and conductive heating (by contact with a hot plate). The thermal death of adult insects of *C. maculatus* in conductive heating was experimentally evaluated, under isothermal conditions, at temperatures of 50 °C, 52 °C, 55 °C and 60 °C. The treatment times for the total insect population reduction were 35 min, 14 min, 3 min, and 1 min, respectively. The increase of 3 °C, from 52 °C to 55 °C, resulted in a reduction of more than 50% of the treatment time. The same behavior occurred with the increase from 50 °C to 52 °C, evidencing that small variations in temperature influence the death of the insects. The reduction of *C. maculatus* through the vacuum was evaluated by experiments under isobaric conditions (2.2 kPa and 4.2 kPa), with a constant decompression rate of 2.12 kPa s^{-1}. The death time was 60 min for both vacuum treatments. The pressure variation in the analyzed range does not affect the treatment time for adult insects of *C. maculatus*. Both treatments showed sigmoid thermal death behavior. Experimental data were fitted to mathematical models. The Weibull model presents the best fit, higher adjusted coefficient of determination ($R^2_{aj} > 0.98$) and smaller root means square error (RMSE < 0.06). The conductive heating and vacuum treatment methods are effective for the disinfestation of adults of *C. maculatus* and free of chemical residues. The heat treatment at all temperatures investigated eliminated insects faster than the vacuum treatment.

Keywords: Disinfestation, Insects, Grains, Heat treatment, Vacuum

Ascorbic acid stability in powders of typical peruvian fruits

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Preserving ascorbic acid in fruits derivates is always a challenge for the food industry, which implies to improve in both processing and storage. Thus, the main objective of this research was to evaluate the stability of ascorbic acid in fruit powders during storage. Powders of four typical Peruvian fruits: camu-camu (CC), golden berry (GB), blackberry (BB) and banana passion fruit (BPF) were obtained by microencapsulation with gum Arabic using a spray dryer. These powders (P) packed in glass jars were stored in presence of light (L) and dark (D) in temperatures of 25 and 35 ° C for 45 days; under these storage conditions the ascorbic acid content was evaluated every 15 days. The degradation of acid ascorbic in fruit powders during storage fit to a kinetic of first order. The range of rate constant, k (day^{-1}), estimated to each typical fruit powder were between 0.0033±0.0003 to 0.0051±0.0003 for CC-P, 0.0138±0.0003 to 0.0282±0.0018 for GB-P, 0.0123±0,0008 to 0.0206±0.0018 for BB-P, and 0.0094±0.0007 to 0.0328±0.0003 for BPF-P. Higher rates constant were obtained in the presence of light and temperature of 35 °C. Thus, it is better to use dark packings and low temperature during storage of fruit powders. In these conditions stability of ascorbic were 85.94% ± 1.35% for CC-P, 53.11% ± 0.004% for GB-P, 58.79% ± 5.58% for BB-P, and 64.83% ± 0.23% for BPF-P.

Keywords: Fruits powders, Microencapsulation, Degradation kinetics, Vitamin C

Development of lambari fishburgers - a sustainable, safe and convenience fish product

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Although fish consumption has grown worldwide, the per capita consumption in Brazil is still low. Among the barriers that inhibit the increase in fish consumption, the presence of fish bones is a major concern, especially with regard to consumption by children. Healthy and convenience fish products, preserved with natural compounds present the appeal to attract new consumers. Lambari (Astyanax altiparanae) is a promising species in continental Brazilian aquaculture, which can be used for the production of bone-free fishburgers from its mechanically separated meat (MSM). Cinnamon (*Cinnamomum zeylanicum*) may be used as a natural antioxidant for fishburgers meeting the consumers' demands for natural products. The objectives of this work were to develop lambari fishburgers and study their stability for six months of storage at -22 °C. The extract of cinnamon (EC) was obtained by extraction with hydro-alcoholic solution and dehydration using a spray-dryer. Beheaded and gutted lambaris were processed in a deboning machine and the MSM was used to make fishburgers added with 0.25% EC (ECT), added with 0.25% sodium erythorbate (SET) and without antioxidant (WAT). Fishburgers were also made with a mixture of 50% MSM and 50% ground meat to compare with 100% MSM fishburgers in relation to the presence of bones using scanning electron microscopy (SEM) performed on a Hitachi TM 3000 microscope (15-kilovolt acceleration voltage and Energy Dispersive Spectroscopy -EDS). Lipid oxidation (malondialdehyde levels - mg/kg), weight loss after cooking and instrumental color were evaluated in fishburgers sampled during storage. EC was effective in reducing lipid oxidation in fishburgers, since malondialdehyde values were higher in WAT (0.77±0.20mg/kg) than in both ECT (0.57±0.14mg/kg) and SET (0.69±0.29mg/kg) treatments ($p < 0.05$). The storage affected weight loss after cooking, which increased from 10.79±2.52% to 18.56±2.21% after 6 months of frozen storage. Weight loss was not affected by treatment, showing that the EC did not alter the water retention of the fishburgers. The chroma value was higher in ECT (9.12±1.96) compared to SET (8.10±1.57) and WAT (7.02±1.12), showing that the EC enhanced the color of the fishburgers. Samples of fishburgers containing 50% of ground lambari presented elements with light color and non-porous appearance in SEM images. The EDS detected high calcium concentrations for these elements, indicating that they were fragments of bones. Fishburgers made with 100% MSM did not have this type of structure, confirming the efficiency of the deboning process and the safety of the product for consumption.

Keywords: Food preservation, Cooking loss, Scanning electron microscopy

Avaliação de qualidade na produção do iogurte grego delactosado simbiótico com quinoa (*Chenopodium quinoa*) e saborizado com manga (*Mangifera indica l.*).

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O iogurte grego é um alimento acrescido de sólidos totais (gordura e proteína) podendo ser caracterizado como iogurte com creme. O objetivo da pesquisa foi processar um iogurte grego delactosado, adicionado da cultura probiótica de *Lactobacillus acidophilus* (LA10 da Globalfood), enriquecido com quinoa (*Chenopodium quinoa*) e saborizado com manga (*Mangifera indica L.*). Foram controlados os parâmetros indicadores de qualidade físico-química e microbiológica e a viabilidade de crescimento das bactérias ácido-lácticas (BAL) semanalmente, sob temperatura de 4°C ± 1°C até 42 dias. Para produção do iogurte foram utilizados 2 L de leite integral UHT delactosado, 10% (m/m) de açúcar, 3% (m/m) de quinoa, 12%(m/m) de leite em pó, 2% (m/m) da cultura de iogurte e 2%(m/m) da cultura LA10 (10^{10} UFC.g^{-1}). Os resultados físico-químicos do iogurte estão descritos na Tabela 1.

Tabela 1 –Composição Centesimal média do Iogurte Grego.

Gordura (%)	Proteína (%)	Umidade (%)	Fibra Bruta (%)	Cinzas (%)	Carboidratos (%)
6,50 ± 0,00	5,50 ± 0,03	66,41 ± 0,00	0,38 ± 0,00	1,36 ± 0,02	23,85 ± 0,00

Fonte: os autores.

O iogurte apresentou padrão físico-químico em acordo com a IN 46 (BRASIL, 2007). O teor de gordura mostrou-se acima de 6,0%, classificando-o como iogurte com creme. O percentual de proteínas mostrou-se acima do padrão mínimo estabelecido de 2,9%. Este resultado aponta o iogurte grego como veiculador de proteínas de alto valor biológico, sendo o leite fonte de caseínas e albuminas. A umidade média de 66,41% pode ser considerada baixa, explicada pelo aumento dos sólidos totais, responsável pela consistência final do produto. A fibra bruta (0,38 g de fibras.100 g^{-1}) tem contribuição importante no aumento da viabilidade do probiótico e na saúde do consumidor, ao longo do tempo. A contagem de BAL viáveis (Agar MRS a 37°C ± 1°C , 72h ± 2h) em sistema de anaerobiose apresentou concordância com a legislação vigente (> 10^7 UFC.mL^{-1}). No dia da produção 2,35 x 10^8UFC.mL^{-1} e no 42 º dia, 7,56 x 10^8UFC.mL^{-1}, respectivamente, caracterizando o alimento como probiótico em acordo com RDC n°2 (BRASIL, 2002). O iogurte apresentou presença de coliformes a 30°C (23 NMP.mL^{-1}), contudo abaixo do tolerável pela RDC nº 12 (BRASIL, 2001) e ausência de coliformes a 45°C (<3,0 NMP.mL^{-1}). Conclui-se que o processamento do iogurte grego simbiótico, sabor manga, apresentou padrão físico-químico e microbiológico satisfatórios.

Keywords: Controle de Qualidade, Segurança dos Alimentos, Bio conservação dos Alimentos, Probióticos

Phenolics compounds retention in sweet potatoes flour during storage

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The nutritional composition of sweet potatoes includes the high content of easily digestible carbohydrates, low lipid and protein contents, and the purple pulp sweet potato variety has a high content of phenolic compounds, including flavonoids and anthocyanins. One possibility to exploit the marketing potential of sweet potatoes is the application of processing technologies aimed at increasing the shelf life associated with the retention of the bioactive components of the raw material such as flour processing. The objective was to evaluate the effect of storage temperature (5 and 25 ºC) and time on the color, contents of phenolic compounds and anthocyanins of purple pulp sweet potato [*Ipomoea batatas* (L.) lam] flour stored for 180 days.The sweet potatoes were washed, sanitized, sliced, blanched (hydrothermal blanched: 100 ºC for 1 minute), dehydrated (at 70 ^{o}C/7h) and ground. The samples were packaged in individual polyethylene containers and then placed in paper bags protected against light. The potatoes flour was stored in refrigerated chambers over a period of 180 days under two different temperatures (5 ± 2 ^{o}C and 25 ± 2 °C). At 0 (zero), 30, 60, 90, 120, 150 and 180 days of storage samples were taken to perform the analysis of the total phenolic compounds, total anthocyanins and instrumental color (L* a*, b*, h^{o} e C*). Analyzes were performed by spectrophotometric methods and the average were subjected to Tukey test with 5% error probability. It was found that storage temperatures do not interfere in the content phenolic compounds, anthocyanins, color parameters (a*, b *, h^{o} and C*), however, most of them were influenced by the storage time. There was a reduction in phenolic compounds and anthocyanins contents, after 90 days of storage. The sweet potatoe flour showed 49.82% of phenolic compounds, and 53.58 % of total anthocyanins at 180 days of storage. Our results show a greater stability of the compounds under study with temperatures of 5 and 25°C in the 180-day storage period and suggest that sweet potatoes flour can be stored at room temperatures taking into consideration the variety of temperatures in different regions.

Keywords: *Ipomoea batatas (L.) lam*, Anthocyanins and Bioactive compounds

Effects of natural ingredient in growth control of specific spoilage organisms (SSO) in minced meat during storage

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Nowadays, the increasing demand for safer and natural foods became suitable to use natural ingredients for shelf-life extension of meat and meat products. The antimicrobial ability of natural ingredients is highly important, as the spoilage of food products is frequently associated to microbiota. *Salicornia ramosissima*, also known as purple glasswort, is a halophyte belonging to *Amaranthaceae* family that can be found in salt flats and it is very common in Iberian Peninsula. *Salicornia ramosissima* can be used fresh or as dried powder. Fresh beef (semitendinosus and semimembranosus muscles) was obtained from a local slaughterhouse and transported to laboratory under refrigeration. Then, beef was cut, minced in amounts of 20g and was added different concentrations of dried purple glasswort (1% (m/m) (A), 1.5% (m/m) (B) and 2% (m/m) (C)). Control samples, untreated (0), were also prepared. Samples were packed in MAP (modified atmosphere packaging) (70%O_2/30%CO_2), stored at 2ºC and microbiological and sensory analyzed at day 1,3,5,7 and 10. At each time of storage, Lactic acid bacteria (LAB), *Pseudomonas* spp., psychrotrophic microorganisms, *Enterobacteriaceae*, *Fungi*, mesophilic microorganisms, as well as *Brochothrix thermosphacta*, were analyzed, respectively according to French standard V04-503:1988 and V04-504:1998, Portuguese standard 2307:1987, and the last following ISO procedures. The tasting panel evaluated each sample 60 min after the end of storage time, for color, fresh or spoiled odors, and overall assessment of freshness. It was also observed that the odor of fresh beef was maintained during more time in treated samples when compared to control samples. Specifically, the spoiled odor was detected in samples treated with *Salicornia ramosissima* after 7 days of storage when compared to untreated samples in which this odor seems to appear since day 5. It was also noted that *Salicornia ramosissima* added to fresh beef, showed effects on the control of development of SSO, particularly on psychotrophic microorganisms. At day 3, in beef samples with the C formulation the obtained values were 6.66±0.23 log ufc/g, while in samples with other formulations the obtained values were higher than 7 log ufc/g. At day 5, in beef samples using C formulation was obtained values of 7.72±0.11 log ufc/g. It is showed that formulation C extended the shelf-life of burgers in 2 days. This study showed that *Salicornia ramosissima* has a significant effect in maintaining fresh odor of beef and can be used as preservative, promoting growth control of some spoilage microorganisms in minced meat, particularly on psychotrophics.

Keywords: Spoilage, Minced meat, Salicornia ramosissima, Microorganisms, Spoiled odour

Teores de licopeno, sólidos solúveis totais e acidez total titulável em tomates tipo grape armazenados sob refrigeração em duas diferentes embalagens

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Para atender às exigências do mercado, o uso de embalagens e refrigeração são necessários afim de manter as características e a qualidade dos frutos até sua aquisição pelo consumidor final. No Brasil, os tomates do tipo "grape" são comercializados tradicionalmente em embalagens polietileno tereftalato (PET) e, mais recentemente em filmes plásticos com tecnologia de zeolitos, que conforme o fabricante indica, permite uma com permeabilidade seletiva a gases, modificando a atmosfera interna de forma passiva. Neste estudo objetivou-se avaliar o comportamento dos frutos sob refrigeração em duas diferentes embalagens. Os frutos utilizados nesta pesquisa foram provenientes de cultivo comercial em casa de vegetação, cultivados em substrato de fibra de coco, localizado em Pará de Minas – MG lat 019.7818°S long 044.6185°W. Os frutos foram colhidos de forma manual no período da manhã e transportados sob refrigeração para o laboratório Conservação de Alimentos da Universidade Federal de São João del-Rei, onde foram separadas 40 porções de 180g e imediatamente embalados em dois diferentes modelos de embalagens: embalagem rígida termo moldada fabricada em PET e embalagem em filme plástico com tecnologia de zeolitos (VEGETALPACK). As embalagens foram armazenadas em câmaras tipo B.O.D. à 15 °C±2 e as amostras para análise foram retiradas antes do armazenamento e aos 5, 10, 15 e 20 dias de armazenamento. Foram realizadas análises de acidez total titulável (ATT), sólidos solúveis totais (SST) e licopeno. O experimento foi realizado em triplicata, com três repetições e os valores encontrados foram submetidos a análise de variância pelo teste F e as médias comparadas, quanto significativas, pelo teste de Tukey (α=5%). Os teores de SST e ATT foram influenciados pela interação entre a embalagem utilizada e o tempo de armazenamento. Aos 5 dias não apresentaram diferenças estatísticas entre as embalagens utilizadas, após 10 dias de armazenamento os valores de SST e ATT na embalagem VEGETALPACK eram respectivamente 7,58°Brix e 0,44% enquanto que na embalagem PET os frutos apresentavam em média SST 6,62°Brix e ATT 0,42%. Aos 20 dias de armazenamento os frutos na embalagem VEGETALPACK (SST= 7,01°Brix e ATT=0,41%) apresentava valores ligeiramente inferiores aos frutos armazenados
na embalagem PET (SST 7,33°Brix e ATT 0,55%). Os teores de licopeno nos frutos contidos na embalagem PET foram superiores em todas as analises, partindo de uma média de 36,61 mg de licopeno/100 g de tomate aos 5 dias de armazenamento e atingindo uma concentração média de 52,43 mg de licopeno/100 g de tomate aos 20 dias de armazenamento. Já os frutos armazenados
na embalagem VEGETALPACK apresentavam concentração de 31,62 mg de licopeno/100 g de tomate aos 5 dias e atingiram concentração média de 45,15 mg de licopeno/100 g de tomate aos 20 dias.

Keywords: *Lycopersicon esculentum* (L.), Licopeno, vegetal pack, Embalagem, Qualidade

Influência da embalagem e do tempo de armazenamento sobre o teor de vitamina C em tomates tipo grape

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O tomate é um fruto que constitui importante fonte de vitamina C. O teor dessa vitamina pode ser influenciado por diversos fatores, como adubação, condições fitossanitárias, condições de estresses biótico e abiótico, e pelo tempo entre colheita e consumo. Objetivou-se avaliar a influência da embalagem e do período de armazenamento sobre o conteúdo de vitamina C em tomates do tipo grape. As amostras do hibrido Tomini utilizadas foram provenientes de um cultivo comercial em casa de vegetação, com uso de substrato de fibra de coco, localizado em Pará de Minas - MG lat 019.7818°S long 044.6185°W. Os frutos foram colhidos manualmente no período da manhã, organizados em porções de 180g e embalados em dois tipos de embalagens: caixa rígidas termo moldadas de polietileno tereftalato (PET) e filme plástico VEGETALPACK adicionado de zeolitos, conferindo uma permeabilidade seletiva a gases ao material. As embalagens foram armazenadas a 15°C em câmaras tipo B.O.D e as amostras para a quantificação de vitamina C foram retiradas para analise aos 5, 10, 15 e 20 dias de armazenamento. O teor de vitamina C foi avaliado por HPLC conforme proposto por Benlloch 1993. As amostras homogeneizadas, centrifugadas e filtradas (Minisart RC 0,45 µm) foram injetadas em um HPLC SHIMADZU Prominence, Detector DAD SPD-M20, bomba LC20AT, coluna ThermoScientifc C-18 ODS-2 HYPERSIL 250 mm x 4,6 mm. A fase móvel utilizada foi KH_2PO_4 50mmol/L e $C_{19}H_{42}BrN$ 5 mmol/L com o pH ajustado a 4 (com H3PO4). O detector foi ajustado para λ = 254 nm e a corrida cromatográfica com um fluxo de 1mL.min-1. O experimento foi feito em triplicata, com três repetições e os teores de vitamina C observados submetidos à ANAVA (α = 5% SAS STAT). Os tomates armazenados nas embalagens do tipo VEGETALPACK apresentaram teores médios d vitamina C de 14,24mg/100g, já embalagem do tipo PET, apresentou teores de 20,96mg/100g. As quantidades médias de vitamina C foram sempre superiores nos frutos armazenados nas embalagens do tipo PET com exceção ao verificado no 5 dia. O decréscimo da quantidade de vitamina C nos frutos armazenados na embalagem VEGETALPACK, pode ser expressa conforme modelo Y=-6,2449X + 29,86, que foi obtida após análise de regressão e com R2=0,9992. A embalagem do tipo PET conservou melhor os teores de vitamina C, tendo a embalagem do tipo VEGETALPACK influenciado de forma negativa os teores de vitamina C nos frutos armazenados.

Keywords: *Lycopersicon esculentum (L.)*, Vitamina C, Vegetal pack, HPLC, Armazenamento

Analysis of volatile compounds in Serpa PDO cheese

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The volatile compounds of cheese are formed from the main constituents of the milk, namely lactose, citrate, lipids and proteins. These compounds are responsible for the characteristic flavor of different varieties of cheese and its formation depends on several factors, namely the composition of the raw material.
Serpa cheese is one of the portuguese Protected Designation of Origin (PDO) cheese, typically produced in Baixo-Alentejo region from native sheep´s milk.
In this work, the volatile profile of two sets of Serpa cheeses, commercial (n= 7) and nonconforming according to sensorial analysis (n=24), was analysed by gas chromatography and mass spectrometry, after previous extraction and concentration by solid phase microextraction. The identification of the compounds was based on the comparison of the mass spectra from peaks in the chromatograms with spectra from the NIST library and Kovats index was also determined.
In the commercial cheese samples were identified 51 compounds, being the predominant volatile compounds from the family of the acids (31%), namely acetic, propionic and hexanoic acid, followed by the alcohols (22%), from which ethanol and butanol, esters (20%), namely 3-metil-butil acetate, and ketones (12%), and the remain compounds were sulphur compounds, phenolics, hydrocarbonates, amines and aldehydes.
In the nonconforming cheese samples, 81 compounds were identified. The esters were present in higher proportions (22%), namely ethyl-butanoate, followed by the acids (21%), from which acetic and propionic acids, and the ketone class (19%) was present in a wide variety as 15 ketones were identified, namely the predominant was 2-penthanona, in contrast to only 6 in the commercial samples. The family of the alcohols was about 17% and the remain compounds were in the same proportion as in commercial samples.
The profile identified in the two sets of samples was similar and mostly composed by free fatty acids, which generally predominate in cheese from raw milk.
From these results we can conclude that lipolysis and proteolysis are probably in the advanced stages in nonconforming cheeses, since ketones, esters and phenolic compounds have higher expression and are secondary and tertiary products of these reactions. This study data complemented with microbiological characterization of the sample, maturation time and descriptive sensory analysis can contribute to a deeper knowledge of the flavor chemistry, characteristic of Serpa cheese.

Keywords: Volatile profile, Serpa PDO cheese, Nonconforming cheese, Gas chromatography, Mass spectrometry

Microbial and sensorial quality of fresh-cut yellow melon coated with an edible film of taro corms starch added with nanoparticles of *Bixa orellana* oil

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The melon (*Cucumis melon* L.) presents high commercial value in Brazil, where it is marketed as fresh fruit and fresh-cut product. Fresh-cut melon (FCM) is an emerging product in the Brazilian market due to the convenience that offers. However, FCM is highly susceptible to microbiological contamination, has acceleration senescence and, therefore, high perishability. Coating FCM by using renewable and edible starchy raw materials, such as taro corms (*Colocasia esculenta* L.), may delay the senescence. The addition of active ingredient, such as annatto oil (Bixa orellana L), as nanoparticles, in these coatings can minimize microbial development without negatively impacting the acceptance of the coated product. In this sense, the objective of this work was to evaluate the microbiological and sensorial quality of FCM coated with 3% taro starch film containing 0.5% glycerol incorporated using ultrasound (F), in which was added annatto oil nanoparticles (ONP). Slices of yellow melon, 36x2 cm (length x width), were immersed in the filmogenic solutions of: F, F+3%ONP, F+5%ONP and slices without coating, packed in a PET tray. After application, the slices were stored for 14 days at 5ºC and evaluated for total and fecal (thermotolerant) coliforms, *Salmonella* sp, and molds and yeasts, according to the official FDA methods, every 2 days, in 4 replicates. In parallel, the purchase intention was evaluated by 24 trained panelists (1 = extremely disliked, 5 = not liked, nor disliked 9 = extremely liked), 6 = limiting score. On the 2nd day, coated slices showed no microbial development, but mold and yeast were observed in the uncoated. On the 4th day, slices with 3%F presented molds and yeasts and positive result for total and thermotolerant coliforms. Notably, slices coated with F+5%ONP did not present positive results for total and thermotolerant coliforms and/or *Samonella* during 14 days, in contrast to slices of the other coatings. For purchase intention, on the 8th day, uncoated slices presented scores below 5, while those with F+5%ONP maintained grades higher than 7 for 14 days. Taken together, the use of taro starch coating added with 5% of annatto oil nanoparticles showed an inhibitory effect on the development of pathogenic microorganisms, without affecting sensory acceptance and food safety, characterizing as a healthy alternative and for the maintenance of FC yellow melon purchase intention for 14 days.

Keywords: Melon, Annatto, Nanoparticles, Taro, Fresh-cut, Film

Vacuum-packed fresh Atlantic salmon (*Salmo salar*) preserved by hyperbaric storage at low temperatures

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Fish is a highly perishable food characterized by short shelf-life, due to the action of different damage mechanisms, such as microbiological spoilage, autolytic degradation and lipid oxidation. Hyperbaric storage (HS) has attracted great interest due to the possibility to increase food products shelf-life and quality compared to the conventional method of refrigeration (RF), mainly of highly perishable food products (as the case of fresh fish). HS application using low temperatures was recently published, which verified that HS (50 MPa/5 °C) of hake loins [1] and Atlantic mackerel fillets [2] maintained the microbial load after 7 and 12 days, respectively. The present work aimed studying the hyperbaric storage at low temperature (60 MPa/10 °C) of vacuum-packed Atlantic salmon (*Salmo salar*) for 30 days, evaluating endogenous microorganisms and important physicochemical quality-indicators (pH, lipid oxidation, protein stability and textural properties). HS showed to be efficient not only for microbial growth inhibition of salmon samples but allowing also obtaining additional microbial inactivation (~1.3 log units of total aerobic mesophiles). Furthermore, most of the physicochemical quality-indicators were kept in similar levels to initial salmon or better than RF. Lipid oxidation mechanisms were efficiently slowdown, being quantified mainly products from the primary lipid oxidation (5-6 mg Fe/kg lipids), while at RF there was a strongly increase of ~6.3-fold of tertiary lipid oxidation products. Similarly, after 30 days drip loss values were lower for HS samples (2.6%), compared to RF (6.6%), but in both cases it was observed a water holding capacity similar to fresh fish (~80%). Textural properties of fresh fish (hardness, adhesiveness and springiness,) were maintained during HS (only for resilience was verified a decrease of ~70%). This way, HS may represent an advantageous methodology for shelf-life extension of fresh Atlantic salmon compared to conventional refrigeration.

Keywords: Hyperbaric storage, Atlantic salmon, Salmo salar, Microbial stability, Lipid oxidation, Texture

Extending the shelf life of fresh salicornia (*Salicornia ramosissima*) an halophyte species

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Salicornia ramosissima J. Wood is a halophyte plant, widely distributed in coastal zones of Portugal and in many other similar Iberian Peninsula areas. Its salty taste imparted from several salts besides sodium led, for health reasons to its use instead of NaCl, mainly in gourmet cuisine. Even the hydroponic salicornia production becomes intermittent by adverse weather conditions (low temperature and wind) and extension of shelf life is important to face it. After harvesting, the plants are weighed, packed in clam-and-shell polyethylene packages, stored at 5 °C and distributed under refrigeration. After 15 days of storage at this temperature, plants started wilting and darkening. As no significant microbiological growth occurred, it was hypothesized that the darkening was due to the action of peroxidase (POD), as fresh salicornia contains 60.34±12.15 $\mu mol.min^{-1}.mgprotein^{-1}$ of this enzyme. The objective of this study was to find the best process to decrease the POD reaction rate, in *Salicornia,* by lowering the storage temperature (ST) to 1 °C. Moreover, 4 pre-treatments were tested: 1. Single blanching 2. Pulsed UV-C radiation (45 pulses, 390.4 kJ/m^2) followed by blanching (30s at 90 °C); 3. Filter paper impregnated with a 2% (w/v) sodium metabisulphite ($Na_2S_2O_5$) solution; 4. Pulsed UV-C radiation followed by packing with $Na_2S_2O_5$ solution. A control (without pre-treatment) was also tested. Over 18 days of storage, the POD reaction rate (k_{POD}), color (*L*, *a*, *b*), yeasts, molds, mesophiles, psychotrophic aerobic microorganisms and total coliforms were evaluated. Results showed that lowering the ST from 5 to 1 °C was the main effect on shelf life extension as the control plants remained in good condition till the 18th day having a k_{POD} of 0.029±0.008 day^{-1}. Plants from treatment 4 presented the lowest k_{POD} (0.022±0.009 day^{-1}), meaning, although not significantly different from the control, pulsed UV-C followed by $Na_2S_2O_5$ contributes to the plant's green color retention until the 18th day. Regarding pre-treatments 1 and 2, the blanching conditions were not effective to inactivate POD, ($k_{PO\ =}$ 0.050±0.007 day^{-1} and 0.055±0.008 day^{-1} respectively), causing a decrease of 15% in *L* (lightness) and an increase in the *a value* of 60% (loss of green color). The microorganisms evaluated didn't grow significantly. To the fifteen days at 5 °C, a three days extension of shelf life was added to *S. Ramosissima* when stored at 1 °C and adding $Na_2S_2O_5$ to the package. Tests with increased concentrations of the latter should be carried out in future.

Keywords: Salicornia ramosíssima, shelf life estension, active packaging, peroxidase, pulsed UV-C radiation

Interfacing Food Engineering and Food Security

Food Safety

Oral Communications

Implementation of a Food Safety Management System according to the ISO 22000 family in a winery: a case study

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Nowadays there is an increase concern with food safety, which leads to a rise in the consumers demand level and consequently interest from the producers, retailers and authorities. In addition to the legislation published by authorities, many companies are voluntarily implementing complementary Quality Management Systems for Food Safety, like ISO 22000 standard, in order to increase the quality assurance of their products. This work presents a methodology to carry out hazard analysis and control measures assessments to establish properly Operational Prerequisite Programmes (OPRP) and the HACCP plan in a winery, according to the ISO 22000 standard. This study focused on the stage, treatment, bottling and storage of wines.

Twenty-five of the total hazards identified in this study were considered as significant (RI≥ 4; Risk Index), having been subjected to a Decision Tree. Control measures were selected in order to prevent, eliminate or reduce the hazards to acceptable levels for food safety. After selection, the control measures were classified regarding its necessity of being managed by the OPRP or the HACCP plan. The bottling step, both during and immediately before it, and the final fining should be managed by the HACCP plan. The remaining steps were managed by OPRP.

The hazards controlled by measures which are managed through the HACCP plan or OPRP were identified in the following steps: the analytical control, before transport (excess of SO_2); SO_2 addiction (excess of SO_2); fining (excess of oenological products); racking/filtration (contamination with foreign bodies, like glass or metal); wine fining, just before bottling (excess of SO_2); final filtration, both with plates and membranes (contamination with foreign bodies, like glass or metal) and in the filling/corking step (contamination with foreign bodies, like glass or metal), both before and during the filling step.

The control of those steps in the wine industry guarantees food safety and helps to improve its competitiveness in the global market.

Keywords: ISO 22 000; Winery, Food Safety Management System

Microbiota evaluation of swine carcasses in the slaughter process

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Over the swine slaughter process exists a potential microbiological contamination of carcasses. This contamination occur due factors that envolve the slaughterhouse environment, utensils, equipments as well as hygiene and manipulation practices by handlers. This study aims the formulation and aplication of a checklist in slaughterhouse; evaluation of microbiota on carcasses surfaces (in several areas of the external and internal surfaces) in two phases of slaughter process (Phase A- after scraping, before evisceration; Phase B- before refrigeration).

Swine carcasses surfaces were delimited with templates (100 cm2) previously sterilized by Ultraviolet light. It was used a non-destructive method with tampon gauze according to ISO procedure. The enumeration of mesophilic microorganisms, Enterobacteriaceae and generic *E.coli* were performed in 120 samples, according to ISO procedures.

No significant differences ($p>0,05$) were observed between the values of mesophilic microorganisms from external surfaces of the two phases (A, B). The obtained average counts were 2,81 log CFU/cm^2 in Phase A and 2,85 log CFU/cm^2 in Phase B. Considering Enterobacteriaceae and generic *E.coli* counts, were observed highly significant differences ($p\leq0,001$), when the two slaughter phases were compared. For these microorganisms were obtained average counts of 0,33 log CFU/cm^2 and 0,07 log CFU/cm^2 in Phase A, and 0,94 log CFU/cm^2 and 0,32 log CFU/cm^2 in Phase B, respectively.

After evisceration, external surfaces presented higher levels of mesophilic microorganisms and Enterobacteriaceae comparatively to the internal surfaces. For mesophilic microorganisms counts, this difference was highly significant ($p\leq0,001$). The average counts for mesophilic microorganisms and Enterobacteriaceae were 2,89 log CFU/cm^2 and 1,09 CFU/cm^2 on external surfaces and 2,14 log CFU/cm^2 and 0,84 log CFU/cm^2 on the internal surfaces. Generic *E.coli* presented higher counts in the internal surfaces (average value 0,53 log CFU/cm^2) than on the external surfaces (average value 0,43 CFU/cm^2).

The results obtained are indicative that exists cross contamination through different phases of carcass preparation. There are evidences of faecal contamination, which proves the necessity of implementation of a training program based on the accomplishment of good hygiene and production practices.

Keywords: Swine, Slaughter process, Slaughterhouse, Microbiological Contamination

The impact of inclusion of hybrid rye in mixture formulas for pig on the level of cadmium and lead in the liver, kidney and muscles

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Introduction: One of the most widespread heavy metals in nature are lead (Pb) and cadmium (Cd). Their common feature is the ability to accumulate and the long duration of biological half-life, which causes chronic toxicity. The biggest threat is their movement in the soil-plant-animal-human trophic chain. Aim: The aim of the study was to determine the impact of inclusion of hybrid rye in feed formulas for pigs nutrition on the content of cadmium (Cd) and lead (Pb) in the kidneys, liver and meat in pigs. Material and methods: Sixteen Polish Landrace pigs of both sexes were used in this study. Pigs were randomly divided into a control (n=8) and an experimental group (n=8) and housed in controlled fattening individual balance cages. Diet of animals from control group contained barley and wheat (50%/50%). Composition of diet for animals from the experimental group (hybrid rye group; HR) contained wheat (20%), barley (20%) and hybrid rye (60%). All animals were fed with the corresponding diet from starting 30 kg until they reach final 100 kg. of body weight. At the end of the experiment the animals were killed in a local slaughterhouse and samples of the liver, kidney and diaphragm muscle were collected for analyses. The content of cadmium and lead was analised using the atomic absorption spectrometry technique. Results: The content of Cd in selected tissues of both groups was the lowest in the diaphragmatic muscle, intermediate in the liver and the highest in the kidneys. When comparing Cd content in tissues samples between groups, pigs fed a mixture with an hybrid rye inclusion of 60% showed that Cd content was lower than that in the control group. For diaphragmatic muscle 0,01±0,003 vs. 0.02±0.01 mg/kg, liver 0,04±0,02 vs. 0,08±0,03 mg/kg, and 0,23±0,11vs. 0,27±0,07 mg/kg, respectively. The content of Pb in analised tissues was the lowest in diaphragmatic muscle, intermediate in kidneys and the highest in the liver. Samples from the group of pigs fed a diet with 60% inclusion of modern rye varieties showed lower Pb content in all tissues. For diaphragmatic muscle 0,11±0,03 vs. 0.24±0.14 mg/kg, liver 0,29±0,12 vs. 0,43±0,23 mg/kg, and 0,16±0,04 vs. 0,29±0,09 mg/kg, respectively. In conclusion, feeding pigs with 60% inclusion of hybrid rye grains results in lower Cd and Pb content in the tissues, which diminish the risk of exposition of humans to these heavy metals.

Keywords: Cereals, Heavy metals transfer, Modern rye varieties, Liver, Kidney, Diaphragmatic muscle

Food safety, new needs, new challenges

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Is our food safe? Nobody can answer this question, but it has never been checked better than today.
Nowadays Food Safety is a growing concern among society. This concern has been considered by governments and they are implementing new legislations in order to ensure the food safety. Every citizen has the right to know how the food he eats is produced, processed, packaged, labelled ans sold.
Every year the number of banned and controlled substances increases with more complex compounds and lower quantitation limits, this is a challenge for analytical instruments manufacturers, because it is necesary to develop new instruments able to perform such complicated analysis of these substances at trace level with a high level of confidence in the obtanied results. In this way Shimadzu is offering the full range of "sate of the art" instruments in order to maintain the highest level of food quality and food safety.

- LCMS systems for the analyisis of mycotoxins, polar pesticides, antibiotics, marine toxins, acrylamide, hormones, corticosteroids, beta agonists.
- GCMS systems for the analysis of dioxins, PCB's, non polar pesticides, VOC's, PAH's, POP's, flavour and off-flavor.
- HPLC systems for the analysis of vitamins, sugars, dyes, aminoacids,
- GC systems for the analysis of FAME's, MOSH/MOAH, cholesterol,
- ICP/MS for the analysis of metals at trace levels

Interfacing Food Engineering and Food Security

Food Safety

Poster Communications

Perceção do consumidor face ao risco de *Listeria monocytogenes* em alimentos prontos a consumir

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Na sociedade atual, as alterações dos estilos de vida conduzem a novas necessidades que se refletem de forma preponderante e direta na alimentação diária do consumidor em geral. Como forma de resposta, a indústria alimentar tem desenvolvido novos produtos alimentares, convenientes e de fácil preparação, por forma a permitir ao consumidor maximizar o seu tempo de lazer. Estes produtos são vulgarmente designados por alimentos prontos a consumir (*Ready-to-Eat* - RTE). Contudo, apesar das vantagens relacionadas com a sua conveniência, estes produtos são uma preocupação em termos de segurança alimentar.
A listeriose é uma infeção causada pela bactéria *Listeria monocytogenes* (*L. monocytogenes*), habitualmente associada ao consumo de alimentos RTE. Apesar de pouco frequente, a infeção pode ser grave, especialmente em imunodeprimidos, grávidas, recém-nascidos e idosos.
Este trabalho teve como principal objetivo avaliar a perceção do consumidor, da Região Oeste de Portugal, face ao risco de *L. monocytogenes* em alimentos RTE. Com este trabalho pretendeu-se compreender: i) a perceção do consumidor face à segurança de alimentos RTE; ii) a perceção do consumidor face ao risco de *L. monocytogenes* em alimentos RTE. Foi realizado um inquérito por questionário aplicado a uma amostra de 457 indivíduos (maioritariamente constituída por indivíduos do sexo feminino, com idades compreendidas entre 31 e 40 e com um nível de escolaridade de nível superior). Os resultados permitiram constatar que a perceção do consumidor relativamente à bactéria *L.monocytogenes* pode ser influenciada pelas características sociodemográficas (género e idade) e pelo historial de intoxicações alimentares. O ato de reflexão sobre os riscos inerentes a um alimento RTE antes de o consumir demonstra-se igualmente como um fator que pode influenciar a perceção de risco do consumidor. Os alimentos RTE mais associados pelo consumidor ao risco de *L. moncytogenes* foram os queijos frescos de pasta mole, patés, frutos do mar refrigerados e produtos à base de carne. Por último, verificou-se que a perceção de risco sobre a *L.monocytogenes* não exerce influencia na decisão de compra de alimentos RTE.
Embora a listeriose seja uma doença comum a nível europeu, conclui-se que esta é subvalorizada. Atendendo à alteração dos hábitos alimentares com preferência por alimentos RTE, ao envelhecimento da população e ao aumento da esperança média de vida dos pacientes imunodeprimidos, torna-se urgente a necessidade de intensificar a informação fornecida ao consumidor sobre a bactéria L. *monocytogenes*.

Keywords: *Listeria monocytogenes*, Alimentos prontos a consumir (RTE), Perceção de risco, Consumidor, Segurança alimentar

Ocorrência de insetos, fungos e ocratoxina a em cafés de diferentes regiões cafeeiras do estado de São Paulo/Brasil

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O intuito deste trabalho foi avaliar a micobiota e a infestação por insetos em seis amostras de café provenientes de quatro regiões cafeeiras do Estado de São Paulo/Brasil referentes à Safra 2018. Os grãos brocados podem indicar a presença de insetos em seu interior, o que resultará em fragmentos de insetos após os processos de torração e moagem. Além do resíduo da infestação nos grãos e outros prejuízos como a queda de frutos, redução de peso das sementes danificadas pelas larvas e perda da qualidade dos grãos e da bebida do café, as perfurações nos grãos podem proporcionar também a penetração de microrganismos.

Um inseto adulto de Rhysopertha dominica e uma pupa de Hypothenemus hampei foram observados na análise de infestação externa dos grãos crus. A infestação interna dos grãos sadios, após a quebra dos grãos e do isolamento das sujidades segundo método 988.16 da AOAC, revelou a presença de ácaro, fragmentos, larva e pupa de H. hampei, todos em baixa quantidade e distribuídos em quatro amostras. Nos grãos brocados não foram observados insetos.

A legislação brasileira, RDC no 14/2014, estabelece o limite de tolerância de até 60 fragmentos de insetos considerados próprios da cultura em 25 gramas de café torrado e moído e preconiza o uso da metodologia 988.16 da AOAC. Todas as amostras atenderam à legislação, uma vez que somente uma amostra apresentou 03 fragmentos de insetos e as demais, ausência.

Os principais fungos detectados nos grãos crus beneficiados foram Penicillium brevicompactum, Fusarium sp., fungos dematiáceos, Cladosporium sp., P. citrinum, Eurotium rubrum e Aspergillus section Circumdati, sendo este último, isolado em quatro amostras. Os níveis de ocratoxina A no café torrado variaram de 0,49 a 2,76 µg/kg. Para a análise de ocratoxina A foi utilizada coluna de imunoafinidade para limpeza e extração da amostra e detecção e quantificação por cromatografia líquida de alta eficiência com detector de fluorescência. As duas amostras que apresentaram níveis maiores de ocratoxina A (2,27 e 2,76µg/Kg) apresentaram infecção por Aspergillus section Circumdati. A legislação brasileira, RDC no 07/2011, estabelece 10 µg/kg como limite de tolerância para ocratoxina A em café torrado e moído.

Os resultados mostraram que os cafés analisados apresentaram baixa contaminação por insetos e fungos e encontram-se seguros para o consumo. Medidas de manejo da cultura estão se mostrando eficazes para o controle da infestação e de fungos após a proibição do uso do inseticida Endosulfan, até então comumente utilizado.

Keywords: Segurança alimentar, Coffea, Insetos, Ocratoxina A, Micobiota, *Hypothenemus hampei*, Infestação

Validação de planos pré-requisito operacionais de uma empresa de distribuição alimentar

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Face à exigência cada vez maior das empresas em garantir a qualidade e segurança dos produtos que comercializa, foi efetuado um estudo a um ponto crítico da cadeia de distribuição: a transição dos produtos frescos e congelados do armazenamento para a expedição. Neste ponto, os produtos são retirados das câmaras de refrigeração/congelação e são colocados no cais de carga, enquanto esperam para serem carregados nas viaturas de expedição. Neste intervalo de tempo, os produtos podem estar sujeitos a temperaturas impróprias de conservação. Para melhor perceber o impacto da exposição a estas temperaturas do cais foi realizado um estudo em que foi avaliada a temperatura superficial e interior de vários produtos durante o tempo que estes permaneciam no cais de carga. As temperaturas foram medidas com sondas de perfuração, ficando uma a cerca de 2 mm de profundidade para a medição das temperaturas superficiais, e outra a 5 cm de profundidade (ou no centro térmico no caso dos produtos de pequena dimensão) para a medição das temperaturas no interior do produto. Os produtos selecionados abrangeram as 3 categorias de produtos perecíveis comercializados pela empresa: dos refrigerados (produtos processados) foram estudados o iogurte e o bacon. Dos frescos (carne crua) foram estudados uma peça de carne de porco inteira e um frango. Dos congelados foram estudados um gelado e um semifrio. O estudo demonstrou que o método atual de trabalho pode provocar a quebra da cadeia de frio nos seguintes produtos: à superfície do iogurte e do bacon na categoria dos refrigerados; à superfície e no interior do frango nos frescos; e à superfície do gelado, na categoria dos congelados. No entanto, apesar de estes produtos terem atingido temperaturas acima do recomendado, o tempo em que estiveram a estas temperaturas, de acordo com a literatura, não foi considerado crítico, não colocando em causa a segurança alimentar. Nos restantes produtos, peça de porco e semifrio, a cadeia de frio não foi quebrada. Neste trabalho foram também elaborados sugestões e procedimentos de trabalho para melhoria da manutenção da cadeia de frio nos produtos em que os procedimentos atuais quebram essa cadeia.

Keywords: Qualidade, Segurança Alimentar, Binómio Tempo/Temperatura, Sistemas de gestão da segurança alimentar, Programas pré-requisito operacionais (PPRO's)

Histamine determination in fishery products: alternative methods for extraction and quantification

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Fish or fishery products, due to their chemical and nutritional richness, have a high potential for deterioration. Many of the substances formed are highly harmful to the consumer, mainly because some compounds are produced due to the failure of adequate storage conditions. Histamine is generated in fish by the decarboxylation of L-histidine, mainly in species of the family *Scombridae* [(1)], when the handling and storage conditions are not appropriate [(2)]. Due to the high allergenic potential of histamine, an effective traceability system is needed to ensure the safety and quality of fish.
The FishBioSensisng project aims to improve food safety and quality of fishery products by developing innovative methodologies using nanotechnology-based sensors to enable a rapid and sensitive detection of microbiological and chemical conditions. It is intended that these sensors have high sensitivity and selectivity, being ideally disposable, portable and easy to use. This will enable real-time monitoring of fish products throughout the food chain.
Currently, the methods described for the extraction of histamine from fish require an initial processing from the muscle using organic solvents (trichloroacetic acid (TCA) or perchloric acid)[(3)]. After this extraction, the presence/absence of histamine can be determined using colorimetric or enzymatic methods, although for its quantification the recommended method is HPLC.
This work is focused on the development of an efficient histamine extraction involving "green" solvents, such as acetic acid, in detriment of TCA or perchloric acid, and two alternative extraction conditions (vortex and ultrasonic bath) were studied. After the choice of species to be analysed (according to the frequency and amount of histamine present - the *Scombridae* family), samples preparation was based on the analytical reference method (NP 4490: 2009 and Regulation (EC) No 1141/2007), as well as through the new developed methods. The production of histamine was firstly evaluated by a qualitative method (thin layer chromatography) and then quantified by HPLC-DAD [(4,5)].
Histamine extractions obtained using acetic acid have shown good normalized results. This work allows a comparison of the developed procedures with the available methodologies, giving a valuable contribution to determine which are the most adequate eco-friendly and sensitive method to perform the quantification of histamine.

Keywords: Histamine, Eco-friendly extraction, Fishery products

The content of cadmium and lead in the soil and in selected cereal grains - soil - seed heavy metals transfer

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Introduction: Cadmium (Cd) and lead (Pb) are naturally present in the earth crust at different quantity and together with the anthropogenic activity can be the source of food contamination. The bioavailability of this metals for the crop plants depends on soil physicochemical features and plants predilection to their increased uptake and organ accumulation and this facilitate their entrance into the food chain. Rye grows well in much poorer soils than those necessary for most of other cereal plants and require less use of pesticides making this cereal more save and attractive as alternative for energy supply in the food and feed ratio. Aim of the study: The aim of the study was to estimate the transfer of Cd and Pb from the soil from 6 different places in Poland (Kondratowice, Walewice, Boguszyn, Wyczechy, Prusim and Marianowo) to 7 cereal species (Population winter rye, winter heterozygote rye, winter wheat, winter triticale, pseudostratified winter barley). Material and methods: The total content of Cd and Pb and their bioavailability was performed using the atomic absorption spectrometry technique (SpektrAA 220Z Varian, Australia). Results: The Cd content in the soil samples was from 14.6 to 157 µg/kg, while bioavailability from 10 to 95%. The highest content of Cd in soil samples (2.8 mg/kg) was found in Prusin but the bioavailability was only 0.7%. The Pb content in soil amounted between 18.8 and 37.4 mg/kg and the bioavailability 11.5 to 40.6%. The Cd content in the grains of modern rye varieties was 5.32 and 9.22 µg/kg, while in wild rye variety it was 21.5 µg/kg. The highest value of Cd (51.5 µg/kg) was found in barley grains. The Pb content was low in the grains of rye, triticale and wheat (71-103 µg/kg), while it was high (209 µg/kg) in barley grains. The transfer of Cd from soil to rye and wheat grains amounted from 20.1 to 48.2%, while 214% for barley. Pb transfer amounted to 1.9, 3.8 and 5.8% for rye, wheat and barley grains, respectively. In conclusion, the transfer of Cd and Pb is the lowest in modern rye varieties and that make these grains safer for human food and animal feeding.

Keywords: Soil, Cereals, Heavy metals transfer, Modern rye varieties

Influencia das boas praticas usadas na produção da ostra em aquacultura na qualidade microbiológica do produto final

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A produção de ostras em aquacultura nos rios Sado e Mira é desenvolvida de acordo comas técnicas tradicionais e artesanais utilizadas desde longa data. A forma como as ostras são manuseadas durante o processo de produção influencia fortemente a qualidade final da ostra produzida. No rio Mira é produzida a ostra portuguesa (*Crassostrea angulata*) e no rio Sado, para além desta, ainda se produz a ostra do pacifico (*Crassostrea gigas* triploides). As duas ostras são semelhantes, no entanto, a formação da concha pode apresentar diferentes rugosidades. A rugosidade natural da *C. angulata* é, normalmente, maior do que a *C. gigas*. A manipulação das ostras colocados sobre estruturas elevadas do sedimento permite que as ostras tenham um contacto reduzido com microrganismos e diminui a rugosidade natural da ostra através movimentação regular dos sacos (manual ou ação da maré). Este processo permite que a concha da ostra no final apresente uma aparência mais atrativa para o consumidor. Para além disso, para garantir a qualidade do produto final, as ostras são previamente depuradas para remover algumas partículas de sedimentos acumuladas sobre a concha. Foram realizadas analises microbiológicas de Coliformes totais, fecais e *E. coli* ao sedimento, à concha e ao animal pelo método dos tubos múltiplos para determinação do nº mais provável. No caso da ostra foram realizadas analises antes e depois da depuração. Das análises realizadas, verificou-se que o nº de microrganismos no sedimento é sempre mais elevado do que na ostra. No sedimento as gamas de Coliformes totais, fecais e *E. coli* variaram entre não detetável para cada um dos parâmetros analisados e de $6{,}8x10^6$, $4{,}1x10^4$ e < 3 NMP/100g (sol. seco), respetivamente, dependendo do local de amostragem. Entre as espécies de ostras, as conchas de *C. angulata* apresentaram valores mais elevados de microrganismos do que a *C. gigas* antes e depois da depuração. No animal, os valores de Coliformes totais, fecais e *E. coli* foram bastante baixos e praticamente inexistes (<3 NMP/100g (sól. seco)) antes e depois da depuração. Este trabalho permitiu verificar a importância do processo de produção (manuseamento) para a qualidade final da ostra, podendo dizer-se que a ostra produzida nos rios Sado e Mira apresenta uma Excelente qualidade em temos microbiológicos para os parâmetros analisados.

Keywords: Ostra, Produção, Controlo, Qualidade, Microbiologia

Avaliação sensorial e nutricional de ostras aquacultura dos rios Sado e Mira

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A ostra é um molusco bivalve, que atinge cerca de 10 cm de comprimento e a sua concha inferior é convexa e a superior chata. Desprovida de pés, fixa-se através de um cimento segregado pelo manto. As proteínas, lípidos, minerais e glicogénio contribuem para o valor nutricional e características sensoriais, sendo que em particular cor e textura podem ser monitorizadas como indicadores da frescura durante o tempo de vida útil. Efectivamente, os atributos de apreciação visual como seja a cor pode ser vital para a aceitação por parte do consumidor, o qual pode associar a cor ao *flavour* e frescura.

O presente trabalho visa a caracterização da ostra *Crassostrea gigas* e *Crassostrea angulata*, de viveiros localizados nos rios Mira e Sado. O período de amostragem compreendeu os meses de maio a outubro de 2018, sendo os meses de maio, junho e julho ideais para o consumo.

Foram analisadas ostras selvagens depuradas e ostras de aquacultura, depuradas prontas para comercialização e consumo humano.

A parte edível foi submetida às análises de composição química e provas sensoriais. Determinou a % de Humidade, % cinza, % de proteína, % de gordura total permitindo o cálculo do valor energético.

A análise sensorial foi executada em 3 sessões por um grupo de provadores (N=30), aos quais foram facultadas amostras depuradas, no sentido de se avaliar descritores de apreciação da aparência, do cheiro, do sabor e da textura, utilizando uma escala de 1 (mínimo de intensidade) a 5 (máximo de intensidade) para cada descritor.

A ostra apresenta baixo valor energético é de fácil digestão. As ostras *C. angulata* e *C. gigas*, em termos gerais, foram bem pontuadas, tendo apresentado as pontuações mais elevadas (4) em certos parâmetros como a cor creme-marfim, o brilho do corpo do bivalve, a limpidez do exsudado, o cheiro a mar, a firmeza, a elasticidade e a suculência. Em particular, na cor creme-marfim verificaram-se diferenças significativas, quer entre as ostras, quer entre os sistemas de natural e de viveiro. Na cor esverdeada-acinzentada também se verificaram diferenças significativas, em particular entre as ostras do meio natural (selvagem) e as criadas em viveiro. Estes atributos denotam o grau de frescura aquando do momento da prova, traduzindo a qualidade do bivalve, quer de meio natural, quer de viveiro.

Keywords: *Crassostrea gigas*, *Crassostrea angulata*, Aquicultura

Are edible seeds microbiologically safe after six-month storage at room temperature?

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In the present work the microbial quality of 35 samples of edible seeds of sesame (5), flaxseed (5), chia (5), pumpkin (5), sunflower (5), flaxseed flour (5) and a mixture of seeds (5), marketed in the Algarve, was studied during a six-month period at room temperature. The microbiological parameters used for the quality evaluation were the aerobic cultivable microorganisms at 30 °C (ACM), filamentous fungi and yeasts (FFY), *Escherichia coli*, *Staphylococcus* coagulase positive and *Salmonella* spp., following the methods described in the ISO standards. The water activity (a_W) was also evaluated during the same period. At the beginning of the study, the samples with a highest average level of ACM were flaxseed ($2.73x10^6$ CFU/g) followed by flaxseed flour ($2.94x10^6$ CFU/ g) and those showing the lowest levels were sunflower ($1.69x10^3$ CFU/g), chia ($2.94x10^4$) and sesame seeds ($4.80x10^4$ CFU/g). The highest average values of FFL were enumerated in flaxseed flour ($3.45x10^4$ CFU/g), flaxseed ($1.63x10^4$ CFU/g) and chia ($4.15x10^3$ UFC/g) while in the other seeds, this microbial group was enumerated in levels below 10^3 CFU/g. The ACM and FFY values counted in the seeds stored at room temperature decreased during a six-month period. There was also a decrease in the a_W values in all seeds except for sesame. At the end of the study, the lowest levels of a_W were measured in sunflower (0.49) and sesame seeds (0.50), while the samples with the highest values were flaxseed (0.55), and flaxseed flour and pumpkin seeds (0.53). These three types of samples were also the ones that presented the highest levels of ACM after six months of storage at room temperature, namely $1.56x10^5$ UFC/g, $2.28x10^4$ UFC/g, $2.69x10^4$ UFC/g, for flaxseed, flaxseed flour and pumpkin seeds, respectively. Staphylococci, *E. coli* and *Salmonella* were not detected in any samples at any time, thus allowing to conclude that they met the European Union's microbiological criteria. However, although the levels of the microbiological parameters studied (cultivable microorganisms and fungi) decreased during the storage period, there may be changes in the nutritional quality and, eventually, the production of mycotoxins, which should be evaluated.

Keywords: Edible seeds, Microbiological quality, Room temperature

Sustainable Innovation in Food Product Design

Plenary lectures

Engineering foods for the elderly

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Over 100 million people in the world are over 80 years old and this figure may triple by 2050. In some countries like Japan and South Korea, this segment will represent almost 15% of the population. Elderly people, particularly the frail ones, have special nutritional demands and experience physiological dysfunctions such as masticatory and swallowing problems, loss of muscular and bone mass, and reduced taste and appetite. Thus, food engineers face a unique opportunity to participate in multidisciplinary endeavors to deliver foods that comply with these requirements and provide a better quality of life for the elderly. The well-being of an aging population encompasses not only physical and physiological aspects but also psychological, emotional and social aspects. This presentation will review current technological efforts and public policies dealing with this pressing issue.

Sustainable Innovation in Food Product Design

Gastronomic Engineering

Oral Communications

Estabilidade sensorial e aceitabilidade global do paté de lapa, *Patella* spp. com adição de medronho, *Arbutus unedo*

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As lapas do género *Patella* são moluscos gastrópodes em crescente utilização na alimentação humana. São produtos ricos em ácidos gordos polinsaturados, cujo consumo tem vindo a substituir os produtos de origem animal terrestre. No entanto, a deterioração da qualidade nutricional e sensorial deste tipo de produtos (decorrente da sua oxidação) é um fator preponderante no momento do seu consumo. Assim, nos últimos anos tem-se verificado um interesse crescente na utilização de antioxidantes naturais de origem vegetal (frutas e vegetais) em detrimento de antioxidantes sintéticos, aquando da elaboração de produtos reestruturados de origem animal (nomeadamente, dos patés). Por outro lado, existe uma relação benéfica entre o consumo de frutas e vegetais, ricos em compostos fenólicos e a prevenção de determinadas doenças. Por conseguinte, e dando seguimento às novas tendências alimentares, assentes em escolhas mais conscientes e saudáveis por parte do consumidor, este trabalho pretendeu desenvolver um novo produto alimentar, o paté elaborado a partir de lapas, com adição do fruto silvestre medronho. Desta forma, foi possível a valorização de matérias-primas de relevante potencial nutricional, permitindo ao consumidor a disponibilidade de um produto inovador e, simultaneamente, uma mais-valia funcional e económica para integrar na sua dieta diária. Para garantir a estabilidade sensorial do produto, assim como validar a preferência do consumidor ao longo do tempo de armazenamento, foi realizada uma caracterização sensorial multivariada, por via de uma análise de componentes principais. Neste sentido, foram produzidas três formulações de patés de lapa: i) com BHT (controlo); ii) com 3% de medronho; iii) com 6% de medronho. Os resultados da avaliação da estabilidade sensorial e da aceitabilidade do consumidor indicaram que, ao fim de 30 dias de armazenamento, o paté com 6% de medronho é fortemente caracterizado pelo padrão de associação que ocorre entre o flavor a mar e a cor. Contudo, a mesma formulação, ao fim dos 90 dias de armazenamento, é fortemente associada à correlação que existe entre o flavor residual e o flavor a frutos silvestres. No que respeita à formulação com 3% de medronho, esta evidencia um padrão de classificação elevado em termos de oleosidade no início do armazenamento, em oposição ao flavor a ranço, textura superficial e cremosidade, cuja a avaliação se evidencia mais elevada findo o período de armazenamento. Com os resultados obtidos foi possível determinar qual a formulação cujo perfil sensorial apresenta uma maior estabilidade e, por conseguinte, com maior potencial de aceitabilidade por parte do consumidor.

Keywords: Lapa, Medronho, Paté, Inovação, Estabilidade sensorial, Análise de componentes principais

Development of pasta type “talharim” added with mechanically deboned meat and tomato powder

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Pasta is among the main foods with high carbohydrate content consumed by Brazilian population, an average per capita of 6.2 kg per year. Its consumption is proportional to the purchasing power of the population. Pasta can be developed with improved nutritional characteristics added with other ingredients such as m*echanically deboned meat* (MDM) from tilapia. Eleven formulations of pasta type “talharim” were developed using surface response, with addition of up to 15% of MDM and 7.5% tomato powder, and the cooking characteristics such as swelling, loss of solids and cooking time were evaluated. Trough statistical analysis were selected three formulations that showed the best results for those parameters. The selected formulations were: F2 (MDM =12.5% and tomato powder = 2.5%), F3 (MDM = 7.5% and tomato powder = 7.5%), F4 (MDM =12.5% and tomato powder = 7.5%) to compare with the standard formulation F0 (MDM = 0% and tomato powder = 0%). For those, MDM was prepared by washing cycles to remove fat and undesirable aromatic compounds; the drying step took place in an oven with forced air circulation for 8 hours at 65ºC. After that, the dried MDM was ground and sieved to provide appropriate particle size. The pasta consisted of a mixture of solid and liquid ingredients into the dough mixing machine. It was found that the addition of MDM and tomato powder promoted the increase of pasta weight of up 220.17% and produce a volume increase of up to 234%. The cooking time ranged from 4.33 to 9.23 min and loss solids from 0.011 to 0.86 %. For the chemical composition, the following results were obtained: proteins ranged from 9.93 to 14.79 %, fat ranged from 8.61 to 11.25 %, ash from 1.80 to 2.78%, moisture from 7.78 to 5.22 % and carbohydrates from 71.74 to 64.52 %. It was observed that with the increasing proportions of MDM and tomato powder in formulations there was an increase in acidity numbers and reducing sugars and a decrease in water activity. In relation to sensorial analysis, there were no significant differences among formulations with respect to the attributes color, flavor, texture and overall acceptance. It can be concluded that the addition of the tomato powder up 7.5% and MDM up to 12,5% into “talharim” dough is a good alternative to improve nutritional values of these foods without affecting its sensory and cooking characteristics.

Keywords: Tilapia (O*reochromis niloticus*), Mechanically deboned meat, Noodles

Development of canned sea urchin gonads: stability and acceptance

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The gonads (or roe) of the echinoid *Paracentrotus lividus* is considered a luxury seafood product, despite being only available during a short period throughout the year. Canned seafood are convenient products thus representing a good solution to valorize sea urchin gonads that are less appealing for fresh consumption and guaranteeing the consumption of this product off season. Therefore, the aims of the present study were: i) to develop canned sea urchin gonads; ii) to test product stability using physicochemical, microbial and sensorial analyses; and iii) evaluate consumer acceptance. Live sea urchins (≥ 50 mm diameter) were steamed and gonads manually removed and placed in 50 g cans, a NaCl solution was added and the remaining volume was filled with water. The cans were sterilized (30 minutes / 121 °C) in industrial conditions. An aging study was carried out, where one group of cans was maintained at ambient temperature (20 °C) and a second group was subjected to 40 °C during 3 months. Results of microbial tests show that stability and commercial sterility was guaranteed. The results of a preliminary acceptance test (62 consumers) evidence a good acceptance of the product (58 % of the responses were in the category like very much). The most appreciated attribute was the "marine flavour", and the less positive attribute was the high salt content. The remaining analysis are still ongoing.

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Keywords: Sensory, Microbiology, pH value, Consumer

Edible insect *Alphitobius diaperinus* as a source of biopeptides

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Entomophagy, the practice of eating insects, is currently an important subject and has been done for centuries around the world. About 2 billion people already consume insects and there are more than 1900 species of edible insects described in literature. Edible insects are a promising protein source for the future generation, due to its sustainability and low environment impact. The main aim of this study was to hydrolyze and analyze the potential of the Buffalo's insect powder (i.e. the edible insect Alphitobius diaperinus), to develop an improved insect powder with biological properties. An enzymatic hydrolysis of the Buffalo's insect powder was performed using two enzymes (Alcalase™ 2.5L and Corolase PP). The selected condition for Alcalase™ 2.5L was a ratio of 1.5% enzyme/substrate (E/S) during 4 h (degree of hydrolysis of 19.5%) and for Corolase PP was a ratio of 3.0% (E/S) during 6 h (degree of hydrolysis of 36.0%). Then, the insect protein hydrolysates were characterized, namely their biological activities such as antioxidant and antihypertensive properties (inhibitory capacity of the enzyme angiotensin-converting, ACE). The antioxidant capacity of hydrolysates was evaluated, and based on the ABTS scavenging assay both conditions showed a similar result (95.0 and 95.7 µmol Trolox Equivalent/g of insect powder). The validation by the ORAC scavenging assay showed that the Corolase PP hydrolysates obtained the highest value (944.8 compared to 825.6 µmol Trolox Equivalent/g of insect powder for Alcalase™ 2.5L). All insect protein hydrolysates were able to inhibit the ACE demonstrating a relevant antihypertensive activity, although, insect protein hydrolysates obtained with Alcalase™ 2.5L showed the best result with an IC50 of 55.5 µg of protein/mL. The enzymatic hydrolysis also increased the amount of small peptides and free amino acids. Therefore, the Buffalo's insect powder demonstrated to be an excellent source of protein and the enzymatic hydrolysis of insect protein can be a feasible process to obtain peptides with bioactive properties, such as antioxidant and antihypertensive activities. The potential of these modified insect powder's to be used as an additive or ingredient in the food industry is huge, with the advantage of using an innovative and sustainable source of protein with biological properties.

Keywords: Edible insect, Protein hydrolysates, Bioactivity

Sustainable Innovation in Food Product Design

Gastronomic Engineering

Poster Communications

Contenido de carotenoides y compuestos fenólicos de flores en el contexto de la alimentación funcional

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Una gran variedad de estudios sugiere que una dieta apropiada y rica en compuestos bioactivos puede contribuir a disminuir el riesgo a desarrollar ciertas enfermedades crónicas no transmisibles. En la actualidad, el uso de flores en la gastronomía va en aumento; sin embargo, poco se conoce sobre los beneficios para la salud que pueden aportar desde un punto de vista dietético. En este contexto, se estudió el contenido de carotenoides y compuestos fenólicos de flores. Las muestras de pétalos se recolectaron del IMGEMA Real Jardín Botánico de Córdoba, vivero "Projardín" de Madrid y "Plantas El Pino" de Sevilla, durante la primavera de 2015. En dichas muestras se evaluaron los parámetros de color del espacio CIELAB y luego los pétalos fueron congelados y liofilizados. El contenido de carotenoides y compuestos fenólicos del material liofilizado fue analizado mediante RRLC y UPLC, respectivamente y el contenido total fue expresado como la suma de los compuestos individuales identificados. De una revisión bibliográfica se dedujo que el 85 % de las especies estudiadas presentaron uso medicinal, 70 % uso gastronómico y en el 10% no se encontró información sobre estos usos. En relación con el color, se observó que la mayoría de las tonalidades de flores podrían agruparse en dos cuadrantes (primero y cuarto) del plano a*b*. Especies como la *Calendula officinalis, Canna indica* y *Tagetes patula* presentaron valores de 4140, 2454 y 2790 µg/g de peso seco (PS) de carotenoides totales, respectivamente; mientras que, *Pelargonium x domesticum, Fuchsia magellanica* y *Punica granatum* mostraron valores de 195, 192 y 179 mg/g PS de compuestos fenólicos totales. La mayoría de especies presentaron importantes concentraciones de violaxantina con concentraciones entre 100 a 1100 µg/g PS, sin embargo, también se evidenció presencia de *cis*-anteraxantina, fitoeno, zeaxantina, luteína epóxido, luteína, β-caroteno y β-criptoxantina. Por otra parte, el mayor número de especies presentó importantes concentraciones de etil galato con concentraciones entre 8 a 57 mg/g PS. No obstante, también se evidenció la presencia de ácido cafeico, ácido clorogénico, crisina, ácido ferúlico, galangina, ácido gálico, kaempferol, ácido *m*-cumárico, ácido *p*-cumárico, miricetina, naringenina, naringina, ácido *p*-hidroxibenzoico, quercetina y quercetrina. Se observó claramente que, especies que presentaron altos contenidos de carotenoides, mostraron bajos contenidos de compuestos fenólicos. Los resultados del presente estudio son de interés para innovar en alimentación y gastronomía mediante la promoción del uso de flores coloridas y con un contenido importante de compuestos bioactivos.

Keywords: Alimento funcional, Compuesto bioactivo, Flores Comestibles

Dried snacks of *Opuntia-ficus indica* (L.) quality and storage capacity

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Opuntia-ficus indica (L.) grown in arid and semi-arid areas, which shows good nutritional and medicinal characteristics although some of them are still subject of study. The objective of the present work was to evaluate the effect of different types of dehydrated fruits (dehydrated slices, dehydrated bars or powder) on the storage ability of 2 ecotypes of *Opuntia-ficus* fruit (Orange and Green). Fruits were prepared without peel and cut in slices or mixed as pulp then dried at 60 ºC. Then slices were stored and pulp prepared as dehydrated bars or powder, then stored at room temperature for 9 months. Periodically, quality measurements of color (CIELab), soluble solids content (ºBrix), titratable acidity, water activity, humidity, total fiber content, ash content, protein content, sugars, phenolics, flavonoids, tanins, betalains and antioxidant activity were determined as well as microbial contamination and taste panels. *Opuntia-ficus indica* dried food products showed very good nutritional quality attributes. The storage temperature had no effect on the quality attributes. With the exception of color, there was no significant differences between cultivars quality. The fruit powder was lower in ºBrix than the fruit bars and higher in bioactive compounds (total phenols, tannins, flavonoids and betalains) and antioxidant activity. Dehydrated sliced fruits, although they are nutritionally rich, do not seem to be commercially viable because they contain too many seeds in the opinion of the taste panel. Fruit Bars are a good source of energy and with good overall acceptance by the taste panel. The quality was maintained for all treatments up to 9 months storage with microbial development under the standard limits.

Keywords: Prickly pear, bBetalains, Phenolic compounds, Antioxidant activity

Development of gastronomic strategies for the application and valorization of new inverse emulsions of vegetable origin

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Strategic innovation must anticipate consumer's acceptance and commercial potential in their design process. The main objective of this study was to develop gastronomic applications with the use of water-in-oil (60 to 65% lipid phase) innovative inverse emulsion prototypes (which preserve expensive/seasonal raw materials and value surplus/regional by-products) (1), appealing to the final consumer. Five emulsions were analyzed - 3 strawberry and pepper (red and yellow) processed differently, with aqueous vegetable phase and 2 mustards with red fruits or beet. Initially a sensory evaluation was carried out (hedonic scale 1-9) with a panel of tasters (9 food professionals) and the online Foodpairing® tool was used. After defining the purpose of each culinary preparation (starter, main course, dessert, for Food Service or domestic end consumer), a recipe set was developed based on previous results and also based on culinary know-how, creative/aesthetic talent of the researcher. A script of the tasting menu was established, and also a test book with parameters of acceptance/purchase intention/marketing/ use potential. Finally, an acceptance test was carried out through a tasting lunch inserted in a pedagogical restaurant for 40 consumers (domestic/food professionals). The panel positively evaluated all emulsions (global appreciation mean values between 5.6 and 7) but none was pointed out as having potential gastronomic use by itself, but always as an ingredient of some composition. There were 33 combinations of ingredients with the Foodpairing® tool, which, cross-checked with the panel of tasters, led to 34 gastronomic compositions further developed in a culinary workshop. At the evaluation lunch, the yellow pepper emulsion was the most appreciated (average value of 7.51) and the strawberry was the least appreciated globally (average value of 6.65). Regarding delicacies developed and presented, all had positive appreciation (average values of global appreciation between 6.87 and 8.65). The intention to purchase varied for each emulsion and the type of delicacy in which it was used: in some it increased by 57%, but in others it decreased, for example by 14%; globally, most tasters would buy the creams analyzed and see potential commercialization in all emulsions.
The opinion of the chefs was quite important and useful, but not always coincident with the ingredients proposed by the application of Foodpairing®. Global innovation implies acceptance by the consumer and education for the gastronomic application, situation evidenced with the consumer test that was realised.

Keywords: Gastronomic applications, Food emulsions, Innovation, Regional vegetable by products

Utilization of flavor network analysis for a new recipe in Marmara Region

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Natural flavor compounds give natural taste and odor characteristics to the food ingredients. According to food pairing theory, ingredients that contain higher number of shared flavor compounds go well together in a dish. In this study, flavor network analysis was used to create a new food in Marmara Region by evaluating the ingredient pairs based on number of shared compounds. A new dessert was formulated with four main ingredients, rice, milk, bean and figs of which six combinations of ingredient pairs shared highest number (39, 38, 31, 18, 16, 14) of flavor compounds. The pair of rice and milk shared 39 flavour compounds which is at least 20% higher than the number exists in the analyzed pairs of 12 ingredients. Among the flavour compounds, eight of them were common in all four ingredients and they interestingly had similar taste and odor characteristics as it showed how flavor pairing worked well in design of new dish. According to 9-point hedonic scale of consumer preference test, 80% of 20 panelists extremely liked the dish. Knowledge on flavour science and food pairing theory will pave the way to create highly preferable food formulations.

Keywords: Network analysis, Flavor compounds, New recipe, Sensory characteristics, Marmara region

Solubilidade proteica de farinhas de trigo e pescado (*Rachycentron canadum*) e seus pães em diferentes extratos

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O trabalho teve como objetivo avaliar e evidenciar as interações que caracterizam a organização estrutural das proteínas em farinhas de trigo, de pescado e de seus pães. Os pães foram elaborados com duas farinhas: a) 100% farinha de trigo (PC); b) mix de 10% de polpa integral de pescado e 90% de farinha de trigo (PE). Ambos foram formulados com 1% de NaCl, 1,5% de fermento biológico seco e 60% de água. A massa foi dividida em pedaços de 250g, fermentada em estufa a 30ºC / 90 minutos e forneada a 200ºC / 20 min em forno elétrico pré-aquecido. Solubilização salina: foram suspensas 0,4g de amostra em 8mL de tampão sódio-fosfato 50mmol.L^{-1} contendo NaCl 0,1 mol.L^{-1}, em pH 7. A suspensão foi agitada por 60 minutos e centrifugada a 10.000g por 20 min/20ºC. Solubilidade em desnaturante (ureia): foram pesados 0,16g de amostra e colocados em 8mL de tampão sódio-fosfato 50mmol.L^{-1}, contendo NaCl 0,1M, ureia 6M, em pH 7. A solução foi agitada por 60 minutos e centrifugada (10.000xg, 20 min, 20ºC). Este teste foi repetido em presença do redutor ditiotreitol (DTT) 10mmol.L^{-1}. A quantidade de proteínas nos diferentes extratos foi determinada em triplicata, empregando o método colorimétrico Bradford. Alíquotas de amostras (0,1mL) foram adicionadas a 5mL de reativo de Bradford. Agitou-se em Vortex e após 10 min determinou-se a absorbância a 595nm. A quantificação proteica foi através de curva-padrão de BSA (albumina do soro bovino). Observou-se que metade das proteínas extraídas foram albuminas e globulinas, solubilizadas através do tampão salino. A farinha deste pescado é constituída por alta quantidade de proteínas, porém, metade dessa concentração não foi solubilizada através dos meios utilizados, sugerindo a presença de proteínas das fibras musculares (polímeros insolúveis). Observou-se redução média de 20% na solubilização das proteínas presentes nos PE em solução salina, em comparação ao PC. Quando utilizada a ureia, a extração de proteínas nos PE (com farinha integral) foi superior a 76%, chegando a 93% quando utilizada a farinha desengordurada, o que evidencia a presença de complexos agregados proteicos, e ratificado pela análise nas farinhas. O aumento na quantidade de proteínas solubilizadas através da adição de ureia e DTT ao tampão de extração evidencia a importância tanto das interações hidrofóbicas quanto das ligações dissulfídicas na estabilidade dos agregados proteicos.

Keywords: Cobia, Pão enriquecido, Farinha de pescado, Solubilidade proteica

Desarrollo de un paté vegano funcional a partir del hongo *Pleurotus ostreatus* con agregado de extracto de orégano (*Origanum vulgare*) y evaluación de su vida útil

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Actualmente existe un fuerte movimiento por el consumo de alimentos naturales reducidos en grasa, sal y azúcar agregado. Pleurotus ostreatus es el tercer hongo comestible más producido a nivel mundial, posee actividad hipoglucémica antitrombótica, reduce la presión sanguínea y el colesterol, entre otras. La utilización de éste como base para la formulación de paté, brinda una alternativa al tradicional a base de carne.
Debido a sus propiedades antioxidantes, los conservantes naturales obtenidos a partir de especias como el orégano (Origanum vulgare) pueden aumentar la vida útil de un alimento, relacionado con la presencia de compuestos bioactivos.
El objetivo de este trabajo fue desarrollar un paté vegano funcional por agregado de compuestos bioactivos de orégano, optimizar las condiciones de su preparación, estudiar su estabilidad fisicoquímica, microbiológica y sus propiedades antioxidantes.
Se optimizaron las condiciones de escaldado del hongo (ácido: acético, cítrico y láctico y su concentración) y la relación masa de orégano/volumen de solución, en función de obtener un producto seguro (pH <4,5) y sensorialmente aceptable. Se estudió la estabilidad fisicoquímica (color y pH) y microbiológica (recuento total de: coliformes totales, mesófilos aerobios, mohos y levaduras) de un paté elaborado con agregado de extracto de orégano (PO) y otro obtenido en iguales condiciones sin el extracto (PB), con una periodicidad de treinta días durante seis meses de almacenando en lugar fresco y protegido de la luz.
El color y pH fueron estables durante el almacenamiento. Los parámetros microbiológicos se encontraron por debajo de límites establecidos para productos similares. Los valores obtenidos a 120 días fueron: coliformes totales <100 ufc y mohos y levaduras <100 ufc para ambos patés y mesófilos aerobios 3.102 ufc para PO y 2.102 para PB).
Se determinó la actividad antioxidante frente a radicales ABTS (Re et al. 1999) y el contenido de polifenoles totales por el método de Folin-Ciocalteu (Singleton et al. 1999). Se observó un aumento en la capacidad antioxidante del PO con respecto a PB de 0,8 a 1,7 meq trolox/g muestra, pudiendo estar asociado al aumento significativo en el contenido de polifenoles totales debido al extracto de orégano, aumentando de 142 (PB) a 366 (PO) mg de ac. Gálico/g de muestra.
En base a los resultados obtenidos, se puede afirmar que el paté de hongo Pleurotus ostreatus desarrollado con extracto de orégano resulta una alternativa de producto vegano funcional con estabilidad fisicoquímica y microbiológica almacenándose a temperatura ambiente y oscuridad durante seis meses.

Keywords: Pleurotus ostreatus, Paté vegano, Alimento funcional, Vida útil

Elaboração e caracterização de iogurte de leite de búfala enriquecido com a farinha da banana verde integral (*Musa paradisíaca*)

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O leite bubalino possui altos percentuais de gordura, proteína e minerais, quando comparado com leite de outras espécies de mamíferos. O iogurte quando elaborado com este tipo de leite exibe uma viscosidade e uma textura mais firme não necessitando de adições de substâncias espessantes, além disso quando aliado ao incremente de culturas probióticas, este produto exibe uma capacidade funcional. Os mesmos ainda podem ser saborizados e enriquecidos com frutas e cereais, logo este trabalho tem como propósito elaborar iogurte deleite de búfala enriquecido com farinha da banana verde integral (casca e polpa), como uma nova alternativa de apreciação desse produto, aumentando seu aporte nutricional, além de estimular a inovação no setor lácteo, através de análises físico-químicas e centesimais. Foram elaboradas cinco formulações distintas: Controle com 0% de farinha, I1 com 1,5% de farinhada casca da banana verde (FCBV); I2 com 1,0% de FCBV e 0,5% de farinha da polpa da banana verde (FPBV); I3 com 0,5% de FCBV e 1,0% de FPBV; I4 com 1,5 % de FPBV. O teor de fibras encontrado nas amostras de iogurte fora de 0,346 ± 0,337%, 1,227 ± 0,064%, 0,892 ± 0,570%, 0,724 ± 0,474% e 0,502 ± 0,104% para as formulações C, I1, I2, I3 e I4, respectivamente, não havendo diferença estatísticas entres elas. Observa-se que ouve um acréscimo de 71,8% entre as formulações C e I1; e de 31,07% entre a que não contêm farinha (controle) e a que possui apenas FPBV (I4); resultados estes bastantes expressivos, podendo ser explicado pela quantidade elevada de fibras contidas na FCBV valor este superior ao da FPBV, dessa forma as farinhas oferecem um aporte considerável de fibras ao produto. Com a incorporação da farinha integral da banana verde, as formulações I1, I2, I3 e I4 obtiveram um incremento de fibras muito maior do que o estipulado pela legislação brasileira, podendo estes iogurtes serem rotulados como produtos enriquecidos. Diante dos resultados pode-se concluir que a FIBV agregou valor ao produto, aumento seu aporte nutricional em seus teores de fibra, além disso a utilização do leite de búfala na elaboração do iogurte auxiliou a dar corpo ao produto final, o qual possui grandes possibilidades de inserção no mercado consumidor com fabricação em escala industrial.

Keywords: Leite de Búfala, Iogurte, Farinha integral da banana verde

Sustainable Innovation in Food Product Design

Plant Based Alternatives to Meat and Dairy

Oral Communications

Desenvolvimento de *fishburguer* enriquecido com fibra

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Diante do cenário atual, onde há uma demanda por alimentos de fácil preparo e com bons teores nutritivos, o pescado tornou-se uma boa opção para a produção do hambúrguer de peixe (*fishburguer*), uma vez que a pesca é uma atividade econômica e socialmente importante em países costeiros, sendo uma boa fonte de nutrientes e proteínas de alta qualidade. Observa-se também uma crescente tendência no mercado para o consumo de alimentos funcionais, destacando-se neste contexto os alimentos enriquecidos com fibras, ácidos graxos poliinsaturados, óleos essenciais, vitaminas, minerais, antioxidantes como os carotenóides, flavonoides e antocianinas, e que podem contribuir para a prevenção de doenças cardiovasculares, cancerígenas, entre outras. O consumo de fibra na dieta humana tem um impacto considerável, traduzindo-se este em efeitos benéficos para a saúde, sendo a chia uma excelente fonte de fibra dietética com características benéficas para o metabolismo humano. O trabalho teve como objetivo formular um hambúrguer de peixe com elevado teor de fibra. Para isto, foram elaboradas quatro formulações de hambúrguer de sardinha contendo amido, óleo de soja e farinha de chia, respectivamente, nas seguintes proporções (p/p): Padrão (5%, 2% e 0%); A (0%, 2% e 5%); B (5%, 0% e 2%); C (0%, 0% e 7%). Foram realizadas análises fisico-químicas nas amostras elaboradas, e testes de cocção, como perda de peso na cocção (PPC), redução de diâmetro (RD) e rendimento da cocção (RC) após trinta, sessenta e noventa dias após congelamento, para todas as formulações. Entre as quatro formulações elaboradas, a formulação C apresentou os melhores resultados com teores de fibra de 2%, proteína de 19% e os menores de lipídeos, 2%. Ao comparar todas as quatro formulações produzidas com hambúrgueres comerciais, feitos a partir da carne bovina e de frango, os mesmos apresentaram em média 86% menos gordura, 50% menos calorias e 6% a mais de proteína. Ao realizar teste de cocção para diferentes dias de armazenamento refrigerado dos hambúrgueres, verificou-se que a adição da farinha de chia provoca uma redução na perda de peso na cocção, no diâmetro e no rendimento da cocção de cerca de 50% já após 60 dias, mantendo o mesmo comportamento quando avaliado após 90 dias. Desta forma, conseguiu-se formular um *fishburguer* com alto teor de fibra e baixo valor calórico, apresentando-se uma alternativa saudável para o consumo de novos produtos.

Keywords: Pescado, Chia, Alimento funcional

Development, sensorial analisys and proximal composition of a chocolate cake enriched with *Spirulina* sp. LEB 18 for children's school meal in Brazil

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Microalga contain bioactive compounds that can suplements population nutrition and energy needs. Among these microorganisms, some are certified as GRAS (Generally Recognized as Safe) as *Spirulina* genre. Microalgae of this genre are known by it's protein rich biomass (40% to 75%). Strain LEB 18 generally presented larger amounts of essential amino acids than the theoretical quantities recommended in dietary protein for children. In this study we evaluated a chocolat cake mixture enriched with *Spirulina* sp. LEB 18 composition and the sensory acceptance by school children. The product obtained was evaluated for proteins (Kjeldahl), lipids (soxhlet), ash and moisture (Association of Official Analytical Chemists – AOAC) and carbohydrate (by difference) content. Sensory analysis was performed by 70 children aged 7 to 12 years on a facial hedonistic scale of 5 points. The best cake mix formulation obtained contain 3% *Spirulina*. The cake mixture had a 40% increase in protein content (21.48% w w^{-1}). The average score attributed by sensory analysis performed by the children was 4.86 and the acceptability index was 88.6%. To be accepted a product must reach index equal to or greater than 70%, indicating a good acceptability of the formulated cake. *Spirulina* enrichment in the diet contributes to more nutritive feeding in school-age children, and may reduce malnutrition rates in Brazil.

Keywords: Superfood, Nutrition, Microalga

Engineering properties of W/O-high internal phase emulsions (HIPEs) and O/W emulsion manufactured with lecithin-PGPR mixture: role of process and emulsifiers interaction

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High internal phase emulsions (HIPEs) are systems with interesting texture that could be applied to reduce trans- and/or saturated fat content in food products. However, it is always a challenge manufacturing and stabilizing emulsions with high water content. In addition, strategies aiming at synthetic or semi-synthetic ingredients replacement by natural alternatives for food formulations has been pursuit. Lecithin is a natural ubiquitous emulsifier used in food, pharmaceutical and cosmetic applications. In this regard, water-in-oil (W/O) HIPEs stabilized by a mixture of polyglycerol polyricinoleate (PGPR) and lecithin (LEC) as emulsifiers were studied by ranging the components concentration. Coarse (W/O) HIPEs were produced by adding the dispersed phase dropwise into continuous phase using a rotor-stator device. Despite of the difficult to incorporate a high-volume fraction of dispersed phase (75% w/w), HIPEs were formed by the application of adequate mechanical process and mixture of emulsifiers. At fixed total amount of emulsifier (2 % w/w), W/O HIPEs stabilized with LEC:PGPR ratios of 0.5:1.5 and 1.0:1.0 showed similar droplet size with a better kinetic stability compared to the emulsions containing only PGPR. These results indicated a possible synergistic interaction between LEC and PGPR, which was also confirmed by dynamic interfacial tension profile and interfacial dilational rheology. The presence of lecithin at certain ratios could increase the dilational modulus, strengthening the interfacial film stabilized by PGPR because of the reinforcement promoted by lecithin molecules. In order to evaluate the effect of another process, coarse (W/O) HIPEs were subsequently subjected to high-pressure homogenization and eventually oil-in-water (O/W) fine emulsions were formed. Confocal microscopy confirmed the phases inversion attributed to high input of energy leading to the formation of O/W emulsions. All coarse W/O HIPEs showed shear thinning behaviour and high viscosity at low shear rate whereas O/W fine emulsions showed low viscosity and Newtonian behaviour. The increase of lecithin content in emulsifier mixture led to more stable O/W emulsions. Conversely, more stable W/O-HIPEs were produced by lecithin and PGPR mixtures ratio of 0.5:1 and 1.0:1.0. These systems could be applied in a range of food products with reduced fat level still keeping the desired texture properties. Moreover, tailored W/O-HIPEs and O/W emulsions would fulfil the consumers demand by healthy and "label-friendly" products.

Keywords: Food emulsion, Natural emulsifier, Soybean lecithin, Phases inversion

Electrostatic complexation of pea protein with xanthan and Arabic gum and their stabilizing properties

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Pea protein (PP) is interesting for food industry due to their functional and nutritional properties, besides to be one of the most produced vegetal proteins in the world. However, the PP emulsifying capacity is low, when compared with animal proteins, limiting their application. For this reason, the aim of this work was to study the electrostatic complexation of PP with xanthan gum (XG) and gum Arabic (GA) with the purpose to produce emulsions with higher stability. Firstly, the strength of the electrostatic interaction between the PP and the gums were determined by analysis of ζ-potential and polymer ratios PP:XG and PP:GA were fixed. The polymeric ratios PP:XG (1.2:1, 4.5:1, 7.8:1 and 11.1:1) and PP:GA (2:1, 5:1, 8:1 e 1:2) were studied in different pH values (2.0 – 3.5) and the ζ-potential of complexes were determined. Complexes with higher complexation yield were used to produce oil in water emulsions with 40% sunflower oil and 60% of complex dispersion (2.0% w/w) using a rotor-stator device (IKA®-Werke GmbH & Co Germany) at 11.000 rpm by 6 min. The emulsions stability was evaluated from creaming index (CI%) in 24h, size and droplet size distribution and fluorescence microscopy. PP:XG complexes obtained at 4.5:1 pH 2.5, 7.8:1 pH 2.75 and 11.1:1 pH 2.75 and PE:GA complexes obtained at 2:1 pH 2.75, 5:1 pH 3.0, 8:1 pH 3.0 e 1:2 pH 2.25 presented the higher complexation yield. Emulsions made with PP:XG presented the higher stability (CI between 15.0 – 22.5%), followed by PP:GA emulsions (CI between 22.0 – 28.5%). Both, with a value of CI% lower than that presented by emulsions stabilized only with PP (CI between 36.0 – 40.0%). These results are attributed to the synergy between the PP emulsifying property and the steric stability offered by the gums. The emulsions with complex presented a monomodal behavior with a mean droplet diameter between 12.99 – 19.00 µm, similar to observed to PP-only emulsion. Fluorescence micrographs confirm the oil-in-water emulsions formation with PP presence in the droplets interface. The complex obtained with PP:XG 4.5:1 at pH 2.5 showed the lowest CI-value (15.0 ± 0.6%) after 24h and did not present a phase separation in the first 30 min of observation, being the best system evaluated in this work.

Keywords: Pulse proteins, Emulsion stability, Emulsifying property, Steric stability

Efeito da substituição parcial da proteína de leite por proteínas vegetais na textura de requeijão cremoso

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A indústria de alimentos procura constantes inovações de formulações para atender públicos específicos, melhorar características sensoriais e nutricionais, reduzir custos, etc. No contexto atual, a substituição de ingredientes de origem animal pelos de origem vegetal é importante de ser avaliada devido a: implicações em custos, classificação dos produtos, atendimento a públicos específicos e/ou alterações sensoriais, nutricionais e de segurança. O objetivo deste estudo foi avaliar as alterações de textura oriundas da substituição parcial da proteína de leite em requeijão cremoso por proteínas vegetais (fava, ervilha e lentilha). Comparou-se uma formulação base (contendo somente proteína láctea) com 12 formulações contendo proteínas de fava, ervilha e lentilha. A formulação base foi produzida com água mineral, massa coagulada de queijo, creme de leite, proteína láctea (77% de proteína), leite desnatado em pó, cloreto de sódio, sorbato de potássio, sal fundente, aroma de requeijão, acidulante ácido láctico e amido de milho modificado. Os ingredientes foram utilizados para obter produto final com 9-10% de proteína, 24-26% de gordura e 3- 5% de carboidratos. Nas formulações com ingrediente vegetal, fez-se a substituição de 25% da proteína láctea pelas proteínas vegetais através de um delineamento fatorial de mistura para avaliar os efeitos das concentrações das proteínas de fava, ervilha e lentilha. Os requeijões foram obtidos através das seguintes etapas: (1)moagem a frio da massa de queijo em equipamento Geiger por 3 min, (2) homogeneização da massa com sal fundante e NaCl por 1 minuto, (3) adição de metade da água e do creme de leite, (4) primeiro cozimento sob agitação por 5 min a 70-75°C, (5) adição dos demais ingredientes, (6) aquecimento da massa a 90°C por 3 min, (7) envase a quente e (8) resfriamento até temperatura ambiente e estocagem a 5°C. O perfil de textura (firmeza, tensão de cisalhamento, espalhabilidade e adesividade) dos requeijões foi avaliado em texturômetro. Houve aumento de todos os parâmetros (15,5-74,9% da firmeza; 34,6-99,7% da tensão de cisalhamento; 5,3-49,2% da espalhabilidade e 18,1-93,7% da adesividade). A proteína de fava provocou maior aumento das propriedades e a proteína de ervilha, os menores aumentos. Os requeijões presente no mercado brasileiro apresentam perfis de textura muito variáveis, o que possibilita inferir que existe potencial a ser explorado no uso das proteínas vegetais investigadas, tanto em relação a origem como em relação a concentração, de modo a se obter formulações com menor custo e sensorialmente aceitas pelos consumidores.

Keywords: Requeijão, Textura, Proteína vegetal, Processamento de alimentos

Development and physical-chemical characterization of vegetable food based on baru almond (*Dipteryxalata*vog.) to vegan public

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With regard to the search for differentiated foods, there are several categories of new products that stand out for attending to public that present increasingly specific needs. In this respect, it is mentioned the vegan public, that although a growing increase in the number of people is observed, it is observed that the products available to this public are scarce and the existing ones, for the most part, present low nutritional values. An alternative to this problem is the incorporation of nutritionally rich food matrices to these products and the almond of baru (*Dipteryxalata*Vog.) As a healthy and safe option is pointed out. The present research had as objective to perform the physical-chemical characterization of two formulations of baru almond based on moisture, lipids, ashes, proteins, dietary fiber, non-nitrogen extract and total caloric value, (AV1 - added pepper and oregano and AV2 - added onion and garlic). Among the main results obtained, the formulations showed high concentrations of lipids (AV1 = 11% and AV2 = 9%), ashes (AV1 = 3.4% and AV2 = 4%), proteins % and AV2 = 5%) and dietary fibers (AV1 = 20.44% and AV2 = 24.4%). These results demonstrate that the developed formulations present superiority in the physico-chemical composition and it is concluded that it is feasible to use baru almond and food condiments in new products aimed at the vegan public.

Keywords: Biome Cerrado, Veganism, Cheeseanalogue

Sustainable Innovation in Food Product Design

Plant Based Alternatives to Meat and Dairy

Poster Communications

Evaluation of physical and sensory properties of ice creams, with fat and sugar reduction, and protein increase

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Background: The increase in number of the elderly population sets important challenges in food development directed to this group's nutritional needs, food that also need to meet sensory desirable characteristics. Objective: The aim of this study was to evaluate the physical and sensory characteristics of ice creams nutritionally adequate for elders in terms of fat, sugar and protein, and a standard ice cream. Methods: Four ice cream formulations were elaborated; a standard formula with 14.14% of sucrose, 3.9% of protein (from skimmed milk powder and whey protein concentrate) and 7.5% of vegetable shortening; and three ice cream formulations with sugar reduction (substituting sucrose for inverted sugar [fructose/glucose – F/G]), protein enrichment (from skimmed milk powder), and fat reduction (substitution with long-chain inulin in a 1:0.7 fat:inulin proportion). Considering F1 (7% F/G, 5% protein and 0% fat), F2 (10.6% F/G, 7.5% protein and 1.75% fat) and F3 (10.6% F/G, 10% protein, 1.75% fat). Rheological parameters were analyzed; for large deformations: consistency index (K), flow behavior index (n), thixotropy (%Tx), and for small deformations: storage (G') and loss (G'') moduli and phase displacement angle (δ). Overrun was also measured, and sensory profiles by a multidimensional approach were performed to all samples, evaluating texture, flavor and odor attributes. Results: The sensory consistency and rheological parameters values (at both large and small deformations) increased when dairy protein levels also raised, when comparing samples F2 and F3 to the standard. Regarding to the sugar reduction, a 50% reduction (F1: 7% f/g,) presented less sweet flavor than the standard, while a 25% reduction (F2, F3: 10,6% F/G) was sweeter instead. Additionally, sugar substitution did not affect the rheological properties of sample F1 (50% reduction) when compared to the standard. In terms of fat, a complete substitution of vegetable fat for long-chain inulin favored air incorporation (overrun) in F1, with respect to the other three samples; however, it had the least sensory quality. Conclusions: Protein increase in ice cream samples leads to increased rheological values and product palatability. Partial fat substitution is effective since negative sensory attributes are not perceived. Sugar reduction, substituting sucrose for inverted sugar affects flavor attributes, however it does not affect texture attributes.

Keywords: Ice cream, Older adult, Inulin, Rheology, Sensory analysis

Snack bars enriched with microalga: Sensory evaluation by schoolchildren

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Diets with low concentrations of nutrients such as protein and minerals contribute to the increase in diseases, besides affecting the growth and development of children. Snack bars are considered ready-to-eat food increasingly present in the diet of children. Studies have been carried out aiming for the introduction of bioactive compounds into formulations of this product to provide healthier food for the consumers. In this context, the microalga *Spirulina*, which has a high concentration of nutrients and biocompounds has been used to improve the nutritional health of the population. Therefore, this study aimed to evaluate the influence of this microalga on the sensory acceptance of snack bars by schoolchildren. Snack bars enriched with 2% (SP2) and 6% (SP6) of *Spirulina* were prepared. A control bar was elaborated without *Spirulina* addition (C). The sensory evaluation was performed with fifty children aged between 8 and 13 after obtaining the consent from children's parents and the head teacher. Children evaluated the freshly prepared snack bars concerning their attributes (appearance, flavor, and taste). The analysis was performed using a 5-point facial scale with verbal anchors (1 = dislike a lot, 2 = dislike, 3 = neither like nor dislike, 4 = like, 5 = like a lot). Data were analyzed using analysis of variance (ANOVA), and the Tukey test was used to determine the differences between the means at 95%. The means of the attribute appearance of samples C and SP6 was 4.2±0.9 and 3.9±0.8, respectively, without significant differences ($p > 0.05$). These results were higher scores than the mean obtained for sample SP2 (3.7±0.8), which demonstrates that the children visually accepted the addition of higher concentrations of *Spirulina* (6%). The snack bars C, SP2, and SP6 received scores of 3.9±1.0, 3.9±0.8 and 4.0±0.8, respectively for the flavor, without showing a significant difference ($p > 0.05$) between the samples. Regarding the taste, the means were 4.4±0.9, 4.2±0.9 and 4.1±1.0 for C, SP2 and SP6, respectively and were considered high, since it remained between "like" and "like a lot," without significant differences between the samples ($p > 0.05$). We concluded that *Spirulina* could be used as a nutritious ingredient in snack bars without sensorial characteristics change, therefore being a promising alternative for schoolchildren feeding.

Keywords: Cereal bars, *Spirulina,* Ready-to-eat food, Schoolchildren feeding

Análise sensorial de bebida láctea probiótica (*Lactobacillus casei*) suplementada com extrato hidrossolúvel de aveia

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A crescente busca de novos produtos combinando lácteos fermentados com frutas e cereais, que sejam nutritivos e benéficos para a saúde humana, constituem o foco de investimentos da indústria de alimentos, além de ser uma tendência no mundo inteiro. Entre os cereais destaca-se a aveia pela sua composição em ácidos graxos insaturados, teor proteico, fibras alimentares, compostos antioxidantes, consumida diariamente pelos consumidores por estar presente em muitos produtos. No caso de bebida láctea probiótica, a combinação de aveia com lácteos poderá melhorar as propriedades funcionais de um produto de consumo habitual de grande aceitação pelos consumidores. Assim, o objetivo deste estudo foi avaliar a aceitabilidade sensorial e intenção de compra de bebida láctea probiótica (*Lactobacillus casei*) com adição de extrato hidrossolúvel de aveia. A avaliação da análise sensorial foi realizada através da aceitabilidade do produto pelo teste de escala hedônica de 9 pontos. Também foi indagado aos participantes a intenção de compra utilizando uma escala verbal e numérica de 5 pontos. Foram avaliados os atributos sensoriais como cor, odor, textura, sabor e aspecto global do produto. Os testes sensoriais foram realizados no Laboratório de Análise Sensorial da Universidade Federal de Pelotas, em cabines individuais, com iluminação por luz branca e por avaliadores não treinados, onde todos os indivíduos receberam um Termo de Consentimento Livre e Esclarecido (TCLE) antes de participar da análise. Dentre os avaliadores participantes, 56% eram mulheres e 44% homens, não sendo considerada a faixa etária. Com relação a avaliação do produto, a aceitação quanto ao aspecto global atingiu a média de 7,6, correspondendo a “gostei ligeiramente” na escala hedônica. Com relação a intenção de compra foi observado que a média correspondeu a 1,7 na escala, indicando que para os avaliadores “certamente comprariam e possivelmente comprariam”, sendo um resultado bastante satisfatório, representando um potencial mercadológico para o produto. Assim, conclui-se que a bebida láctea probiótica suplementada com extrato hidrossolúvel de aveia foi aceita sensorialmente pelos avaliadores e ainda, a maioria compraria frequentemente o produto.

Keywords: *Avena sativa* L., Bebida fermentada, Teste afetivo

Elaboração e caracterização de cookie sem glúten a partir da farinha de pupunha (*Bactris gasipaes* Kunth)

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A exclusão do glúten da dieta tem sido um grande desafio para os profissionais da indústria de alimentos, pois produtos que fazem parte dos hábitos alimentares da população são normalmente elaborados a partir de farinha de trigo, por isso este trabalho tem como objetivo a elaboração de um cookie com substituição total da farinha de trigo pela de pupunha. A pupunha (*Bactris gasipaes* Kunth) é um fruto nativo da Amazônia que possui alto valor nutritivo, com destaque aos elevados teores de β-caroteno. No desenvolvimento da formulação do cookie, foram utilizados os ingredientes: farinha de pupunha, açúcar, gordura vegetal hidrogenada, água, aveia, sal, bicarbonato de sódio e castanha da Amazônia. Este trabalho teve como objetivo avaliar as características físicas, químicas, sensoriais e teor de β-caroteno do cookie sem glúten, elaborado a partir da farinha de pupunha. A umidade foi determinada em estufa a 105ºC até obtenção de peso constante. Os lipídios foram extraídos em aparelho Soxhlet. As proteínas foram determinadas pelo método de micro-Kjeldahl, utilizando o valor de 6,25 como fator de conversão. As cinzas foram determinadas em forno mufla a 550°C. O teor de fibra bruta foi obtido no aparelho Determinador de Fibra, modelo TE-149, marca Tecnal. Os carboidratos totais foram calculados por diferença. O valor calórico da amostra foi calculado segundo a Tabela Brasileira de Composição de Alimentos. O teor de β-caroteno foi determinado por HPLC, de marca Shimadzu, coluna C18, com detector UV-VIS a 450 nm. Todas as análises foram realizadas em triplicata. A análise sensorial foi realizada por uma equipe de 60 degustadores com a utilização de uma escala hedônica balanceada com nove pontos e cálculo do índice de aceitabilidade (I.A.%), o qual foi obtido pela multiplicação da média obtida por 100 e dividido pela maior nota observada. Os resultados da composição centesimal obtidos foram em médios 5,3601% ±0,0076 para umidade, 23,4567% ±0,8505 para lipídeos, 0,9606% ±0,0242 para proteínas, 1,5043% ±0,0160 para cinzas, 2,3976% ±0,6166 de fibra bruta, 66,2961% ±1,4785 para carboidratos e 480,13 Kcal/g de energia. Para o teor de β-caroteno obtivemos média de 12,1169μg/100g ±0,2381 este valor corresponde a 11% da ingestão diária recomendada para o indivíduo adulto. O índice de aceitabilidade obtido correspondeu a 83%. Assim podemos concluir que o biscoito de pupunha tipo cookie, apresenta excelentes características importantes para a nutrição, tais como ser isento de glúten, ter elevado teor de β-caroteno e alto índice de aceitabilidade.

Keywords: Pupunha, Cookie, Beta-caroteno, Glúten

Sustainable Innovation in Food Product Design

Valorisation of By-Products from the Food Industry

Oral Communications

Uso integral de la semilla de sésamo negro (*Sesamum indicum L.*)

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El sésamo es una importante oleaginosa dado su alto contenido de lípidos. Contiene 40-50% de lípidos (principalmente lípidos poli-insaturados), 20-25% de proteínas, 20-25% de carbohidratos y 5-6% de cenizas. Debido a su contenido en proteínas, resulta interesante estudiar las propiedades tecnofuncionales de las mismas para poder darle valor agregado, ya que las semillas de sésamo son usadas principalmente para extraer aceites del tipo gourmet. Por lo cual, en este trabajo se estudió el rendimiento de extracción del aceite por fluidos supercríticos (SC-CO_2) y por el método convencional de Soxhlet en semillas de sésamo negro y del residuo desgrasado resultante se obtuvieron concentrados proteicos a los cuales se evaluó la solubilidad proteica. La extracción por método de Soxhlet se realizó utilizando hexano como solvente. Para realizar las extracciones supercríticas se utilizó un extractor de laboratorio con una capacidad de 50 mL, el cual se operó a presiones de 200 o 400bar, temperatura de 40°C, flujo constante de 0,5 sL/min CO_2 promedio y etanol (EtOH) como co-solvente a 0 o 10% respecto al CO_2. Los rendimientos de extracción obtenidos fueron de 41,9% (Soxhlet), 27,6% (Sc-CO_2, 200bar, 0% EtOH), 36,3% (Sc-CO_2, 200bar, 10% EtOH), 29,5% (Sc-CO_2, 400bar, 0 % EtOH) y 42,6% (Sc-CO_2, 400bar, 10% EtOH). Por lo cual se seleccionaron los residuos de Soxhlet (HSox) por ser un método convencional y la extracción supercrítica de mayor rendimiento (HSc-CO_2-EtOH) por ser una tecnología novedosa y más verde, para obtener y estudiar los concentrados proteicos. Los residuos se desolventizaron y se determinó contenido proteico total siendo de aproximadamente 45% para ambos, la solubilidad proteica a pH 9,0 determinada por el método del ácido bicinconínico fue similar (13,2% para HSox y 11,1% para HSc-CO_2-EtOH). Se realizó el análisis por calorimetría diferencial de barrido de ambos residuos presentando los termogramas un pico endotérmico correspondiente a la desnaturalización proteica a 110,8°C y una entalpía de desnaturalización levemente mayor para HSc-CO_2-EtOH. Los concentrados proteicos (CSox y CSc-CO_2-EtOH), se obtuvieron por solublización a pH 9,0 y posterior precipitación a pH 4,5 de ambos residuos, luego se dispersaron a pH 9,0 y liofilizaron para su conservación. La solubilidad proteica a pH 8,0 fue similar para ambos concentrados (alrededor del 36%). Con los mismos se realizaron emulsiones aceite-agua. No existieron grandes diferencias entre los concentrados de ambas tecnologías (solubilidad y propiedades emulsionantes). Por lo cual, sería adecuado utilizar la extracción supercrítica, por ser una tecnología más amigable con el medio ambiente.

Keywords: Sésamo negro, Extracción supercrítica, Extracción convencional, propiedades tecnofuncionales de proteínas

Preservation processes applied to kiwi peel as strategies to add value to fruit wastes

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Wastes from food industries are considered potential new sources of natural occurring polyphenolic compounds with health promoting biological activities. Particularly, the residues of fruits (peel and seeds) may have higher nutritional content, bioactive compounds and antioxidant activity than the pulp or juice. In this context, the interest in the effective utilization of these wastes is growing.
The objective was to assess the impact of freezing and freeze drying applied as preservation processes of kiwi peel, evaluating some bioactive compounds and antioxidant activity.
Kiwis (*Actinidia deliciosa*) surfaces were rubbed gently with a gauze to remove excess fuzz and make them smooth. Peel was removed by hand with a stainless steel knife and cut into small slices.
Approximately 200 g of peel were submitted to a freeze drying process (-45 °C, 20 Pa, 96h). Dried samples were packed in polyethylene flasks (100 mL) and stored at room temperature. The same amount of peel was frozen in a forced air freezer at -80 °C. Frozen samples were also packed into polyethylene flasks and stored at -18 °C. The processes were replicated twice.
Total phenolics, chlorophylls and antioxidant activity were analyzed before and after processes and after 21 days of storage.
Fresh cut kiwi peel had 54.5±42.9 µg/g (in dry basis; d.b.) of total phenolics, 105.3±39.6 µg/g (d.b.) of total chlorophylls and 1158.1±227.9 µg/g (d.b.) of antioxidant activity.
The freezing process did not affect significantly these compounds. At the end of frozen storage, phenolics content increased 5 times, while total chlorophylls and antioxidant activity of frozen peel were retained.
The impact of freeze drying was significant in all compounds analyzed. When compared to fresh samples, freeze dried peel presented a total phenolics content 10 times higher. However, at the end of storage, the content was comparable to the one detected in fresh cut peel. In terms of total chlorophylls, the content in freeze dried samples was 5 times higher. At the end of storage, this content was retained (548.1±33.7 µg/g d.b.). A decrease of 42% of the antioxidant activity was observed in freeze dried samples, also observed at the end of the storage.
Frozen kiwi peel retained quality parameters, even after 21 days of storage. Dried peel had higher total chlorophylls content but lower antioxidant activity at the end of storage. When microbiological assessed, kiwi peel preserved by freezing or freeze drying can be used as a food ingredient with potential health benefits.

Keywords: Freezing, Freeze drying, Phenolics, Chlorophylls, Antioxidant activity

Strategies for reduction and valorization of co-products of a fruits and vegetables industry

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Food waste is a global constraint for food security, which is aggravated by population growth, natural resources scarcity and environmental constraints. The implementation of management policies and valorization of agro-industrial wastes are important strategies to promote food safety and security. In this scope, it was carried out the quantification of by-products generated by a horticultural center that produces and commercializes minimal processed fruits and vegetables and fresh products. Significant amounts of discarded vegetal materials, residues and by-products were quantified. About 40% of overall fresh vegetable wastes are discharged by fresh-cut production processes and, under current management practices, this reality has a null economic return for the company. Reducing the amount of these wastes by increasing technological processes efficiency and their utilization for bioenergy production are the strategies proposed, considering the high perishability and contamination levels of these materials. Regarding the by-products from raw materials processed for the fresh fruit market, the amount estimated was 10 to 20% of the total raw material. These are usually directed to other destinations with low economic profit namely juice industry. These byproducts exhibit greater physiological / biochemical stability than the residues from fresh-cut products. Consequently, the nutritional value and / or the bioactive potential allow them to be regarded as raw materials or as matrices for the extraction of phytochemicals of interest. Their use in the development of new food products, food supplementation or as source of natural additives consist on added value strategies. By-products with no edible characteristics for food consumption (contaminated fruits and tubers) and wastes from the fresh-cut production are suggested to be directed to the energy production. However, the practical feasibility of these new valorizations combines high economic investments in which the implementation costs are presently higher than those imputed in the traditional management of these materials. In this sense, it will be necessary a phased planning, a temporal definition of goals and the quantification of the impact of the proposed strategies in terms of economical return. The development of new food production lines and innovative phytochemical extraction technologies are still at an early stage, requiring a continuous collaborative effort between research institutions and industry.

Keywords: Ney food products, Phytochemicals, Bioenergy, Circular Economy, Valorization Strategies

Valorization of Tannat grape skin into health promoting food ingredients

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Every year winemaking industry produces large amounts of by-products, being necessary a sustainable management of such waste. Among red varieties, Vitis vinifera cv Tannat presents a unique polyphenolic profile. The aim of this work was to characterize Tannat grape skin and the extract obtained by hydro-alcoholic-acid extraction (EHAA), as well as to valorize this by-product by evaluating its in vitro biological properties (antioxidant, antidiabetic, antiobesity and anti-inflammatory). The characterization was performed by determining ashes, dietary fiber, moisture, fat, protein and total carbohydrates (by difference) following AOAC methods (1999), and polyphenolic content and anthocyanins according to Slinkard & Singleton (1977) and Giusti & Wrolstad (2005), respectively. Antioxidant capacity was measured by ABTS (Re et al., 1999) and ORAC-FL (Dávalos et al., 2003). The antidiabetic potential was evaluated by analyzing the effect on intestinal α-glucosidase enzymatic activity (Martinez-Saez et al., 2017), the antiobesity effect was determined by measuring pancreatic lipase enzymatic activity (Adisakwattana et al., 2012), and the anti-inflammatory capacity by measuring nitric oxide production in RAW 264.7 (Benayad et al., 2014). The extract effect on cellular viability was evaluated by MTT. Extract total polyphenolic content was of 11.459±1.048 g GAE/100g dry extract and anthocyanins of 2.030±0.085 g Cyd/100g dry extract. The extract presented antioxidant capacity (0.474±0.036 mg/mL for ABTS and 0.715±0.063 µmol TE/mg of dry extract for ORAC-FL) and intestinal α-glucosidase inhibition capacity (IC50 0.8885±0.0793 mg/mL). The results also showed pancreatic lipase inhibition capacity (IC50 2.4310±0.0799 mg/mL) and anti-inflammatory effect, mainly as a preventive agent (IC50 587 µg/mL) on RAW 264.7 macrophages. Cellular viability was not affected ($p > 0.05$) at the tested concentrations (250-1000 µg/mL). To the best of our knowledge, this is the first time that Tannat grape skin has been associated to antidiabetic, antiobesity and anti-inflammatory potential. In brief, results suggest EHAA to be a good candidate as a functional ingredient to reduce the risk of chronic diseases associated to oxidative stress, inflammation and energetic metabolism disorders, giving added value to the by-product Tannat grape skin.

Keywords: Tannat grape skin, Chronic diseases, By-product, Bioactive properties

Influence of moderate hydrostatic pressure on the enzymatic component of pineapple by-products

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The abiotic stress induced by moderate hydrostatic pressure (MHP) processing can activate some enzymatic antioxidant systems in fresh fruit, consequently improving the antioxidant capacity of fruits. An increase in enzymatic activity related with the biosynthesis and accumulation of secondary metabolites can be associated with late response of plants to abiotic stresses. MHP can also enhance an effective response parameter for greater application in enzyme catalysis (Eisenmenger and Reyes-De-Corcuera, 2009). The aim of the present study was to evaluate the effect of the MHP on the enzymatic activity of pineapple by-products enhance bioactivity through enzyme induced stress biosynthesis.

Pineapple core cylinders (± 52.5x30 mm) and the shell (± 110x40 mm) of pineapple by-products were packed (± 40 g) in polyamide/polyethylene (PA/PE-90, Alempack, Elvas, Portugal) bags, vacuum, and pressurized in a pilot-scale high pressure equipment (Hiperbaric 55, Burgos, Spain) at the University of Aveiro. Response surface methodology (RSM) coupled with a central composite rotatable design (CCRD) was used to evaluate the effects of pressure (50 - 400 MPa) and treatment time (1-15 min) on the responses variables: bromelain (BRM), polyphenol oxidase (PPO) and phenylalanine ammonia-lyase (PAL) activities. A total of twelve experiments were carried out.

The results indicated that MHP treatments may have a good potential to be used as abiotic stress to promote synthesis of functional compounds. Pressure seems to be the main factor affecting the studied enzymes' activity. Both the core and shell presented different patterns in what concerns BRM and PAL activities, with BRM presenting a maximum activity at moderate pressure (200 MPa) and treatment times (8 min). BRM comparing with raw material, it was observed an increase of 75% for shell and 230 % for core. PAL activity presented a maximum at the same treatments, but at different levels for core (18 %) and shell (266 %). Higher hydrostatic pressures (>300 MPa) and treatment times (>10 min) yielded a decrease of PPO activity.

These results hint MHP treatments as a possible technique to enhance enzymatic activities in fruit by-products, which may contribute for reducing food waste and improve waste management.

Keywords: Abiotic stress, Moderate hydrostatic pressure, Enzyme activity, Bioactive compounds, Pineapple by-products

Valorization of non-compliant *Bravo de Esmolfe* Apples and *Saco* Cherries: development of antioxidant extracts

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In the last years, consumption of fruits and vegetables became more interesting because of the beneficial properties associated with the high level of bioactive compounds such as phenolic compounds. The phenolic compounds of apple and cherry have been linked with diverse human health properties namely the prevention of chronic, cardiovascular and cancer diseases, mainly associated with their antioxidant activity. Nowadays, a special interest has increased on the recovery of these compounds from non-compliant fruits, which are fruits that do not have market value and cannot be sold, and therefore, an effort to find value-added for these food losses has been made to comply with circular economy concept. On the other hand, previous results from IBET group showed that traditional Portuguese varieties such as *Bravo de Esmolfe* apple[1] and *Saco* cherry[2] are powerful antioxidant sources compared with exotic varieties. Furthermore, revenant amounts of apples and cherries are not completely sold because many of them are considered non-compliant fruits although they are still safe and nutritious. In order to obtain bioactive compounds from these fruits, green extraction methodologies and solvents have been widely investigated. With this context, the aim of this work was to develop novel antioxidant extracts through green solvents and methodologies to apply in cosmetics and food products. *Bravo de Esmolfe* apple and *Saco* cherry antioxidant extracts were obtained using non-compliant fruits with water and/or ethanol employing microwave and ultrassound technologies. The content of total phenolic compounds (TPC) was evaluated by Folin-Ciocalteu method, total anthocyanins by pH-differential method and antioxidant activity (AA) evaluated through ABTS˚, DPPH˚ and ORAC method. Using microwave extraction and the conditions of water:ethanol (50:50 (v/v)) (in the case of cherry with 0,1% HCL), 300W during 15 min it was possible to obtain the highest value of TPC (4,44 g/ g dry extract for apple and 12,5 g/g dry extract for cherry) and AA (ABTS˚: 3,92 mg/g dry extract for apple and 10 mg/g dry extracts for cherry and DPPH˚: 5,11 mg/g dry extract and 9,5 mg/g dry extract, respectively) for both fruits. As expected, high positive correlation between TPC and AA (by ABTS˚ method) was observed, associated to the higher antioxidant content. Identification of phenolic compounds by HPLC of the different extracts also reinforced these properties. The results demonstrated that non-compliant *Bravo de Esmolfe* apple and *Saco* cherry are an excellent source of antioxidants and may be valorized with added-value towards applications as natural additives for food and cosmetic products.

Keywords: Bravo de Esmolfe Apple, Saco Cherry, Green extracts, Antioxidant activity

Sustainable Innovation in Food Product Design

Valorisation of By-Products from the Food Industry

Poster Communications

Produção de emulsões alimenticias utilizando biossurfactante produzido por levedura

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O uso de biossurfactantes desperta grande interesse industrial em função da diversidade de estruturas e produção a partir de fontes renováveis, obtendo produtos resistentes às técnicas de processamento, constituindo um grupo atrativo de compostos com uso potencial nas indústrias alimenticias e biotecnológicas. As leveduras conseguem sintetizar biossurfactantes e algumas não apresentam riscos de toxicidade e patogenicidade, podendo utilizar seus metabólitos em formulações alimenticias. Neste sentido, o objetivo desse trabalho foi produzir um biossurfactante a partir da levedura *Candida bombicola* para aplicação em emulsões tipo maionese. O biossurfactante foi produzido por *Candida bombicola* cujo meio continha 5% de melaço de cana de açúcar, 5% de óleo de fritura residual e 5% e milhocina, durante 120 horas a 200rpm. A propriedade emulsificante do biossurfactante foi testada na formulação de um molho tipo maionese, sendo testados quatro tipos de espessantes: gomar guar, goma arábica, carboximetilcelulose e goma xantana, nas concentrações de 0,2%, 0,5% e 0,8%, até obtenção do molho mais consistente, semelhante à maionese, com aferição do pH de todas as formulações. Após seleção da melhor condição, foram testadas formulações com o biossurfactante isolado de *Candida bombicola* nas concentrações entre 0,2% e 0,8% (v/v) para obtenção da emulsão mais estável. Os molhos obtidos foram armazenados a 4^{o}C, sendo armazenados por seis meses, onde foram realizados testes de viscosidade e microbiológicos. O biossurfactante produziu emulsões estáveis apresentando melhor estabilidade como emulsificante na concentração de 0,5%. As gomas arábica, xantana, guar e carboximetilcelulose utilizadas
nas formulações dos molhos avaliadas na menor concentração empregada (0,2% v/v) apresentaram viscosidade absoluta em torno de 10.0000 mPa.s, onde a goma arábica permaneceu na mesma faixa de viscosidade mesmo com a elevação da concentração. Já a goma xantana e guar, chegaram a valores próximos a 70.000 mPa.s na concentração de 0,8% (v/v). As gomas guar e carboximetilcelulose não apresentaram separação de fases em todas as concentrações testadas, obtendo-se a melhor formulação com a biomolécula associada a essas duas gomas. Em relação ao pH, todas as formulações testadas apresentaram valores de 3,70 ± 0,05 (média ± DP) estando dentro da faixa recomendada que é de 3,3 a 3,8. Todas as amostras apresentaram-se negativas para os microrganismos *Salmonella* sp., Estafilococos Coagulase Positiva e Coliformes a 45^{o}C. Dessa forma, o biossurfactante produzido por *C. bombicola* apresentou potencial de aplicação em sistemas alimentares como constituinte de emulsões do tipo maionese apresentando durabilidade e segurança microbiológica após seis meses de armazenamento.

Keywords: *Candida bombicola*, Bioemulsificante, Aditivos alimentares

Valorização do sub-produto da indústria do óleo de mamona: estudo da extração de proteínas da torta

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A indústria de óleo produz um sub-produto rico em proteína, como é o caso da torta de mamona, cuja valorização pode ser feita via fracionamento. O objetivo deste trabalho foi o estudo da extração de proteínas da torta de mamona (TM) em meio alcalino, verificando-se o efeito das condições de processos, do agente alcalinizante e do pH. A TM foi moída a 20^{o}C, em moinho termostatizado, e caracterizada granulometricamente com a utilização de peneiras de 12, 16, 20, 28, 35 e 48 “mesh”. A TM foi analisada quimicamente para determinação dos seus componentes, incluindo teores de aminoácidos, minerais, fibras, e composição de ácidos graxos dos óleos extraídos, segundo metodologias clássicas. O estudo da extração das proteínas foi realizado com temperatura controlada a 50^{o}C, em banho-maria termostatizado, sob agitação constante (400 a 600 rpm), com auxílio de um agitador mecânico, por 30 minutos. A dispersão foi centrifugada a 4.000 rpm, a 4^{o}C/20 minutos. O sobrenadante, rico em proteínas solubilizadas, foi liofilizado após congelamento em nitrogênio líquido. Maiores rendimentos, em termos de proteínas extraídas utilizando-se NaOH a pH=9, foram observados (25,3%) quando a extração foi realizada com baixa concentração de TM na solução extratora, a 50^{o}C, e quando o resíduo (decantado) foi submetido à lavagem com água destilada (27,3%), o que significa que apesar da solubilização das proteínas, uma fração dessas ficou adsorvida nas partículas do resíduo seco, sendo então lixiviadas após a adição desses resíduos em água destilada. Além disso, o menor rendimento (11,4%) foi observado para a extração realizada a 30^{o}C. No estudo do efeito do agente alcalinizante, em pH=9, observou-se que o maior rendimento, em termos de proteínas extraídas, foi observado quando se utilizou KOH (19,6%), seguido de NaOH (18,7%) e $Ca(OH)_2$ (8,2%). E, no estudo do efeito do pH, utilizando-se apenas o NaOH, observou-se que, de maneira geral, o aumento do pH contribuiu para o aumento do rendimento de extração de proteínas da torta de mamona, variando entre ~16 e ~38%, quando o pH foi elevado de 8 para 11. Entretanto, deve-se considerar que o aumento do pH até 11 exigiu um consumo considerável de soda. Além disso, observou-se que a aparência visual destas soluções mudou em função do pH de extração das proteínas, apresentando uma cor marrom clara para pH= 8 e 9, e uma cor marrom escura para pH 10 e 11. Em conclusão, a TM tem grande potencial como fonte de proteína.

Keywords: Resíduo, Proteína, Extração

Revalorización del salvado de arroz desgrasado proveniente de la industria aceitera

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El interés en el uso de salvado de arroz (SA) para la elaboración de alimentos se centraliza en sus características nutricionales, en su bajo costo y en su extensa producción a nivel mundial. A partir del SA se obtiene aceite y también salvado de arroz desgrasado (SAD) como subproducto del proceso. El objetivo de este trabajo fue obtener y evaluar un concentrado de salvado de arroz desgrasado (CSAD) enriquecido en proteínas y fibra alimentaria total (FAT) a partir de salvado de arroz desgrasado (SAD). El SAD se tamizó (<355 µm, ASTM) y dispersó en agua destilada (100 g/L). Se trató con α-amilasa termorresistente 1 mL/L (60 min, 95 °C, pH 5,5) y amiloglucosidasa 10 mL/L (30 min, 60 °C, pH 4,5) para eliminar el almidón. Se agregó etanol 71% $^{V}/_{V}$ para precipitar las proteínas y fibra; el precipitado se secó a 40°C para eliminar el etanol y se dispersó en agua destilada (100 g/L) ajustando el pH a 8,0 y finalmente se liofilizó obteniendo el CSAD. El contenido de proteína (N×5,7) fue 27,4±0,1% $^{P}/_{P}$ y de FAT fue 49,2±0,3 % $^{P}/_{P,}$ representando un incremento del 78 y 79 % respectivamente, en relación al SAD. El contenido de carbohidratos digeribles disminuyó de un 42,25±0,21 a 0,49±0,21% $^{P}/_{P.}$ Se determinó la capacidad de retención de agua (WRC) y la capacidad de unión al aceite (OBC) en SAD y CSAD. CSAD presentó valores más altos de WRC y OBC. Los valores de WRC fueron 2,3±0,1 y 6,9±0,2 g retenidos de agua / g de muestra seca, y de OBC 2,7±0,4 y 6,0±0,3 g retenidos de aceite / g de muestra seca para SAD y CSAD, respectivamente. Teniendo en cuenta que el contenido de FAT y proteína es mayor en el concentrado, un aumento en el WRC y OBC eran esperados. El alto valor de OBC del CSAD indica su potencial aplicación en alimentos con alto contenido de grasa. Por otro lado, el alto valor de WRC permitiría su uso como ingrediente modificador de la viscosidad y la textura, además de reducir las calorías de los productos alimenticios formulados debido al bajo contenido de carbohidratos digeribles presentes en el CSAD. Este trabajo permitió obtener concentrados ricos en FAT y proteína a partir de un residuo industrial, que podría usarse como ingrediente alimentario, aumentando así el valor de este importante subproducto.

Keywords: Salvado de arroz desgrasado, Retención de agua, Unión al aceite

Evaluation of the suitability for industrialization of the Imperial (*Roystonea oleracea*) hearts of palm

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The objective of this research was to evaluate the industrial adaptability of the hearts of palm from "Imperial" palm trees, originating in the Caribbean and cultivated in Brazil. In the raw material analyzes were performed of yield by weight, diameter and acidification curve. The process consisted of harvesting, peeling, cutting, packaging in glass jars (600ml), adding the acidified brine, packaging closure, pasteurized (98ºC/50min.), cooling and storage at room temperature (25ºC). The canned Imperial heart of palm was submitted to analyzes of microbiological, head space, vacuum, equilibrium pH, objective color evaluation and sensorial acceptance test for color, appearance, texture, flavor and overall quality using a nine-point hedonistic scale and 50 hearts of palm consumers. The results showed averages of yields of 465g of basal part and 324g of toletes and initial diameters of 4.74cm and final of 3.54cm. To lower the initial pH of the raw material to 4.3, 0.8 g of citric acid / 100 g of hearts of palm was required. The canned hearts of palm have shown equilibrium pH values under 4.5 and 17 inch Hg medium vacuum, being inside the security line require for this kind of product, according to the Codex Alimentarius. Commercial sterilization assessment has shown that, for canned heart of palm, no acid-tolerant thermophilus aerobic microorganisms (*B.coagulans* and *Alicyclobacillus*), acid-tolerant mesophilic microorganisms (butyric anaerobes and lactic bacteria), molds, or yeasts were found. As for sensory evaluation, all evaluated attributes received 81% of the tasters' scores corresponding to the terms "like" the scale used, which indicates the optimal acceptability of the product. According to the values obtained for the parameters L (71,97), a (- 1,70) and b (5,34), there is light coloration, close to white, with slight shades of green (a-) and yellow (b +). It is noteworthy that this species of palm heart does not present enzymatic darkening, which constitutes an advantage for the industrialization of the product. Thus, it can be concluded that the Imperial hearts of palm shows adjusted characteristics for industrialization, resulting in good quality canned palm heart.

Keywords: Heart of palm, Imperial, Quality, Industrialization, Preserve

Produção de farinha de sementes germinadas de jaca

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As sementes de jaca (*Artocarpus heterophyllus* Lam.) são ricas em nutrientes tais como proteínas, fibras e sais minerais, sendo utilizadas para o consumo humano. A germinação é uma tecnologia de processamento barata e eficaz que melhora a qualidade nutricional das sementes. Diante disso, este trabalho teve como objetivo produzir farinha a partir das sementes germinadas de jaca secas e analisar na farinha os compostos fenólicos, taninos, perfil mineral e a citotoxicidade. As jacas foram devidamente higienizadas, cortadas e os gomos separados manualmente das sementes; estas foram lavadas em água corrente e colocadas em bandejas com substrato de vermiculita sob condições de temperatura e umidade relativa do laboratório, sendo irrigadas com água destilada a cada 2 dias. Após 15 dias de germinação, as sementes estavam com radículas com comprimento de aproximadamente 2,5 cm, sendo então colhidas, limpas e encaminhadas para a secagem em secador convectivo na temperatura de 75 °C e velocidade do ar de 1,3 m s^{-1} até atingirem o teor de umidade de aproximadamente 9,5%. Após a secagem as sementes germinadas secas foram trituradas e determinado os compostos fenólicos pelo método espectrofotométrico de Folin e Ciocalteu, utilizando-se o ácido gálico como padrão; os taninos utilizando a curva de ácido tânico como padrão; e a determinação dos minerais por espectrômetro de fluorescência de raios-X por energia dispersiva. Os dados gerados foram submetidos à análise de variância e à comparação entre médias pelo teste de Tukey a 5% de probabilidade. A análise de citotoxicidade da farinha foi realizada utilizando *Artemia salina.* Os resultados foram submetidos ao tratamento estatístico utilizando-se o programa estatístico Bio Stat 2009®, efetuando-se a análise PROBIT, que forneceu os valores de DL50. Encontrou-se um valor médio para os taninos e compostos fenólicos de 2,60 ± 0,02 g/100 g de farinha e 1,93 ± 0,01 g/100 g de farinha, respectivamente. A partir do resultado do perfil mineral da farinha verificou-se que o potássio, cálcio e fósforo, estão em maiores concentrações, com valores de 2347,95; 189,36 e 171,44 mg/100 g de farinha, respectivamente; e o percentual encontrado para os microminerais ferro, zinco, rubídio, manganês e cobre foi 9,32; 4,65; 14,11; 2,40 e 2,15 mg/100 g de farinha, respectivamente. O valor médio de DL50 (dose letal para 50% de ocorrência) calculado para a farinha de semente germinada de jaca foi de 1463,25 µg/mL, sendo considerado levemente tóxico ou atóxico.

Keywords: *Artocarpus heterophyllus*, Secagem convectiva, Perfil mineral, Citotoxicidade

Preparation of potential antioxidant ingredients by fermentation of pea flour by the autochthonous microbiota

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Fermentation is an economic method to produce and preserve food. Sourdough is a flour and water mixture that is spontaneously fermented by the indigenous microbiota of seeds composed by stable associations of acid lactic bacteria (LAB) and yeasts. LAB can present specific protease activities able to release bioactive peptides. Legumes –peas among them- are widely consumed and present interesting nutritional and functional properties. The aim of the present work was to evaluate the fermentation of pea flour by autochthonous microbiota in the preparation of a functional ingredient containing potentially antioxidant peptides. Yellow peas (*Pisum sativum* var Yams, culture 2016) were used. Dispersion of flour in distilled water (6 g flour + 10.5 ml water) were prepared and incubated at 30 and 37 °C with agitation. pH evaluation was registered obtaining values of 6,24 ± 0,03 at t = 0 and 3,92 ± 0,09 after 48 h for both incubation temperatures. Protein hydrolysis degree was evaluated by reaction of free amine groups with trinitrobenzenesulphonic acid (TNBS); results were 13 ± 2 and 17 ± 2 % after 24 h at 37 °C y 30 °C respectively, without differences after 48 h. Protein solubility (soluble protein in PBS buffer (Lowry method)/100 g total protein (microKjeldahl method)) was similar for all ferments (54 ± 2 %), while at t = 0 solubility was 68 ± 4 %. Electroforesis SDS-PAGE and tricine-SDS-PAGE as well as gel filtration FPLC chromatograpy (Superdex 75 and Superdex 30 columns) suggested the formation of aggregates and also the appearance of low molecular mass molecules (< 6.5 kDa) after fermentation. Antioxidant activity was studied by the ORAC (Oxygen Radical Absorbance Capacity) assay, dose-response curves were obtained and IC_{50} values calculated. All ferments registered an increment in the antioxidant activity respect to the starting dispersion, decreasing IC_{50} values between 1.3 and 2 times, fermented flour after 48 h at a 37 ºC showed the greater ORAC capacity (IC_{50} = 0.065 mg protein/ml). These results point to the fermented pea flour as a potential functional antioxidant ingredient.

Keywords: Yellow peas, Flour, Fermentation, Proteolysis, Antioxidant activity

Desarrollo de una materia prima emergente a partir de dos subproductos de la industria alimentaria, con alto valor nutricional y functional

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Actualmente en el mundo, existe una preocupación por generar valor agregado a los subproductos producidos en la industria alimentaria, y contribuir al cuidado ambiental del planeta. En ese sentido, la industria cafetera y láctea de Colombia, genera dos subproductos de gran impacto: la borra de café y suero lácteo, respectivamente. Dado lo anterior, el objetivo de este trabajo fue desarrollar una materia prima en polvo con propiedades nutricionales y funcionales, mezclando diferentes porcentajes de borra de café con suero lácteo concentrado, por medio del secado spray. La metodología incluyó, la realización de un diseño de experimentos completamente aleatorizado, tomando como variable independiente el porcentaje de borra de café con tres niveles (4, 10 y 16%), como variables dependientes, el contenido de: lisina, HMF (Hidroximetilfurfural), furfural, Abs 420, capacidad antioxidante, polifenoles totales y ácidos clorogénicos. Los datos se analizaron por medio de una ANOVA con un $\alpha = 95\%$; además se hizo un análisis de correlación de Pearson, entre las variables analizadas. Las muestras se procesaron en un secador spray piloto de disco rotativo (PSA 5 Vibrasec), con una temperatura de entrada y salida de 170ºC y 90ºC respectivamente, con caudal de alimentación de 2.0 L/h y aire precalentado tenía un caudal de 540 L/h. Como resultado principal se obtuvo que la actividad antioxidante varió entre 949.45-2199.62 µMol E. Trolox/gramos de materia seca (ms), mientras que la concentración de polifenoles totales (TPC) osciló entre 121.33-200.08 mg AG/g ms. Los niveles de cafeína y ácidos clorogénicos (ACGs) fueron de 0.004 a 0.012 y de 0.00210 a 0.00805 g/100 g respectivamente. En el caso de los indicadores de daño térmico y pardeamiento, se obtuvo que los compuestos de HMF y furfural estuvieron entre 0.136-0.655 y 0.084-0.447 mg/100 g de proteína. La lisina disponible fue de 2.23 a 4.07 g/100g de proteína. En general, el contenido de borra no afectó significativamente las variables analizadas ($p>0.05$), sin embargo, se encontraron correlaciones estadísticamente significativas entre los compuestos de pardeamiento no enzimático (HMF y furfural) y los compuestos antioxidantes (TPC, cafeína y ACGs). En general se puede concluir, que es posible utilizar la tecnología de secado spray para obtener un polvo con propiedades funcionales, nutricionales con potencialidad de ser aplicado en el diseño de alimentos con beneficios para la salud; a partir de los subproductos de la industria alimentaria.

Keywords: Suero lácteo, Borra de café, Ácidos clorogénicos, Compuestos antioxidantes, Lisina disponible

Valorization of barnacle (*Pollicipes pollicipes*) from *berlengas* marine reserve (Portugal) by development of a new food product - pâté enriched with blackberries (*Rubus ulmifolius*)

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In Portugal, the goose barnacles (*Pollicipes pollicipes*) are traditionally very appreciated by seafood lovers, what is reflected on the high values paid by the consumers. In particular, those from Berlengas Islands given that has a *sui generis flavour* and a fairly larger size than others from different Portuguese coastal regions. Although the existence of specific legislation that regulates the fishermen activity on the Natural Reserve of *Berlengas*, particularly in terms of minimum size and maximum daily quantities, is frequently to catch small organisms that has low economic value and eventually are rejected. Therefore, it is urgent to create a step-in food chain to valorize those goose barnacles rejected. On the other hand, food oxidation is the main problem regarding the nutritional quality deterioration on seafood products. Recently, the use of antioxidants from natural origin in replacement of synthetic additives has been increasing, namely in products such as burgers, sausages and pâtés. Furthermore, *Rubus ulmifolius* has been described as a natural source of bioactive compounds, namely antioxidants.

The main goal of this study was to develop a new and innovative seafood product, a *P. Pollicipes* pâté enriched with *Rubus ulmifolius* (wild fruit - blackberries) as a source of natural additive antioxidants. Additionally, it was also characterized the respective nutritional profile and evaluated the physicochemical and microbiological properties along 90 days (at 4 ºC). Moreover, the effect of aqueous extracts from blackberries at 2.5% (ID: PRU2.5) and 5% (ID: PRU5.0) was compared to synthetic antioxidant (ID: PBHT) and to a pâté without antioxidants (ID: PCTR). The production of this pâté involved a set of ingredients and procedures that have been optimized and standardized in order to provide a suitable product quality and insure food safety. Ours results showed that, the small *P. pollicipes* have a high nutritional food (Protein:16,3%; w6/w3=0,41) and *R. ulmifolius* revealed a high antioxidant capacity (595 mg GAE/100g; 0,55 EC_{50}). Through evaluation of antioxidant capacity and oxidative stability of all pâté samples, confirm the high-performance of *R. ulmifolius* extract rich in phenolic compounds as effective inhibitor of lipid oxidation in this pâté (RSA: 31,9% ;*p-value* < 0,05) compared with control. Consistently, the increase of TBARS index, in CTR samples, was significantly higher (*p-value* < 0,05) during refrigerated storage compared to enriched pâté.

Keywords: Barnacles, Seafood product, Pates, Rubus ulmifolius, Lipid Oxidation

Elaboração de biscoito tipo cookies formulado com farinha de kiwi

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O objetivo deste trabalho foi elaborar e avaliar a qualidade microbiológica e a composição centesimal de biscoitos tipo cookies formulados com farinha de kiwi. Para a confecção dos biscoitos tipo cookies foi utilizado a farinha de kiwi obtido após secagem a 70 °C. Foram elaboradas quatro formulações de biscoitos constituído da farinha de kiwi nas proporções 0% (FP), 20% (F1), 25% (F2) e 30% (F3), adicionados em substituição à farinha de arroz. Nos biscoitos foram realizadas análises microbiológicas de coliformes a 35 °C e termotolerantes; Staphylococus aureus e Salmonella sp, segundo as normas da APHA (2001). A interpretação dos resultados foi feita de acordo com os critérios microbiológicos estabelecidos na legislação brasileira, regida pela RDC N° 12, 02 de janeiro de 2001 da Agência Nacional de Vigilância Sanitária (ANVISA). Foram realizadas análises da composição centesimal tais como: umidade, cinzas, proteínas (%), lipídeos (%), carboidratos totais (%) e valor energético (kcal/100g). Verificaram-se ausência de coliformes a 45 °C (< 0,3 NMP/g), Staphylococcus aureus e Salmonella sp em todas as formulações. Esses resultados indicam que as condições higiênico-sanitárias durante o processamento dos biscoitos foram realizadas em conformidade com as boas práticas de fabricação estabelecidas. Os biscoitos tipo cookies apresentaram umidade entre 2,03 a 4,91%. O teor de cinzas dos biscoitos variou entre 0,10 e 1,51%, verificando-se que a formulação padrão apresentou menor teor de cinzas. Verificou-se que o teor de proteínas diferiu estatisticamente entre as formulações, a formulação padrão e a adicionada de 30% de farinha de kiwi não diferiram estatisticamente entre si, com valores entre 5,95 e 6,58%. O teor de lipídeos variou entre 13,32 e 8,85%. Verificou-se que o teor de lipídeos dos biscoitos reduziu significativamente a partir de 25% de substituição da farinha de arroz pela farinha de kiwi. Os teores de carboidratos foram obtidos por diferença e apresentaram valores bastante elevados, variando de 76,47 a 79,60%. Esses resultados indicam que os cookies obtidos são ricos em carboidratos, podendo ser classificados como excelentes fontes de energia. O valor energético variou entre 451,93 a 421,62 kcal. Verificou-se que a substituição da farinha de arroz pela farinha de kiwi (25 e 30%) resultou em biscoito com o valor energético menor do que a formulação padrão. Conclui-se que as amostras analisadas encontram-se dentro dos padrões higiênico sanitário e que os biscoitos adicionados da farinha de kiwi podem ser utilizados por pessoas que buscam o consumo de alimentos de menor densidade calórica.

Keywords: *Actinidia deliciosa*, Cereais, Qualidade

NAFEI - Northern AgroFood-Environment Innovation: Promoção e valorização do setor agroalimentar e agroambiental

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O Setor Agroalimentar constitui um espaço relevante da economia europeia, nacional e da Região Norte, tendo sofrido nos últimos anos uma evolução considerável, adaptando produtos ao gosto dos consumidores ao mesmo tempo que procura processá-los de forma mais saudável e apresentando características inovadoras de modo a torná-los mais competitivos. O objetivo deste trabalho é descrever o "Northern AgroFood-Environment Innovation" (NAFEI) como um projeto de promoção e valorização do setor agroalimentar e agroambiental.

O NAFEI enquadra-se no domínio da Transferência de Conhecimento Científico e Tecnológico e está especialmente orientado para o investimento no Desenvolvimento de Novos Produtos e Serviços, no domínio dos sistemas Agroalimentar e Agroambiental.

Este projeto propôs três ações que são articuladas: (i) Dinamização da Inovação nos Sistemas AgroAlimentar e AgroAmbiental; (ii) Desenvolvimento de Novos Produtos e Serviços e (iii) Promoção da Transferência de Conhecimento e Inovação. Deste modo, foram promovidas ações de sensibilização e motivação, envolvendo meios de comunicação e um roadshow para mobilizar competências individuais, em que se criaram equipas capazes de desenvolver novos produtos e serviços que atraíram o interesse nas cadeias de valor relacionadas, designadamente na produção primária, nos produtores de bens e serviços intermédios (ingredientes, embalagem, equipamentos, etc.), produtos e serviços ambientais e, em particular, produtos e serviços alimentares, incluindo a valorização dos seus subprodutos. Este programa de dinamização foi acompanhado por um *Sounding Board* composto por representantes de empresas, associações, *clusters* institucionais, empresários, investidores, etc. que se envolvem com base no relacionamento com a ESB-UCP, e em geral com a Universidade Católica - Porto e que ofereceu aos candidatos e ao Programa uma orientação de prioridades e de valor para os mercados. Os Projetos que participaram no Programa foram acompanhados por Mentores Científicos e Empresariais. Assim, o NAFEI criou as bases para uma cultura e uma dinâmica de inovação sustentável em que grupos de trabalho com competências, centros de investigação aplicada especializados, e uma proximidade com atores-chave do mercado e do tecido económico, possam permitir que projetos estruturados de novos produtos e serviços fossem avaliados de forma a contribuírem para a criação de valor nas cadeias associadas aos sistemas agroalimentares e agroambientais da Região Norte.

Keywords: Agroalimentar, Agroambiente, Inovação, Valorização de subprodutos, Empreendedorismo

Elaboração e avaliação sensorial de barras de frutas desidratadas com adição de cascas e derivados de laranja

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O objetivo deste trabalho foi elaborar e analisar sensorialmente barras de frutas tropicais desidratadas adicionadas de cascas de frutas e derivados de laranja. As barras eram constituídas de manga (*Mangifera indica*) Tommy Atkins e de banana (*Musa paradisiaca*) tipo prata desidratadas; farinhas das cascas dessas frutas, como forma de aproveitar ao máximo as frutas utilizadas, reduzindo o desperdício e aproveitando as propriedades nutricionais dessas partes que costumam ser descartadas pela indústria alimentícia; e pectina, utilizada como agente ligante em substituição ao xarope de glicose, que é normalmente utilizado com essa finalidade em barras de cereais, tornando esse produto sem adição de açúcar. As duas formulações se diferenciavam pelo derivado de laranja (*Citrus sinensis*) adicionado: F1 – suco de laranja; e F2 – 2% de óleo essencial de casca de laranja. A análise sensorial foi realizada com 126 julgadores não treinados no Laboratório de Análise Sensorial do IFCE Limoeiro do Norte, em cabines individuais e sob luz branca artificial. As amostras foram servidas em copos descartáveis codificados com números aleatórios de três dígitos. Os provadores foram orientados a provar as amostras da esquerda para a direita. As barras foram analisadas quanto à aceitação de aparência, sabor, aroma, textura e aceitação global por meio de escala hedônica estruturada de 9 pontos; intenção de compra por meio de escala estruturada de 5 pontos; e ordenação preferência. O Índice de Aceitabilidade (IA) foi calculado pela razão entre a nota média vezes 100 e a nota máxima em cada atributo. Ambas as formulações apresentaram mais de 50% das respostas do teste de aceitação, para todos os atributos, na faixa de "aceitação" sensorial. A barra F2 foi superior à F1 quanto à aceitação do sabor, da textura e aceitação global. Em contrapartida, a amostra F2 apresentou os maiores índices de aceitabilidade para aparência e aroma, com 68,8% e 77,2%, respectivamente. No teste de ordenação preferência a barra com óleo essencial foi escolhida como a mais preferida, com 54,6% das respostas. Na intenção de compra, a barra F1 apresentou a maioria das respostas (50,8%) na faixa "não compraria", enquanto para F2 a maioria das respostas se concentrou na faixa "compraria" (48,39). A barra de frutas com óleo essencial apresentou os melhores resultados de aceitação dos atributos avaliados e uma boa intenção de compra, o que indica que esse produto, natural, sem adição de açúcares e com aproveitamento quase integral das frutas, tem potencial para ser comercializado.

Keywords: Manga, Banana, Óleo essencial

Desarrollo de galletas funcionales mediante la incorporación de subproductos de la industria citrícola

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Las galletas son un producto masivamente consumido a nivel mundial, teniendo gran potencial como vehículo de ingredientes funcionales. El subproducto de la industria citrícola (SPN): cáscara, hollejo y semillas de naranja, presenta alto % en fibra dietaria y compuestos bioactivos lo que lo hace un potencial ingrediente funcional, siendo el objetivo de este trabajo.
Las galletas se elaboraron siguiendo un diseño factorial completo con un total de 5 formulaciones con dos niveles de variables: SPN (7-13%) categorizado como fuente de fibra según reglamentación Mercosur y sucralosa(S) (0-4%) buscando reducir el azúcar, y un punto central (SPN: 10%, S: 2%) manteniendo constante el resto de ingredientes.
El análisis sensorial se realizó por medio de un panel de 15 jueces semi-entrenados utilizando la técnica Rate-all-that-apply (RATA), evaluando los siguientes atributos: amargor, crocancia, dulzor, olor extraño, olor a naranja, retrogusto, sabor a naranja y sabor extraño. Fueron realizadas dos sesiones, en la primera, se evaluaron las cinco muestras. Y en la segunda, según resultados obtenidos, se seleccionó la muestra con SPN: 10% y S:4% (muestra A) y se elaboró otra (muestra AR) reduciendo el % de azúcar de 10 a 3 %, comparándose con galletas comerciales (C1 y C2).
Los resultados de la primera sesión mostraron que la incorporación de SPN aumenta la intensidad de sabor a naranja, amargo y retrogusto, llegando a valores de 6,39, 5,11 y 4,61, respectivamente (escala 1-9). Mientras que disminuye el dulzor y crocancia del producto hasta valores de 2,22 y 2,67, respectivamente.
Al comparar las muestras A y AR con las comerciales, las diferencias se encontraron en olor (3,77 y 4,11) y sabor a naranja (5,12 y 4,53) respectivamente, debido a que una de las muestras comerciales contenía saborizante artificial (C1), presentando éstas valores de olor (6,82, 2,59) y sabor naranja (6,47 y 2,77) respectivamente. Los resultados mostraron que la concentración utilizada de SPN no tuvo un impacto negativo en el perfil sensorial.
Del estudio con 50 consumidores, comparando AR y A frente a C1. Se obtuvieron valores de aceptabilidad de AR y A (5,51 y 5,13, respectivamente) no presentando diferencias significativas entre si (<0,0001), mientras que C1 presentó una aceptabilidad de 6,62 siendo un valor cercano a las formulaciones desarrolladas.
En conclusión, las galletas mostraron ser un vehículo apropiado para el SPN, categorizado como fuente de fibra y rico en compuestos bioactivos, obteniendo una formulación reducida en azúcar, con un perfil sensorial cercano al del producto comercial.

Keywords: Actividad antioxidante, Galletas funcionales, Subproducto industria citrícola, Naranja, Actividad antiglicante.

Identification of phenolic compounds in mango (*Mangifera indica* L.) peel extracts by UPLC-PDA

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Mango is a tropical fruit with good nutritional and sensory properties. The fruit by-products have been recognized for their functional value, for instance reducing the risk of age and lifestyle related diseases as cardiovascular disorders, different types of cancer, diabetes-related complications, among others. Identification of phenolic compounds, widely known for them antioxidant activity, is an important step for the utilization of mango peel as food ingredient, and to provide an added value to mango production. In this work, the identification of phenolic compounds of mango peel samples from the most commercialized varieties in Ecuador (Tommy Atkins, Haden and Kent) was performed by Ultra Performance Liquid Chromatography coupled with a photodiode array detector (UPLC-PDA). The extracts were prepared with different aqueous solvent systems: ethanol 50%, methanol 50%, acetone 70%; a further purification step on OASIS HLB 6cc VAC packed column and finally the solvents were evaporated to dryness. The dried residue was dissolved in formic acid 1% and analyzed by UPLC-PDA. Furthermore, the antioxidant activity of extracts was carried out according to the Trolox Equivalent Antioxidant Capacity (TEAC) methodology. The results of analysis for Tommy Atkins variety when using methanol 50% as extraction solvent showed a higher presence of polyphenols such as mangiferin and gallic acid, flavonoids as quercetin and rutin. All mango peel extracts showed antioxidant activity (approximately 10,07 g Trolox Equivalent/100 g dry weight). Overall, the results indicate the potential use of these residues as an ingredient in functional food.

Keywords: Mango (*Mangiferina indica L*), Extraction, Polyphenols, Antioxidant capacity, UPLC-PDA

Análise do poder antioxidante/antibacteriano de extratos liofilizados em carne de aves

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Ao longo dos últimos anos tem-se verificado um aumento significativo no consumo da carne de aves. Este aumento conduz à necessidade de inovar na logística do transporte e conservação deste tipo de carnes, de forma a aumentar o seu tempo de prateleira. Por outro lado, há uma tendência comercial/regulamentar para a substituição de aditivos e conservantes sintéticos por produtos de origem natural. Neste contexto pretendeu-se testar um liofilizado de extrato agroalimentar obtido a partir de casca de uva na conservação de carne de aves. Foram testadas várias concentrações (100mg/kg, 300 mg/kg e 500 mg/kg) do liofilizado em carne de frango, tendo-se avaliado a sua eficácia em termos de atividade antimicrobiana e antioxidante. Foi realizado um ensaio controlo em que não houve adição de liofilizado. O ensaio teve a duração de 18 dias, em carnes sob refrigeração a 4ºC, e o efeito da aplicação do liofilizado foi medido através dos teores de acidez, índice de ácido tiobarbitúrico (TBA), humidade, contagem de microrganismos totais viáveis (MTV), contagem de coliformes totais (CT) e cor. Observaram-se oscilações nos valores TBA ao longo do tempo, mas sem diferenças significativas. Há uma tendência para o aumento dos valores de TBA com o aumento da concentração de liofilizado (500 mg/kg) (e.g. ao fim de 18 dias, o valor de TBA do controlo foi de 0,055 mg/kg em MDA e em carne com adição de 500 mg/kg de liofilizado, 0,066 mg/kg em MDA). O mesmo padrão foi observado para os valores de acidez, verificando-se nas amostras com concentração superior de liofilizado (500 mg/kg) um valor de 3,33% de acidez expresso em ácido oleico enquanto que para as amostras controlo se obteve um valor de 2,70%, no final do ensaio. A humidade manteve-se constante ao longo do tempo, apresentando valores médios de 75%. Pode assim concluir-se que a aplicação de liofilizado não contribuiu para regredir o processo oxidativo. A aplicação de liofilizado, sobretudo nas concentrações mais elevadas, resultou numa tendência para um menor desenvolvimento de microrganismos, ficando assim evidente a atividade antimicrobiana associada a estes extratos quando misturados com a carne de aves. Em termos de MTV há uma redução de 0,76 log (UFC)/g, e em termos de CT uma redução de 1 log (UFC)/g, do controlo para a carne de frango com adição de 500 mg/kg de liofilizado. Serão necessários mais estudos que permitam conciliar a atividade antimicrobiana do extrato com a inibição da sua atividade oxidante.

Keywords: Carne de Aves, Aditivos naturais, Liofilizado de extrato agro-alimentar

Assessment of bioactive compounds from Citrus Peels

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Both food and agricultural industry produces large amounts of food wastes, causing environmental issues. Thus, in the last years, the EU legislation, focused on reducing biodegradable waste and encouraged their exploitation. Citrus peel represents approximately half of the fruit mass being the main by-product that results from the citrus fruits processing in beverages industry. This by-product is a valuable source of natural antioxidants, essential oil, fibers, pigments, etc. Nevertheless, the valorization of agri-food by-products has to be achieved in a sustainable way. In this regard, the objective of the present study was to assess the chemical composition of several citrus peels' samples before and after the extraction of essential oil, the final objective being to develop an integrated procedure for the sequential recovery of bioactive components of citrus peels. Four citrus peels samples were taken into study, namely orange, grapefruit, lemon and pomelo. The extraction of essential oils was performed by hydro-distillation using a Clevenger type apparatus. The characterization of the chemical composition of the peels before and after the extraction of essential oils included the evaluation of their total phenolic content (Folin-Ciocâlteu method), total flavonoid content (colorimetric method using a chromogenic system of $NaNO_2$–$AlCl_3$–NaOH), antioxidant activity (DPPH method), fatty acids profiles (GC-MS) and the proximate composition (protein, lipids, carbohydrates, ash, dry matter).
According to the obtained results the citrus peels samples contained appreciable amounts of bioactive compounds having as well good antioxidant activity before and also after the extraction of essential oils (e.g. radical scavenging activity varied between 63.64 – 76.55% before essential oil extraction and between 48.55 – 66.91% afterwards). Thus, valuable biomolecules from citrus peels can be recovered after first extracting the essential oil and then further used for the development of functional food or non-food products.
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Keywords: Citrus peels, Bioactive compounds, Food waste, Recovered biomolecules

Incorporación de péptidos antioxidantes y antihipertensivos en liposomas convencionales para el desarrollo de alimentos funcionales

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En la actualidad, una de las principales áreas de investigación en Ciencia y Tecnología de Alimentos es el desarrollo de nuevos productos que cumplan con las necesidades de salud de los consumidores. Este interés ha conducido al nacimiento de los llamados alimentos funcionales, capaces de ejercer efectos beneficiosos sobre el organismo, adicionales al efecto meramente nutritivo (Sagalowicz & Leser, 2010). Las investigaciones se han centrado en la búsqueda de compuestos bioactivos que presentan actividad biológica y que puedan ser utilizados como ingredientes funcionales, para el desarrollo de estos alimentos, pero su incorporación debe ser estudiada pues puede no llegar a ejercer el beneficio que aporta libre por su degradación durante la elaboración o el almacenamiento del producto, o porque el cuerpo humano los destruye antes de que puedan ejercer su efecto beneficioso, en estos casos la encapsulación es una excelente estrategia a seguir. En trabajos previos (Fernández 2017, 2018) hemos optimizado el proceso de elaboración de hidrolizados lácteos con actividad antioxidante y antihipertensivo y hemos estudiado su bioaccesibilidad mediante estudios in vitro celulares y acelulares.

Por lo que el objetivo de este trabajo fue desarrollar un alimento lácteo fermentado funcional utilizando liposomas como vehículo de hidrolizados de suero lácteo (con actividad antioxidante y antihipertensiva).

Para la preparación de los liposomas se utilizó el método de hand shaken siendo la relación hidrolizado:encapsulante 1:5 y el solvente Cloroformo:Metanol fue sustituido por Etanol para ser utilizado en alimentos. La caracterización de los liposomas se realizó mediante cuantificación de fosfatos y colesterol por espectrofotometría, cambios de entalpía y temperatura de transición por DSC y tamaño de partícula por DLS (Cabrera, 2011). A su vez la estabilidad global se evaluó mediante dispersión de luz. Los liposomas desarrollados y los hidrolizados libres fueron incorporados a un alimento lácteo fermentado elaborado con leche en polvo, almidón, gelatina, inulina CRL, stevia, fermento YO-MIX 495 LYO (250 DCU). Y se evaluó su bioaccesibilidad y estabilidad con el tiempo, mediante actividad antioxidante, parámetros microbiológicos (coliformes a 44.5°C, hongos y levaduras) y químicos (acidez) según normativa vigente (MSP 2002).

Ambas formulaciones resultaron aptas para el consumo según análisis químico y microbiológico, y la formulación que utilizó liposomas como vehículo presentó una mayor estabilidad de la actividad antioxidante con el tiempo de almacenamiento y resistencia a las condiciones del tracto digestivo por lo que estamos frente a una alternativa innovadora en la formulación de alimentos funcionales con grandes beneficios para la salud.

Keywords: Yogur funcional, Péptidos bioactivos, Actividad antioxidante, Actividad antihipertensiva, Liposomas

Desarrollo de films alimentarios a partir de lignonanofibras de celulosa provenientes de residuos hortícolas

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El sistema de economía lineal ha sido beneficioso en términos de desarrollo y bienestar social, gracias al avance tecnológico, globalización de los mercados y recursos, disponibilidad energética, etc. En un mundo con recursos limitados, este modelo basado en el uso y desecho de los recursos no es compatible [1,2], y ha llegado a su máximo, derivando en el agotamiento de recursos y la sobreproducción de algunos materiales (ej. plásticos). Resulta necesario evolucionar hacia una economía circular real, con el objetivo de mantener el valor de los recursos, restringiendo el uso de materias primas y energía. De este sistema nace el concepto de "bioeconomía", en el que la biomasa se convierta en materiales con valor añadido.

España es uno de los países con mayor producción de cultivos hortícolas [3]. Dicha producción genera una gran cantidad de residuos, difícil de gestionar por el elevado volumen de éstos. Por otro lado, el destino habitual de estos subproductos supone una gran pérdida de dinero y recursos. En la bioeconomía, la industria se compromete en una producción con un mayor compromiso ecológico, satisfaciendo las exigencias del mercado.

En este trabajo se realizó un pasteo mediante el proceso Specel® de los subproductos generados del cultivo de tomate, pimiento y berenjena. Las pastas de celulosa obtenidas fueron caracterizadas fisicoquímicamente en términos de su contenido en α-celulosa, lignina, holocelulosa, cenizas y extraíbles en etanol, de acuerdo con las normas TAPPI. A partir de éstas se obtuvieron LNFC mediante un pretratamiento mecánico y posterior homogenización a alta presión, que fueron sometidas a una caracterización química evaluando el rendimiento de nanofibrilación, demanda catiónica y tasa de carboxilos. Además, se realizó un análisis espectroscópico mediante FTIR con el fin de detectar posibles cambios estructurales en los materiales, el grado de polimerización mediante la viscosidad intrínseca y análisis termogravimétrico para evaluar la estabilidad térmica de las distintas materias.

Finalmente, con las LNFC obtenidas se realizaron films, con el consiguiente análisis microbiológico, para evaluar su capacidad antimicrobiana frente a microorganismos alterantes y patógenos de alimentos de origen vegetal; con el objetivo de evaluar su aptitud para la formulación de envases alimentarios y/o su incorporación en los mismos.

Keywords: Bioeconomía, Hortalizas, Lignonanofibras de celulosa, Envase alimentario

Elaboração e caracterização de biscoito à base do resíduo de tambaqui (*Colossoma macropomum*) da bacia amazônica

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As indústrias brasileiras de pescado geram em seu processamento em média 70% de resíduos ou subprodutos como ossos, pele, cabeça, barbatanas e vísceras. A maioria desses subprodutos é descartada, ocasionando danos ambientais. O tambaqui *(Colossoma macropomum)* é uma espécie nativa da bacia Amazônica, é a segunda espécie mais produzida, correspondendo a 27,0% da produção total nacional, sendo a Região Norte sua principal produtora. A sua carne tem boa aceitação no mercado consumidor brasileiro, possui sabor atrativo e alto valor comercial. Os subprodutos oriundos da filetagem do pescado são ricos em proteínas que podem ser utilizadas no desenvolvimento de produtos de alto valor agregado. Este trabalho teve como objetivo elaborar e caracterizar um biscoito à base de peixe mediante adição de massa de espinha e carne de tambaqui. A partir de uma cooperação técnica entre o Instituto Federal do Amazonas e a empresa DIPEIXE foi estabelecida a formulação do biscoito contendo como ingredientes massa de espinha e carne, farinha de trigo, amido de milho, azeite de oliva, óleo de coco, cebola e alho desidratados, salsa, alecrim, açafrão, cebolinha, limão em pó, gengibre *in natura*, sal, bicarbonato de sódio e água. As análises realizadas foram à umidade, determinada em estufa a 105ºC até obtenção de peso constante. Os lipídios foram extraídos em aparelho Soxhlet, usando hexano como solvente. As proteínas foram determinadas pelo método de micro-Kjeldahl, utilizando o valor de 6,25 como fator de conversão. As cinzas foram determinadas em mufla a 550°C. A fibra bruta foi obtido no aparelho Determinador de Fibra, modelo TE-149, marca Tecnal. Os carboidratos totais foram calculados por diferença. O valor calórico foi calculado segundo a Tabela Brasileira de Composição de Alimentos. O perfil de ácidos graxos foi determinado por cromatografia gasosa e os minerais por ICP-OES (Shimadzu Co). Os valores médios obtidos foram 3,6 ± 0,024 para umidade, 12,31 ± 0,325 para lipídeos, 20,11 ± 0,359 para proteínas, 9,25 ± 0,348 para cinzas, 53,31 ± 0,630 para carboidratos e 405,34 Kcal/g de energia. Podemos inferir que a adição de massa de espinha e carne na formulação do biscoito se mostrou uma boa alternativa de aproveitamento de resíduos e por consequência teve o enriquecimento nos teores de proteínas e minerais, podendo ser utilizado na recuperação de grupos populacionais com desnutrição.

Keywords: Resíduo, Colossoma macropomum, Biscoito de peixe

Quantificação de ácido fítico em sêmeas de variedades de arroz

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O ácido fítico (AF), ou mio-inositosol hexafosfato (IP6), é um ácido orgânico e é a principal forma de armazenamento de fósforo nos cereais, leguminosas e oleaginosas. No arroz, este composto encontra-se essencialmente na sêmea, mas também no grão, representando 65% a 73% do conteúdo total de fósforo. O IP6 forma complexos muito estáveis com o fósforo e outros minerais, diminuindo a sua disponibilidade e por isso é classificado como um composto anti-nutricional. Contudo, este composto, tem sido estudado pelos vários benefícios na saúde, nomeadamente, o hipocolesterolémico e hipolipidémico. No projeto Arroz-BIG, interessa compreender o mecanismo de inibição da alfa-amilase e explorar a possibilidade do IP6 diminuir a disponibilidade dos co-fatores da enzima.

O teor de AF foi analisado em três variedades de arroz cultivadas em Portugal pelos métodos colorimétrico/enzimático (Megazyme K-PHYT) e por HPLC-IR (cromatografia líquida de alta resolução com detetor de índice de refração). No método enzimático foi feita uma extração ácida com HCl (0,66 M) seguida de desfosforilação enzimática e quantificação colorimétrica com o corante de molibdato. Este método quantifica o AF pela determinação de fósforo na amostra, considerando que todo o fósforo é proveniente do AF. No método de HPLC, foi feita uma extração ácida com HCl (0,5 M), seguida de filtração a vácuo, evaporação do filtrado, diluição do resíduo com HCl diluído, filtração e quantificação por HPLC-RI com uma coluna C18. Este método quantifica diretamente o AF por calibração externa com diferentes concentrações de AF (0,5 a 10 mg/mL) obtendo-se uma correlação linear (R2=0,9996) entre a área do pico IP6 e a concentração de AF.

Os resultados de AF obtidos enquadram-se dentro da variabilidade esperada; para as variedades Maçarico, Ceres e Ariete de 6,5g/100g, 5,2g/100g e 6,1g/100g, respetivamente, pelo método enzimático, e 12,1g/100g, 8,6g/100g e 7,6g/100g pelo método HPLC. As concentrações são superiores pelo HPLC mas, não se verificou uma correlação significativa ($p<0,05$) entre os dois métodos. Entre variedades verificou-se uma diferença significativa ($p<0,05$) nos valores de AF obtidos pelo HPLC; mas não houve diferenças significativas entre os valores obtidos pelo método enzimático.

Os trabalhos futuros irão incidir na purificação do AF, identificação do IP6 por deteção de massa e avaliação da sua ação inibidora da alfa-amilase.

Keywords: Sêmea de arroz, Ácido fítico, Colorimetria, Enzimático, HPLC

Valorization of brewers spent grain as ingredient in food industry

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In recent years, the consumers' global demand for healthier food products is steadily increasing and the development of novel functional ingredients has become a focus of the food industry. In this respect, the exploitation of food by-products as new sources of bioactive compounds may be one of the most sustainable approaches. The exploitation of brewers spent grain (BSG), the main by-product generated by the breweries, to extract functional compounds and develop innovative products is a research direction of great interest from the perspective of food-health relation as well as from the environment protection regulation. With a hypothesis that this by-product could be efficiently valorized in developing new added-value food products, the objectives of the present study was to assess the chemical composition of BSG in several biologically active compounds and to evaluate its influence as food ingredient.

Three prototypes of breadsticks (supplemented with 10, 20 and 30% BSG) were developed and analyzed in order to assess the contribution of BSG to the nutritional value. The proximate composition (protein, fiber, lipid, and minerals) was performed by near infrared spectroscopy, using a NIR FOSS 5000 system. The content in total phenolics (Folin-Ciocâlteu method), flavonoids (colorimetric method), antioxidant activity (DPPH assay), and consumer preferences (hedonic test) were also determined. A statistical analysis was applied in order to determine the significant differences between the values, considering the control sample as reference.

According to the obtained results, the BSG sample contain appreciable amounts of bioactive compounds (e.g. 17.76% protein, 48.12% fiber, 3.92% minerals) having as well good antioxidant activity (e.g. 204.08 mg GAE/100 g and 27.34% RSA). Regarding the breadstick prototypes, the substitution of wheat flour with 10-30% dried BSG led to an increase in the nutritional value and antioxidant properties, in a dose dependent manner. Thus, compared with the control, the addition of 30% BSG increased the total dietary fiber level from 3.2 to 6.71% and the protein from 6.04 to 7.92%. Also, due to the presence of polyphenols, the antioxidant activity increased from 3.01 to 5.39%. As for the sensorial analysis, the most preferred sample was the prototype with 20% BSG.

The obtained results regarding the BSG composition and its influence on the tested prototypes emphasize the great opportunity to reuse this by-product in developing innovative added-value food products.

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Keywords: Brewers spent grain, Bioactive compounds, Functional ingredients, Waste exploitation

Production and antioxidant capacity of citrinin-free *Monascus* pigments produced in cassava wastewater

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Traditionally, the production of *Monascus* pigments has been done through solid-state fermentation by using rice as the main substrate. Currently, the researches for pigment production and other bioactive metabolites of this fungus have been based on the search for alternative cultivation processes, making use of substrates of low cost, such as agro-industrial residues. This study aimed at evaluating the potential of cassava wastewater as the only substrate source in the production of extracellular pigments by *Monascus ruber* using factorial design to optimize the production of the pigments and evaluate of the production of citrinina and antioxidant capacity of the extracts. A full factorial design was conducted (2^3) by varying some parameters: concentration of cassava wastewater (30 to 70%), initial culture broth pH (6 to 8), and the fermentation time (72 to 216 h) to determine the significant variables in the production of pigments. The variables, substrate concentration and fermentation time had statistically significant effects on pigment production within the levels studied, and these variables were employed in the central composite design to optimize the production of this pigment, varying the concentration of cassava wastewater (50 to 100%) and fermentation time (120 to 360 h). The optimum region predicted by the models with 100% of the substrate for the production of yellow, orange and red pigments was observed in the range of 336 to 384 h, which lead to a production of pigments of about 6.0 AU_{400}, 3.5 AU_{470} and 2.4 AU_{510}, respectively. No citrinin was biosynthesized by strain under the experimental conditions using the cassava wastewater. All the samples presented antioxidant capacity and the best correlation with the pigment formation was observed in the ABTS method. This is first report about the production of citrinin-free *Monascus* pigments in cassava wastewater. These results demonstrated the potential of a toxic effluent to environment as substrate for the production of pigments for foods with bioactive potential.

Keywords: *Monascus* pigments, Agro-industrial waste, Antioxidant activity, Natural dye

Microcapsules as carriers of natural bioactives from tomato (*Solanum lycopersicum* L.) pomace extracts: release studies

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Tomato pomace is rich in carotenoids (mainly lycopene), which have been related to important bioactive properties. In general, carotenoids are known to react easily under environmental conditions, which may create a barrier in producing stable functional components for food purposes. This work intended to evaluate the storage stability and *in vitro* release of tomato pomace extract encapsulated by spray drying, using inulin and arabic gum as wall materials.

Frozen tomato pomace was lyophilized and powdered. The extraction of bioactives was carried out with ethanol in a soxhlet apparatus. Encapsulation assays were carried with tomato pomace extract (15%db) and arabic gum or inulin by spray drying (160 and 200ºC; 3.7 $ml.min^{-1}$). Two wall material concentrations (20 and 10%) were used.

Stability studies were performed in desiccators under four conditions as follows: Dark/O_2; Dark/N_2; Light/O_2; Light/N_2. The relative humidity and temperature was kept at 33% and 25 ºC, respectively. Microparticles were periodically analysed during 27 days. *In vitro* static release studies were performed with yoghurt enriched with microcapsules in simulated gastric and intestinal fluids sequentially, at 37 ºC and under mild stirring.

The microcapsules loading capacity values obtained for 20 and 10% of wall material were 1.1 and 1.3 mg lycopene.g^{-1}particles for inulin, and 0.9 and 1.5 mg lycopene.g^{-1}particles for arabic gum. After 27 days of storage in the dark and with nitrogen, the microencapsulated tomato pomace extract with 20% and 10% of wall material presented a lycopene degradation of 11.2 and 41.2% for inulin, and 43.6 and 49.9% for arabic gum. In general, lycopene degradation was highly influenced by the presence of oxygen and light, even when encapsulated.

During the release studies, more than 60% of the entrapped bioactives were released from the arabic gum particles in simulated gastric fluid, while for the inulin particles the release was only approximately 15%. As such, inulin enabled a higher bioactive protection until reaching the intestinal conditions increasing their bioaccessibility.

Overall, this study highlights that the microencapsulation of the tomato pomace extract using inulin as a wall material is a good strategy to improve carotenoids stability during storage, as well as increased protection of bioactives through gastric conditions, allowing a preferential release in intestinal conditions.

Keywords: Bioaccessibility, Storage stability, *In vitro* digestion, Tomato pomace extract, Bioactive compounds, Yoghurt

Impact of Aurantiochytrium sp. microalgae extracts on oxidative stability of mayonnaise

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Mayonnaise, typical oil-in-water emulsion, is a product very susceptible to lipid oxidation leading to formation of undesirable compounds, as free radicals and reactive aldehyde leading to quality deterioration. The synthetic antioxidants (ethylenediaminetetraacetic acid – EDTA, butylated hydroxyl anisole – BHA and butylated hydroxytoluene – BHT) have been widely used by food industry to attain oxidative stability and shelf-life extension. However, new and natural sources, enriched with biological and functional compounds have been tested and proposed in order to achieve industry and consumer requirements of healthier foods. In this sense, *Aurantiochytrium* sp. microalgae appears as a promising alternative since synthesizes significant amounts of compounds with high value and commercial interest like docosahexaenoic acid (DHA), squalene, antioxidants and others. Additionally, the valorisation of by-products by biotechnological processes are becoming increasingly important in the scope of the biorefinery concept, towards greener and more sustainable processes. The main goal of this study was to evaluate the addition of extracts from *Auranthiochytrium* sp. microalgae on traditional mayonnaise formulation under accelerated storage conditions (45 days at 40 ^{o}C), where oxidative stability (peroxide value, thiobarbituric acid reactive substances (TBARS)), colour (L*, a*, b*) and antioxidant capacity (total phenolics content, DPPH scavenging activity) were assessed. Two mayonnaise samples were taken account as control (with and without synthetic additive). Mayonnaise samples enriched with microalgae extracts, retarded the formation of primary and secondary oxidations products, compared to control mayonnaise samples, revealing the highest protection regarding lipid oxidation, while colour enhancement was observed. Moreover, the maximum antioxidant capacity was achieved immediately at day 0, in mayonnaise enriched with microalgae extracts. Overall, this study demonstrates the potential of biomass extracts application, obtained from biotechnological process of *Aurantiochytrium* microalgae for DHA and squalene production, into mayonnaise reformulation, as strategy to retard lipid oxidation resulting into quality improvement.

Keywords: Microalgae, Antioxidants, Quality, Storage, Mayonnaise

Antimicrobial activities of artichoke (*Cynara scolymus*) purified extracts

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Artichoke (*Cynara scolymus*) solid wastes are rich in phenolic compounds such chlorogenic (CGA), quinic (QA) and caffeic acids (CA), which are reported as antimicrobials. Therefore, its revaluation through the production of extracts that could contain these phenolic compounds is interesting for environmental aspects as well as microbiological. Several solvent based extracts from artichoke or its parts have been tested for antimicrobial effect. But it is usually reported that the extracts still contain solvents such as ethanol or methanol which are well known for their antiseptic properties. This fact, poses a question: If the solvent is complete removed, ¿Have the purified extracts from the artichoke solid wastes antimicrobial effect? The aim of this work was to evaluate the effect of a purified extract on 6 microorganisms to evaluate its antimicrobial effect. The microorganisms tested were: *Escherichia coli*, *Salmonella tiphymoriun*, *Sthaphylococcus aureus*, *Proteus Sp*., *Micrococus Sp*. and *Listeria monocitogenes*. The extract was produced by hydroacoholic extraction at 45°C; then the solvent (ethanol) was removed in rotary vacuum equipment, and the aqueous part was lyophilized. The purified extract was dissolved in the growth media used. The purified extracts were tested on the 6 strains and several controls were run. Control 1: Growth medium without extract; Control 02: Growth medium plus ethanol 1% and extract; and Control 03: Growth medium plus ethanol 10% and extract.
The extract shows a positive effect in the growth of *Escherichia coli* (16.4%) and *Micrococus Sp*. (27.2%); in fact, an effect as growth factor was observed instead antimicrobial effect reported in the literature. No significant effect was observed in the growth of *Salmonella tiphymoriun, Sthaphylococcus aureus, Proteus Sp.* and *Listeria monocitogenes*. Control 02 and control 03 showed an inhibitory effect on all strains. Hence, the presence of at least 1% of ethanol in the extract is enough for attributing an antimicrobial effect to any extract. Therefore, there is a methodology concern about the presence of solvents during the antimicrobial effect evaluation.

Keywords: Artichoke solid waste, Purified extracts, Antimicrobial activity, Solvent removal

Avaliação microbiológica e sensorial de doce em massa elaborado com araticum (*Annona crassiflora* mart.) e albedo de maracujá

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O cerrado brasileiro possui grande diversidade de frutos com grande potencial econômico e nutricional, ainda pouco explorados. Entre eles está o Araticum, muito consumido in natura ou processado, no entanto, poucos dados estão disponíveis na literatura quanto á sua aplicação tecnológica. O incremento do resíduo do maracujá às formulações agrega valor ao produto devido a sua grande quantidade de fibras. Esses resíduos que normalmente são desprezados demonstram um grande potencial para serem utilizados como matéria-prima na elaboração de novos produtos. Este trabalho tem como objetivo processamento do fruto do araticum na forma de doce com substituição da pectina comercial por albedo de maracujá, bem como a avaliação deste, quanto a sua qualidade microbiológica e sensorial. Para o processamento do doce foi utilizado um delineamento experimental com 11 ensaios, variando concentração de ácido cítrico, razão polpa/açúcar e concentração de albedo. As formulações foram submetidas ao processo de concentração à pressão atmosférica e sessado o processo ao atingirem 75ºBrix. Foram realizadas pesquisa de *salmonella*, *staphylcoccus aureus*, coliformes totais e termotolerantes e bolores eleveduras. Para sensorial foi realizado teste de aceitação com 34 provadores não treinados, quanto aos atributos de aroma, sabor, textura, impressão global, atitude e intenção de compra. Constatou-se ausência de todos os microrganismos pesquisados nos doces, denotando boas práticas de manipulação e fabricação dos doces, atestando a segurança aos provadores. As formulações que obtiveram maiores médias entre os atributos foram a 10 e 11, ambas com 0,5% de ácido cítrico, razão polpa/açúcar 50/50 e 1,5% de albedo de maracujá. Apenas o atributo sabor apresentou diferença, nas formulações 5 e 7, todos os demais não apresentaram diferença significativa pelo teste de tukey a 5%. Os demais atributos se aproximaram da média 8, que na escala hedônica indica gostei muito. Quanto a intenção de compra as notas ficaram entre 2 e 4, na escala hedônica, 2 indica “provavelmente não compraria”, 3 indica “tenho dúvidas de compraria” e 4 “provavelmente compraria”. Demonstrando assim uma boa aceitação dos doces**.**

Keywords: Frutos do cerrado, Albedo, Sensorial

Faba bean (*Vicia faba*) pod: a waste or an ecofriendlly nematicide?

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Root-knot nematodes (RKN), *Meloidogyne* spp., is one of the most important plant parasitic nematode, causing significant quality and quantity production losses of a wide range of crops, some of them with relevant economic importance. Society's concerns regarding public health and environment, beyond the need to achieve objectives related with the planet sustainability, have created the need to find eco-sustainable alternatives for synthetic chemical pesticides, including for nematicides. On the other hand, sustainability can be promoted through Circular Economy, converting waste into resources. Thus, the main objective of this study was to evaluate the bionematicidal potential of an agrofood waste, faba bean (*Vicia faba*) oxidized and fresh pod extracts, on second juvenile stage (J2) of *Meloidogyne javanica*. *In vitro* studies were carried out using the two types of extract above mentioned with different extraction solvents (water, 20% ethanol and 70% ethanol) and three different temperatures (45, 60 and 75°C), all with a concentration of 0.05 g / mL, and using distilled water as a control. Four replicates were made for each extract treatment and for control. The alive, immobile and dead nematodes were observed at 24, 48, 72 and 96 hours after the experiment beginning. All the extracts studied had nematicidal potential on *M*. *javanica*. It was observed 100% mortality in the oxidized pod extracts at 72 hours and in the fresh faba bean pod extracts at 96h, being the oxidized faba bean pod extract with 20% ethanol solvent, extracted at 75°C the most effective. The results showed that this waste have high nematicidal potential and may therefore constitute raw material for the development of eco-sustainable alternatives. Nevertheless, studies that lead to the proposal of a new bionematicide should be carried out.

Keywords: Bean faba pod extracts, *Meloidogyne javanica*, Plant nematodes, *Vicia faba*, Waste

Effect of high hydrostatic pressure and enzymatic hydrolysis on the extraction of phenolic compounds from grape pomace

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Grape pomace is characterized by its high content bioactive compounds, such as proanthocyanidins. However, these compounds may be strongly bound to their cell wall matrix, which can difficult their extraction. In this sense, alternatives such as the use of enzymes and application of high hydrostatic pressure (APH) may be efficient to improve their release. The objective of this work was to evaluate the effect of enzymatic hydrolysis and high hydrostatic pressure on the extraction of total phenolic compounds (TPCs) and proanthocyanidins (PAs) from grape pomace, using an enzymatic complex produced by solid state fermentation. For this purpose, Alicante Bouschet grape pomace was extracted for 30 minutes in 4 different conditions: (H1) enzymatic hydrolysis with no APH, (H2) enzymatic hydrolysis with the enzyme previously submitted to APH, (H3) enzymatic hydrolysis simultaneously with APH, and (H4) APH extraction without addition of enzymes. For all treatments, a solid:liquid ratio of 1:8 (grape marc: 0.02 M sodium acetate buffer solution) was used, at pH 5.0. For the H2, H3 and H4 treatments, three pressure levels were tested (50, 100 and 200 MPa). The TPCs were determined by the Folin-Ciocalteu methodology (expressed as mg gallic acid equivalent/100g) and PAs (expressed in g equivalent catechin/100g) were evaluated by the acidified vanillin method. Both enzymatic hydrolysis and APH application improved the bioactive compounds extraction. The enzymatic hydrolysis with APH at 200 Mpa for 10 minutes of extraction resulted in the highest recovery of TPCs and PAs (906.34 mg AGE/100 g and 17.50 g CE/100g). After 10 minutes, a slight reduction was observed in the values of both compounds, except for the H1 treatment. This result may suggest that longer times of APH may negativelly affect the enzymes activity, instead of potentialize it.

Keywords: High hydrostatic pressure, Enzymatic hydrolysis, Proanthocyanidins, Phenolic compounds

Effect of the addition of whey protein and lupine (*Lupinus mutabilis sweet*) flour in the elaboration of bread with ecuadorian wheat (*Triticum spp.)*

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Ecuadorian wheat (*Triticum spp.)* is a kernel few cultivated and underused in the food industry because have a low protein content, in particular, the gluten suitable to make bread and other products. Whey protein and lupine (*Lupinus mutabilis sweet*) flour could be used to forficate Ecuadorian wheat to maximize breadmaking properties in the dough. The aim of this work was to study the effect of partial substitution of whey protein and lupine (*Lupinus mutabilis sweet*) flour, by Ecuadorian wheat (*Triticum spp.)* in functional and sensory properties. Commercial Ecuadorian wheat flour, Chimborazo variety, was used. Whey was obtained from a dairy local factory, and, lupine flour, salt, sugar and yeast were obtained from local markets. For whey protein extraction, membrane technology was applied. Tangential microfiltration with pore size of 0.2 µm, tangencial nanofiltration with a membrane of 5 KDa and diafiltration 1:4 (water:feeding) were used. To optimize breadmaking properties, a response surface methodology was carried out between wheat flour, whey protein and lupine flour in different levels: 90-75%, 5-15% and 5-10%, respectively. The different mixtures were analyzed in Chopin's Mixolab 2 equipment using "Chopin +" protocol, where breadmaking properties of the doughs were determined: water absorption, retrogradation of starch, alpha-amylase activity, viscosity, gluten strength and kneading. For breadmaking, the Chorleywood baking method was used. Volume, weight, loaf volume and heigh of breads were determined. All the response values obtained were analyzed by a multiple response optimization analysis, which allowed to determine the optimal amount of addition of whey protein and lupine flour to the mixture. Finally, an acceptability test was carried out with the optimal mixture. With membrane technology, whey protein was concentrated from 1 to 89%. Best mixtures of wheat flour, whey protein and lupine flour in dough characterization of Mixolab were 90, 5 and 5%, and 86, 10 and 4%, respectively and correlated with best loaf volumes (2.47 to 2.59 cm^3/g, respectively). The optimization of multiple response analysis showed that the best content of whey protein and lupine flour in the mixture were 4.58 and 3.38%, respectively. Loaf volume of this mixture was 2.84 mL/g, similar with a control product made of wheat flour imported with high level of gluten. The bakery aptitude tests showed favorable results, where the control product and the optimized product exceeded the minimum stipulated by international standard, with an assessment of 63.5 and 74.5 out of 100, respectively.

Keywords: Ecuadorian wheat, Breadmaking, Whey, Lupin, Fortification

Extraction yield and functional properties of proteins from coffee pulp (coffea arabica) obtained by wet processing

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The quantification of the protein present in the coffee pulp and the evaluation of its functional properties was performed in this work. In order to evaluate the influence of operating conditions in protein extraction, an experimental design using as factors the pH, temperature and time was applied, two levels each factor were assayed: pH 9 and 12, temperature 25°C and 40° C and time 60 and 120 minutes. The isoelectric precipitation of protein was employed for the separation of proteins and the quantification was done by the Bradford method. Protein isolate yield was 11.72%, giving a total protein extraction of 58,74%. The highest protein purity was obtained from the pulp pretreated with a blanching treatment, with a value of 667,14 ± 7,05 mg protein / g isolate. It was found that pH and temperature had a significant effect on protein extraction, but time did not affect the extraction of protein from coffee pulp. Employing the protein isolate obtained with the best operation conditions of extraction, the functional properties were evaluated, finding a solubility of 85,93%, water holding capacity of 7,10 ± 0.62 g/g and oil holding capacity of 1,75 ± 0.41 g/g, consequently its use for baking and meat industry could be considered. Emulsion capacity value was 50.71 ± 1.89%, emulsion stability was 58,33 ± 2.18% and foaming capacity was 33,67 ± 4.73%, these results were lower than soy protein isolate for instance, therefore its use in industries where foam formation is required is not recommended. These results show that protein extraction from this agroindustrial waste obtained during coffee production, could be a good alternative of valorization.

Keywords: Coffee pulp, Protein, Alkaline extraction, Precipitation, Functional property, Blanching

Olive pomace powders: development and characterisation of new functional food ingredients

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Olive pomace (OP) is semisolid underutilised biomass, but it is also a significant source of fibre and polyphenols with beneficial effects to human health. The development of new food ingredients from byproducts has been widely investigated. However, most of the techniques employed are not considered "green" practices (use of organic solvents) or possess higher total operational costs (novel eco-friendly techniques). The development of powdered products without any extraction step is an excellent solution to obtain natural value-added ingredients safety and environmentally friendly. Besides that, the powdered products may retain several functional compounds, namely fatty acids, polysaccharides, minerals and polyphenols together and in association ascribing multifunctional properties.

The main goal of this study was to develop a fractionation approach to achieve new food ingredients – (1) liquid-enriched powder (LOPP) and (2) pulp-enriched powder (POPP), which may have higher health-promoting effects than dietary fibre and polyphenols itself.

The proximate analysis, fibre profile composition, mineral and fatty acid composition were performed. The free phenolic and bound phenolic profile have been acquired by HPLC. Antioxidant activity (AOX) of free and bound phenolics was analysed using the methods DPPH and ABTS [mg Trolox equivalents/100 g DW]. Safety tests as XTT and Ames test were also executed in order to ensure safety of developed ingredients.

The LOPP exhibited a high AOX, a significant amount of potassium (5.4% DW) and more than 5 mg of hydroxytyrosol and derivatives/g DW. Therefore, a daily consumption of less of 1 g would provide the amount of hydroxytyrosol and its derivatives needed to protect LDL particles from oxidative damage, according to the health claim (EFSA). The LOPP higher amount of potassium also has favourable effects to cardiovascular health, i.e. reduction of blood pressure and decrease the risk of the stroke. The POPP exhibited a considerable amount of total dietary fibre, mainly insoluble fibre (cellulose and hemicellulose) with significant amount of bound polyphenols linked. The insoluble fibre could be fermentable and increase the amount of beneficial bacteria and short-chain fatty acids, at same time that bound polyphenols could act as antimicrobial agents against pathogens and create an antioxidant environment in the gut. The toxicity assays demonstrated that these ingredients are safe.

As conclusion, the olive pomace powders could be applied as functional ingredients into fortification of food products as a source of dietary fibre, phenolics, but also of fatty acids and minerals with safety and health benefits to the consumer.

Keywords: Olive pomace, Powdered products, Antioxidant dietary fibre, Hydroxytyrosol

Biocompatibility of *Salix viminalis*, *Salix atrocinerea* and *Salix fragilis*

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Current consumer trends point at an increase in the interest, and subsequent demand, of more natural products with less added chemicals. Considering this shift in mentality, natural extracts present themselves as an interesting alternative to traditional additives, particularly as they may contribute not only to the stabilization of the matrix they are incorporated into, but also its functionality. *Salix* extracts have been traditionally used as a part of herbal medicine and therefore present an interesting venue through which to improve the functionality of edible and cosmetic matrixes. However, the use of extracts may raise some safety concerns, particularly when considering that, even when the extracts are attained from edible source, the overall intake of bioactive ingredients may be significantly higher than that a normal diet would encompass. Considering this, the present work aimed at characterizing the biocompatibility of three different hydrophilic *Salix* extracts (*S. viminalis*, *S. atrocinerea* and *S. fragilis*) considering their impact upon the metabolic activity, proliferation and membrane integrity of CaCo-2, HaCat and L929.

Overall, metabolically wise, CaCo-2 cell line was the less susceptible to the extracts presence with only the highest concentration of *S. atrocinerea* (2.5 mg/mL) and the lowest concentration of *S. viminalis* (0.625 mg/mL) resulting in metabolic inhibitions above 20%. In fact, the lower concentrations of *S. atrocinerea* (1.25 and 0.625 mg/mL) and all concentrations of *S. fragilis* (2.5, 1.25 and 0.625 mg/mL) resulted in a stimulation of cell metabolism. All extracts exhibited some inhibitory effect upon L929 cell line with only the lower concentrations of *S. atrocinerea* and *S. fragilis* (1.25 and 0.625 mg/mL) exhibiting inhibitions below 20%. For HaCat the lower concentrations of *S. viminalis* (1.25 and 0.625 mg/mL) and the highest concentration of *S. atrocinerea* (2.5 mg/mL) were the only ones that exhibited inhibition percentages above 20% with the lower concentrations of *S. atrocinerea* and *S. fragilis* (1.25 and 0.625 mg/mL) exhibiting some metabolic stimulation. Moreover, it is interesting to note that, while in most cases, the loss in metabolic activity was not accompanied with an increase in lactate dehydrogenase release (an indicator of membrane damage) all extracts, regardless of the concentration tested, resulted in inhibitions of cell proliferation for HaCat and L929, ranging from 35 to 55%, respectively. The only exception was CaCo-2 whose proliferation appeared to be stimulated by all extracts.

Keywords: *Salix* extracts, metabolic inhibition, membrane damage, cell proliferation

Valorization of natural extracts as potential enzymatic browning inhibitors in processed fruits

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Lifestyles of modern consumers, along with the demand for natural, fresh, flavourful, convenient and high-quality products with health benefits have raised the production and consumption of processed fruit. The continuous increase in the consumption of processed produce implies the need to improve supply and distribution systems ensuring quality of these products. Processed fruit browning inhibition represents a challenge for the Food Processing Industry. Browning is often associated with undesirable off-flavors, negative effects on taste and nutritional value and, consequently, shorter shelf life and consumer rejection. Processing causes major tissue disruption, whereby enzymes and substrates sequestered in different organelles come in contact and signaling-induced wound responses are initiated. Consequently, microbiological, enzymatic, and physicochemical reactions take place, accelerating the oxidation of natural phenolic compounds into quinones that are polymerized to brown pigments by polyphenol oxidase (PPO). Peroxidase (POX) is also alleged to be related to browning development, by inducing H_2O_2 oxidation of phenolic compounds[1]. The processing technology to prevent browning reactions, catalyzed by these enzymes, has traditionally been the application of various chemicals, as ascorbic and citric acids[2]. However, there is a rising interest in natural antioxidants as bioactive components of foods. Thus, in this study it is assessed the potential of natural extracts, with antioxidant properties (such as soy protein concentrate, extracts of apple byproduct and olive leaves) as novel enzymatic browning inhibitors. The antioxidant capacity was assessed by the radical scavenging assay using $ABTS^{+}$ radical. The natural extracts inhibitory effect on PPO and POX activity was evaluated using a spectrophotometric assay by reaction of the natural extracts with the pure enzymes, using catechol and guaiacol as substrates, respectively. The present study demonstrated that olive leaves extract had the highest antioxidant capacity (2.688 ± 0.006 mg/mL TEAC equivalent). However, apple byproduct extract was the most effective at inhibiting PPO and POX activities. The study has practical implications in generating novel natural extracts with potential application in the fruits and vegetables processing industry, as new anti-browning agents.

Keywords: Food Conservation, Browning disorder, Oxidative enzymes inhibition, Antioxidants, Natural extracts

Impact of dietary carotenoids on consumers' acceptance of the sea urchin *Paracentrotus lividus*

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The edible parts of the sea urchin are the gonads, which are within the list of expensive seafood products. Knowledge about consumer perception towards this highly demanded gourmet product is not yet well known. Sea urchin colour is considered as the first quality attribute used by consumers, impacting the visual assessment and freshness perception of sea urchins' gonads. The regular production of high quality and prized gonads in aquaculture largely depends on the capacity to produce gonads with a colour highly accepted by consumers. The aim of this work was to evaluate the impact of diets including different sources of carotenoid pigments on the visual appearance of the sea-urchin gonads, using fast profiling techniques, such as Check-All-That-Apply(CATA). Four extruded diets containing 30% protein and 6% fat were enriched with two β-carotene sources: paprika (PAP) and synthetic β-carotene (BC) at two incorporation levels (10 and 25 mg β-carotene/kg). A non-supplemented diet was used as control (CTRL) diet. A panel of 48 untrained panellists was asked to evaluate the gonads following a CATA ballot with a list of 16 sensory attributes divided into two dimensions: appearance (8) and odour (8). The data showed that consumers of sea urchin gonads clustered the samples in three different groups. The group of all females and males fed PAP25 were characterized by attributes such as 'appealing appearance' and 'orange colour' and also by a 'pleasant' and 'sea odour'. Females fed BC25 or PAP10 were also associated with 'soft appearance'. In another group, males fed BC25 were described as 'not appealing' and finally, the other males constituted a group characterized by a 'grainy appearance' and 'yellow colour'. Multiple dimensional analysis (MDA) supported that females fed BC10, CTRL or PAP25 were highly associated with an 'orange colour' and 'appealing appearance'. Males fed PAP10 and BC25 diets were intrinsically related with not desirable attributes, for instance 'brownish colour', and 'soft' and 'not appealing appearance'. Males fed BC10 or CTRL diet were associated with a 'grainy appearance'. However, males fed PAP25 diets were strongly related with a 'pleasant odour'. These results show that samples of the first group were related with positive attributes ('pleasant' and 'appealing'), whereas the other samples were mostly characterized by less demanded attributes, for instance 'not appealing', 'yellow' and 'grainy'. In sum, female gonads evoked positive sensations, while the majority of the males' gonads induced undesirable sensations to consumers.

Keywords: Gonad colour, Diet, Carotenoids, Sensory quality, *Paracentrotus lividus*

Caracterização físico-química de biscoitos tipo cookie incorporados de ingredientes alternativos para pacientes celíacos

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O objetivo deste trabalho foi produzir cookies com farinhas mistas de banana verde (BV), de folhas de moringa (*Moringa oleifera*) (MO) e de albedo de maracujá amarelo (*Passiflora edulis*) (AM), e compará-los por meio de análises físico-químicas. A banana verde tem abundância de amido resistente. A moringa é uma Planta Alimentícia Não Convencional (PANC) com reconhecida atividade hipoglicemiante. O albedo do maracujá foi obtido de cascas dessa fruta, que é um subproduto das indústrias alimentícias, e é rico em fibras solúveis. As farinhas foram obtidas por secagem das matérias-primas em estufa com circulação forçada de ar a 105 ºC e posterior moagem. Os cookies foram elaborados com 3 formulações de farinha mista (BV:MO:AM), sendo elas: F1 = 80% BV, 10% AM, 10% MO; F2 = 75% BV, 20% AM, 5% MO; F3 = 70% BV, 15% AM, 15% MO; e comparados com uma formulação padrão, sem farinha mista. Todos os cookies possuíam ainda farinha de arroz, em substituição à farinha de trigo, açúcar mascavo, essência de baunilha, gotas de chocolate, fermento biológico, manteiga e ovos. Os produtos foram analisados quanto a umidade (U), proteína (P), lipídeos (L) e cinzas (C). Carboidratos (Cb) foram calculados da seguinte forma: 100 – (%U + %P + %L + %C). O valor energético foi calculado como: (%Cb × 4) + (%P × 4) + (%L × 9). F1 foi a amostra com mais cinzas (2,90% ± 0,17), proteínas (7,71% ± 0,02) e carboidratos (83,54%), entretanto com menor teor de lipídeos (4,80% ± 0,20) e umidade (1,05% ± 0,04). Todas as formulações atenderam ao Regulamento Técnico Brasileiro para Produtos de Cereais, Amidos, Farinhas e Farelos, que estabelece umidade máxima de 15% para esse tipo de produto; e apresentaram predominância de carboidratos, dentre os componentes avaliados, com variação de 70% (F3) a 83,54% (F1). O menor teor de carboidratos em F3 se relaciona à maior concentração de farinha de MO (15%) e menor de BV (70%) na sua composição. A incorporação das farinhas mistas reduziu o valor calórico de 419,2 kcal (padrão) para até 400,0 kcal (F3). Esses dois parâmetros tornam o biscoito F3 atrativo não apenas para pacientes celíacos, pela ausência de glúten, mas também para pessoas que desejam incluir alimentos mais saudáveis, com menor índice calórico na sua dieta. Tecnologicamente, a formulação com mais farinha de BV (F1) tende ter a uma maior estabilidade devido sua menor umidade, e, portanto, mais viabilidade para comercialização.

Keywords: Doença celíaca, Moringa, Banana verde, Albedo de maracujá

Malting cereals as a tool for biofortification

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Some soils are poor on selected minerals, and so are the plants that grow on them. An important part of the population suffers from dietary deficiency on essential micronutrients, being iron and zinc the most relevant ones. Biofortification is considered a better approach than adding mineral salts into processed products. It is usually done by the modification/selection of plants with improved absorption and accumulation potential, or by exogenous strategies such as soil application or foliar spraying to compensate possible soil deficiencies. Our approach is to modify the regular cereal grains by a germination/malting process. Germination is an agronomic biotechnique for food processing, considered as a relatively inexpensive and effective method to improve nutritional content of processed grains. The stepping water can be reused, reducing the environmental problems caused by draining an excess of minerals from fertilisers into groundwater.

Germination reduces the levels of antinutrients like phytic acid, and thus increase the bioavailability of micronutrients. Specific bioactive compounds are produced during the germination of some grains, as GABA in rice. This is the major inhibitory amino acid transmitter in the central nervous system, and it is reported to stimulate physical and mental capacities.

The grains were stepped in aqueous solutions for a continuous 24 h period, as this procedure didn't show any significant difference in germination rate with 8h+16 h wet and dry rests (or the reverse). The germinating seeds uptake part of these salts, increasing the metal content. These compounds can be incorporated into organic forms by the activity of the embryo. No differences on germination rate were observed for up to 2 g/L ferrous or ferric solutions, although some authors have reported a possible compromise on the germination rate with high iron concentration. Germination rate peaked at 87±2% on the 2nd day of germination with a sprout of about half the length of the grain (3.6 mm for *japonica* varieties and 5.4 mm for *indica* varieties). This modification of the rice kernels induced compositional changes, increasing lysine content from 2.6 g/Kg to 3.1 g/kg and GABA content from non-detectable to 0.36 g/Kg, compared with non-germinated brown rice. Technological properties were also improved by germination, with a reduction on cooking time by ~10%, although colour became darker, with lower L* and higher Chroma values.

These results show the high potential of this approach. Future developments will be included in the PRIMA-Boomerang project that will start by the end of 2019.

Keywords: Biofortification, Stepping, Germination, Micronutrient malnutrition

Sustainable Innovation in Food Product Design

Consumer Behavior

Oral Communications

Aceitação sensorial de presuntos cozidos com reduzido teor de sódio com aplicação do ultrassom e cloreto de potássio

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Presunto cozido é um dos produtos cárneos mais consumidos. O NaCl é utilizado para atribuir características sensoriais desejáveis e auxiliar na estabilidade. A ingestão excessiva de sódio tem sido associada a doenças cardiovasculares. A substituição parcial do NaCl por outros ingredientes e o uso de tecnologias alternativas, como o ultrassom, vêm sendo estudadas para promover as propriedades sensoriais desejáveis. Avaliou-se a influência da adição do cloreto de potássio e o uso do ultrassom (10 min. a 600W.cm^{-2}) sobre a aceitação sensorial de presuntos cozidos com baixos teores de sal. Foram produzidos quatro tratamentos com adição de 0,50% de NaCl: T1 – Controle – sem adição de ultrassom e KCl; T2 – com ultrassom; T3 – com 0,50% de KCl; T4 –com 0,50% de KCl e ultrassom. As amostras foram apresentadas codificadas com números de três dígitos, de forma monádica sequencial, utilizandose escala hedônica de 9 pontos para os atributos: cor, sabor, gosto salgado, textura e aceitação global, para 106 potenciais consumidores. Para cor, T3 apresentou maior nota (7.64) e T1 a menor (7.08), contudo T2 (7.24) e T4 (7.51) não diferiram de T3 nem de T1. Para sabor, T3 e T4 não diferiram e obtiveram as melhores notas (7.32 e 7.39); T2 (6,90) não diferiu de T3 e foi maior que T1 (6.37), mostrando que o ultrassom e o KCl auxiliam no sabor. Para o gosto salgado, T3 e T4 não diferiram e obtiveram as melhores notas (7.22 e 7.29); T2 (6,75) não diferiu de T3 e foi maior que T1 (6.09), mostrando que o ultrassom e o KCl auxiliam no gosto salgado. Para textura, T3 e T4 não diferiram e apresentaram as maiores notas (7.51 e 7.59) comparadas às de T1 (6.49) e T2 (6.83) que não diferiram entre si, evidenciando que apenas o KCl colaborou para aceitação da textura. Na aceitação global, T4 (7.48) e T3 (7.44) não diferiram entre si e foram maiores que os outros; T2 (6.91) foi maior que T1 (6.42), mostrando que o ultrassom e o KCl auxiliaram a aceitação global, contudo T3 apresentou melhor nota que T4. O ultrassom e o KCl aumentaram a aceitação sensorial e podem auxiliar no processamento de presuntos cozidos com redução de sal. A adição de KCl foi mais eficiente e colaborou para um melhor resultado em aceitação sensorial em presuntos cozidos de baixo teor de sódio quando comparado com o uso do ultrassom.

Keywords: Presunto cozido, Ultrassom, Sódio, Cloreto de Potássio

Check all that apply test to describe low-fat salami type Italian addded with dietary fibers

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Meat researchers need to develop healthier products to meet the needs of new consumers. Dietary fibers have been added as fat substitute in fermented sausages to achieve certain functional characteristics and to maintain the sensory attractive of to the traditional formulation. The effects of partial substitution of pork fat by inulin, fructooligosaccharides (FOS) and α- cyclodextrin (ACD) on the sensory quality of low-fat Italian type salami were investigated. It was evaluated 9 formulations of Italian type salami: C1(80% lean pork, 20% pork back fat); C2 (80% lean pork, 10% pork back fat), T1(80% lean pork, 10% pork back fat, 2% inulin), T2 (80% lean pork, 10% pork back fat, 2% FOS), T3 (80% lean pork, 10% pork back fat, 2% ACD), T4 (80% lean pork, 10% pork back fat, 1% inulin, 1% FOS), T5 (80% lean pork, 10% pork back fat, 1% inulin, 1% ACD), T6 (80% lean pork, 10% pork back fat, 1% FOS, 1% ACD), T7 (80% lean pork, 10% pork back fat, 0.66% inulin, 0.66% FOS, 0.66% ACD). Meat raw materials were ground into a 10mm, mixed with the ingredients and the batch was stuffed into collagen casing (Ø60mm). The fermentation process (3 days - 25º / 95% RH) and drying (10 days - 15ºC / 75% RH) were in to a maturation chamber. The sensory analyses performed were Check all that apply (CATA). The terms descriptors were pre-selected in a tasting of two commercial Italian salami found in the local market. The pre-selection group were 6 consumers of this type of meat product. The multivariate analysis could explain 75.85% of the data obtained in the CATA. All treatments added with ACD showed correlation with the term descriptor “pale”, “whitish color”, “brittle texture”, “spicy”, “sweet taste”, “acid flavor”. The other treatments (Controls and low-fat added inulin and FOS) can be correlated with the term descriptor: “uniform appearance”, “red color”, “brightness”, “juiciness”, “characteristic”. Based on the results, the partial replacement of pork fat by 2% of inulin or FOS can be performed without affecting the main sensorial characteristics of an Italian type salami.

Keywords: Inulin, Fructooligosaccharides, α- cyclodextrin, Term descriptor

Impact of the physical state of sugar on the sweetness of baked goods

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Objective of this research is to understand the impact of the physical state of sugar on the sweetness and texture of baked goods such cakes and cookies. This is important in the formulation of reduced-sugar products with maximized perceived sweetness. A model formulation containing equal parts by weight of butter, sugar, and flour was modified by the addition of increasing amounts of egg, transforming it stepwise into a traditional pound cake. This allows to evaluate of the effect of water (specifically from egg) on the physical state of sucrose in the product matrix.

Using X-ray diffraction (XRD) it is established that that the crystallinity of the sucrose in the product matrix after baking decreases linearly (correlation coefficient R^2 = 0.93) from 85% for the recipe without egg (the "cookie" matrix) to 18% for the recipe that contains equal parts of egg, sugar, flour and butter (the "cake" matrix). Our analysis shows furthermore that the degree of solubilization of sucrose by the water from the egg is very close to the solubility limit of sucrose in water.

From differential scanning calorimetry (DSC), we infer that the dissolved sucrose is associated with two amorphous phases: a phase that is characterized by a glass transition temperature (T_g) that is close to pure amorphous sucrose, and a phase with a T_g that is about 20 ºC lower than pure starch. Upon dissolution in the cake matrix, the sucrose thus partitions into two phases: a concentrated sucrose phase that is characterized by a high molecular mobility and a phase of lower molecular mobility that consist mainly of starch with a minor fraction of sucrose but that is plasticized by the limited amount of sucrose.

The sweetness of the baked products is assessed by sensory analysis (Just-About-Right (JAR) test; n = 33 participants; scale = 1 (not sweet enough) to 5 (too sweet)). The JAR sweetness is observed to decrease linearly (R^2 = 0.85) from 3.31 ± 0.10 for the recipe without egg (the "cookie" matrix) to 2.25 ± 0.15 for the "cake" matrix.

Our results demonstrate that the sweetness of baked goods is strongly impacted by the physical state of sugar: a product with a higher fraction of crystalline sugar is perceived as significantly sweeter than a corresponding product in which the sugar is amorphous. This provides for a novel strategy for designing baked products with reduced sugar content but with high a sweetness perception.

Keywords: Sucrose, Starch, Cake, Differential scanning calorimetry, DSC, X-ray diffraction, Glass transition, Water, Crystallinity

Evaluation of consumers' acceptance of bread supplemented with insect protein

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Edible insects are consumed worldwide, especially in Asia, Africa and Latin America, being a major food source for human and feed. Although insects have a good nutritional value and high-quality protein, European consumers tend to reject edible insects as an alternative food [1]. The aim of this work was to evaluate the factors that influence the acceptance of bread supplemented with insect flour protein. An online survey was applied to 282 Portuguese regular consumers of bread (61% women, aged 42.0±11.3 years old). An exploratory factorial analysis was carried out in order to determine the applicability of the Disgust towards insects' scale and the Food Neophobia Subscale, as variables that predict the acceptance of insect consumption among regular consumers of bread. Their reliability, dimensionality, and internal consistency were high, as reported in previous studies [2]. Disgust scale was the most indicative and influencing of acceptance. It was verified that 80.4% of the respondents considered themselves as frequent bread consumers, whereas mix cereal bread was the most consumed type of bread (52%). Only 42% of the respondents were willing to try any type of bread incorporating edible insects. Through the application of a binary logistic regression model, it was found that the best predictor of acceptance of bread with incorporation of insect protein was the simple willingness to try edible insects in general, increasing 40 times the probability of that consumption. The two other predictors were gender, since men presented an odds-ratio of 2.7 over women, and the consumption of special varieties of bread, with an odds-ratio of 2.5. The acceptance of bread supplemented with insect protein increased with Food Neophilia subscale and strongly decreased with Disgust towards insects' scale (the increase of one point at the subscale reduces to half the probability of consumption). The binary logistic regression model showed a high predictive value, as identified by the high overall value of correct responses of 84.5% and a R2Nagelkerke=0,676. Results show that there is a good market potential among bread consumers that regularly consume special varieties of bread (multigrain, wholegrain, low salt, gluten-free, etc).

Keywords: Acceptance, Bread, Disgust, Edible insects, Food neophobia

Creation and validation of a trained panel for sensory characterization of pear (*Pyrus communis*) cv. 'Rocha' PDO

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In quality certification of Protected Denomination of Origin (PDO) and Protected Geographic Indication (PGI) products, it is well known that these should present sensory characteristics in accordance with the specifications previously approved by the competent authorities. Typically, an expert panel of judges well familiar with the product is set-up and organized in order to evaluate the presence of certain specific sensory characteristics and the absence of possible defects. However, many of the approaches for the sensory approval of PDO and PGI products tend to focus more on the validation of the sensory compliance than on the objective description of the sensory attributes of the product.
The aim of this work was to recruit, select and train a panel for sensory characterization of Portuguese PDO (pear *Pêra Rocha do Oeste*) and IGP (apple *Maçã de Alcobaça*) fruits, in accordance with the ISO 8586:2012, with the objective of correlating the sensory profile with consumer liking and with other physicochemical attributes. The initial recruitment included 52 participants, which after the recruitment and selection tests were reduced to 13 selected assessors that were trained to evaluate the PDO pears. Presently, the panel with 13 members meets weekly or biweekly, conducting training sessions combined with product evaluation for performance assessment. A ballot with 18 attributes and global quality assessment was created, using an anchored line scale. The questionnaire also included a Check-All-That-Apply (CATA) question to evaluate the presence of nine odours and 21 defects. Six PDO pear samples, collected from different orchards (with one in duplicate) from four sub-regions in the PDO region, were evaluated in triplicate. A panel analysis and a Principal Component Analysis were performed on the data collected.
Results show that the panel was able to differentiate the samples from different origins. It is also interesting to note that the duplicated samples and those from the same subregion were perceived as very similar, revealing the efficiency of the panel. The sample from one of the sub-regions yielded a low global assessment, with some assessors identifying defects. The samples with higher global assessment were perceived as sweet, with pear typical odour and taste, juicy, and with the ideal maturity.
Even with less than a year of training, the panel already shows very positive performance indicators, being able to discriminate samples and to be reproducible throughout the evaluations. The panel requires additional training and to evaluate other pears cv 'Rocha' not from the PDO region.

Keywords: Pear, Protected Denomination of Origin, Protected Geographic Indication, Trained panel

Sustainable Innovation in Food Product Design

Consumer Behavior

Poster Communications

Acceptance-rejection and liking level of whole-milk and low-fat and calcium-enriched yogurt mousses, by a population of older adults

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Background: Food product development oriented to the nutritional and sensory requirements of older adults, and mainly the acceptance and liking level of these foods, is a current necessity. Changes in food composition, caused by the development of similar products with improved nutritional profile, may alter its sensory quality. Sensory hedonic tests allow, according to their objective, to determine the consumer acceptance, liking and/or preference of one, two or more products. Objective: To evaluate the acceptance-rejection and liking level of a whole-milk, and a low-fat and calcium-enriched yogurt mousse samples by an elderly consumers group. Methods: Acceptance-rejection and liking level with a five-point scale tests were performed to two yogurt mousse samples. One was a standard formula (8% fat, 0% fiber and 14% recommended daily intake (DRI) of calcium for elders) and the other one was reduced in fat (2.8%), and added with fiber (20% DRI of fiber for elders) and calcium (40% DRI of calcium for elders); fiber, fat and calcium levels were obtained from a prediction model found in previous studies and are in accordance with the DRIs of the Office of Dietary Supplements (ODS) of the U.S. Department of Health & Human Services. The test was assessed with 61 consumers older than 55 years, and the data analysis was made according to the signs test described in ISO 8587:2006/ISO 8587-1:2013 Amendment 1-2013 and by a variance analysis (ANOVA). Results: According to the signs test, for the "I like a lot" score, the nutritionally suitable yogurt mousse for older adults was the most pleasing for this population. Similarly, in the acceptance-rejection test, the ANOVA table showed that there was greater acceptance for the nutritionally optimal mousse. However, both products were pleasing to the majority of the population. Conclusions: Both, whole-milk yogurt mousse, and low-fat, good fiber source and calcium fortified yogurt mousse were accepted by and of high-liking for the elderly consumers, indicating that this type of products can be commercialized and directed to this population.

Keywords: Older adults, Sensory perception, Acceptance-rejection, Liking level, Yogurt mousse

Brownie isento de glúten e lactose: Desenvolvimento da formulação e aceitabilidade

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O cuidado com a alimentação é primordial, principalmente para aqueles que sofrem com desconfortos alimentares. A doença celíaca e a intolerância à lactose são exemplos, pois ambas atuam em danos e desconfortos ao trato gastrintestinal, respectivamente. Com a prevalência de pessoas que se encontram nessa situação percebe-se a necessidade de criar novas opções alimentares. Dessa forma, este estudo teve como objetivo desenvolver duas formulações de brownie com ingredientes isentos de glúten e lactose e avaliar sua aceitabilidade. Foram desenvolvidas duas formulações de brownie: formulação A (massa produzida com biomassa de banana verde e farina de arroz) e formulação B (massa produzida exclusivamente com biomassa de banana verde). A avaliação de aceitação dos brownies foi realizada no Laboratório de Análise Sensorial do Centro Universitário UniFanor Wyden, avaliando os atributos de aparência, cor, aroma, textura, sabor e aceitação global. Foi realizado o teste de escala hedônica de 9 pontos (1 - desgostei muitíssimo e 9 - gostei muitíssimo). Participaram do teste 60 provadores, que assinaram o TCLE (Termo de consentimento livre e esclarecido). O teste de intenção de compra foi realizado utilizando uma escala de 5 pontos (1 - certamente não compraria e 5 - certamente compraria). A análise sensorial foi avaliada através da ANOVA e Teste de Tukey ($p < 0,05$). O presente estudo foi aprovado pelo Comitê de Ética da Academia Cearense de Odontologia (parecer nº 00365018.8.0000.5034). As duas formulações de brownies desenvolvidas adquiriram textura e cobertura característica. Os resultados mostraram que em todos os atributos as notas médias obtidas estiveram na zona de aceitação, onde todas a menor média foi 7,7, para os atributos aparência e textura da formulação B. Para o atributo sabor, a formulação A obteve média 8,3 e a formulação B, 8,2. Nas duas formulações não houve diferença significativa ($p < 0,05$) entre as amostras, em todos os atributos. Considerando a intenção de compra, a média para a formulação A foi de 4,1 e para a formulação B foi de 4,08. As duas amostras foram bem aceitas, sendo a formulação B com maior percentual na nota 5 (certamente compraria), com 45% de respostas positivas ($n = 27$). A elaboração dos brownies foi satisfatória no desenvolvimento e na aceitação entre consumidores, não havendo diferença significativa entre as mesmas. Assim é possível contribuir na diversificação de alimentos destinados a dietas de pessoas celíacas e intolerantes à lactose.

Keywords: Alimento funcional, Biomassa de banana verde, Análise sensorial

Fatores interferentes nas escolhas alimentares de operadores de uma empresa de telemarketing

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Este estudo teve por objetivo avaliar o consumo alimentar e os fatores que são levados em consideração no momento de escolha das refeições por operadores de telemarketing de uma empresa situada em Fortaleza - Ce. Para tanto, foi aplicado um questionário de frequência alimentar online, adaptado do modelo do Sistema de Vigilância Alimentar e Nutricional (SISVAN - 2008), para avaliar o consumo de diferentes fontes alimentares. Foram analisados 229 operadores e coletadas informações sobre o consumo alimentar diário, semanal ou mensal de diferentes grupos alimentares. Foram avaliados também a possível relação dos fatores tempo, local de trabalho, disponibilidade de alimentos e atividades de rotina com a escolhas alimentares dos operadores. O questionário foi composto por 23 questões sendo 22 objetivas e uma dissertativa. O presente estudo foi aprovado pelo Comitê de Ética da Academia Cearense de Odontologia (parecer nº 3.060.102). Sobre o consumo alimentar dos entrevistados, verificou-se que a ingestão de arroz, macarrão, pães, carnes, ovos, peixe e frango possuem porcentagem maior de consumo de duas vezes ao dia, seguido por óleos e gorduras. As frutas e verduras, a ingestão verificada foi de uma vez por semana. Batata frita, salgados, hambúrguer e embutidos, o consumo foi de uma a duas vezes por semana. Dentre os principais fatores para a escolha alimentar, o tempo foi o mais citado (39,6%), seguido por sabor (23,1%), preço (23,1%) e outros fatores como higiene, qualidade, conservação (14,3%). Em relação ao local de trabalho, observa-se que 53% preferem se alimentar mais próximos ao local de trabalho, 37% relatam que às vezes e 10% dizem que não fazem essa escolha. Sobre as atividades fora do horário de trabalho interferirem nas escolhas alimentares, 75% das pessoas tem sua alimentação modificada, 12% às vezes e 15% não sofrem interferência por outras atividades. Sobre a rotina estressante do trabalho, 48% do público entrevistado considera a rotina estressante, 42% consideram que se estressam somente às vezes e 10% relatam que não são afetadas pelo estresse do dia a dia. De acordo com dados coletados, conclui-se que a alimentação dos operadores de telemarketing sofre interferência principalmente da falta de tempo causados por atividades realizadas fora do horário de trabalho, tais como faculdade, cursos, atividade física, dentre outros. Há também o tempo curto de pausa regulamentado para a profissão, levando-os a fazer menos refeições, optar por alimentos disponíveis fora de casa, mastigar os alimentos rapidamente, ingerindo quantidades insuficientes de nutrientes.

Keywords: Telecomunicações, Frequência alimentar, Consumo alimentar

A technological optimization to design a better gluten-free cereal-based cake premix

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Sorghum is the fifth most important cereal crop worldwide. It represents an important crop for future human use, with increasing world population and decreasing water supplies. Nevertheless, there is few industrialized food made with this gluten-free cereal, in order to reach more people around the world. Owing to this fact, food innovation is essential that would expand the range of sorghum-based products available to consumers, especially because, in general, gluten-free products are poor in quality. The main goal of this work was to investigate variations of sorghum flour (S), rice flour (R), and extruded flour (E, containing 87.8 % of sorghum, 7.2 % of orange fiber and 5 % of whey powder) on gluten-free cake premixes, to optimize a formulation whose cake will have the best technological parameters. The mixed flours were blended according to a simplex-centroid mixture design, varying the amount of S, R, and E. Cake premixes were processed using the following ingredients: mixed flour, sugar, shortening, alkalized cocoa powder, natural cocoa powder, sodium bicarbonate, emulsifier, sodium acid pyrophosphate, monocalcium phosphate, salt, chocolate and orange aromas. Cakes were made by adding whole milk, egg and margarine to the cake premix, by following an all-in mixing procedure and by subsequently baking. Oven spring (OS), specific volume (SV), firmness (F), springiness (SP), volume (VI), symmetry (SI), and uniformity (UI) indexes of the cakes were measured on the day they were made. The results were analyzed by the contour maps generated from the fitted regression models obtained. The analysis of variance was performed with a 5 % level of significance. Coded models for OS, SV, F, SP, VI, SI and UI as a function of S, R and E were found and showed some interaction effects. In order to optimize a formulation whose cake will have the highest values for OS, SV, SP, VI and SI, and the lowest values for F and UI, the Response Desirability Profiling showed that the best formulation is the one with 20 % of S and 80 % of R. In another study from the same project, among the developed gluten-free cakes, the formulation with 20 % of S and 80 % of R presented the highest acceptance mean in an acceptance testing with 151 consumers. It is concluded that this formulation is one way to insert sorghum in industrialized foodstuffs, considering the growing demand for gluten-free, more sustainable, convenient and high quality foods.

Keywords: Gluten-free cake premix, Optimization, Sorghum, Sustainability

Sensory acceptance of sweet molded biscuits enriched with proteins

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Because of their high consumption and widespread market, biscuits are potential protein enrichment vehicles. However, often the addition of proteins can generate low global acceptance, mainly due to the bitter taste and the darkening conferred. Thus, a control and four experimental assays of biscuits with different substitutions of wheat flour by pea (PPI), soybean (SPI) and whey (WPI) protein isolates were submitted to an acceptance test of their appearance, color, aroma, taste, texture and overall impression, and also had their consumer purchase intent evaluated. For the acceptance of the parameters aroma, texture and overall impression, there was no significant statistical difference ($p>0.05$), showing that the isolates did not influence them. Regarding the acceptance of appearance, Assay 3 (6% PPI/6% SPI/24% WPI) had the highest score ($p<0.05$) among the assays, with the others having similar scores, even to the control. For the acceptance of color of the biscuits, the assays showed no difference among each other, but presented higher scores than the control; evidencing that the isolates provided a biscuit color that pleased the consumers. In relation to taste, as expected, the control biscuit presented greater acceptance. However, Assays 1 (24% PPI/6% SPI/6% WPI) and 4 (15% PPI/15% SPI/15% WPI) were also well accepted, since they did not present a significant difference to the control. Also, among the assays containing the isolates, no significant difference was observed for this parameter. The positive purchase intent (would certainly buy and would probably buy) of all the assays was lower than the control (66%). However, they were very close to each other: 50, 48, 51 and 53%, for Assays 1, 2 (6% PPI/24% SPI/6% WPI), 3 and 4, respectively. In general, it can be said that biscuits with the three isolates were well accepted by consumers; and even improved some attributes, such as color, for example. It is also important to highlight the contribution of WPI to the acceptance of appearance, as well as of PPI to the acceptance of taste.

Keywords: Pea protein isolate, Soybean protein isolate, Whey protein isolate, Protein enrichment, Biscuits, Sensory analysis

Caracterização e avaliação sensorial da qualidade da bebida de cafés das regiões cafeeiras de mococa e Franca - Estado de São Paulo – Brasil

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O Brasil exportou 35,230 milhões de sacas (60kg) de café em 2018, 14% superior a 2017. Cafés arábica representam 90% dos cafezais brasileiros. A utilização de cultivares e condições de plantio diferenciados são importantes para a sustentabilidade de produção, considerando-se altitudes e variações climáticas. O cultivar Tupi (MCTUP), região: Mococa-SP,663m de altitude, safra de menor rendimento, área ensolarada, resistente à *M. exígua* e à ferrugem, polui menos, tem ciclo de maturação precoce e média a alta produtividade. O cultivar Mundo Novo, região: Franca-SP,1000m de altitude, safra de maior rendimento, áreas arborizada (FRMNA) e ensolarada (FRAMNS); apresenta uniformidade de maturação, elevada capacidade de adaptação a altitudes. A arborização protege o cafezal de intempéries extremas, evita erosão do solo, reduz temperatura ambiente, porém impede o uso de colheitadeiras mecânicas e favorece a incidência da broca e sua propagação. Estudou-se qualidade da bebida do café dos cultivares recém-colhidos da safra 2016/2017 e possível vínculo das características climáticas com as características físicas e sensoriais. Os cafés foram colhidos na fase cereja e foi empregado o delineamento experimental inteiramente ao acaso, parcelas subdivididas para três amostras: MCTUP, FRAMNA, FRMNS, três repetições. Nessas amostras, respectivamente foram realizadas:classificação por: defeitos (198;579;532) e tamanho do grão cru (40%;53%;43% peneiras15+16 – grão chato médio); torração em temperatura máxima 200ºC, determinação do grau de torração Agtron: 85-clara; 65-média; 75-clara; moagem dos grãos (36%;36%;38% no fundo das peneiras):moagem fina, próximo aos cafés do mercado brasileiro. O café verde Mundo Novo foi classificado como fora de tipo: FRMNA com mais brocas e grãos ardidos; FRAMNS com mais cascas; ambos sofreram novo beneficiamento antes de serem torrados, moídos, avaliados sensorialmente. A bebida do café foi avaliada por equipe de julgadores selecionados e treinados em análise descritiva, utilizando escalas de 0-10 cm e10 atributos sendo o último: qualidade global da bebida. 112 voluntários, consumidores de café avaliaram as mesmas bebidas através de escala hedônica de 9 pontos:1=desgostei muitíssimo; 9=gostei muitíssimo. Alguns dados climáticos e os dados sensoriais foram analisados por ANOVA e teste de médias deTukey a 5% de significância. O processo produtivo apresentou os resultados, visualizados por Análise de Componentes Principais, correlação Pearson e 84% de explicação através do eixo horizontal: FRMNS e FRMNA foram caracterizadas por tamanho do grão cru e moagem do pó torroado; maior aceitabilidade global (todas as 3 estatisticamente diferentes: 5,5; 6,1 sendo MCTUP:4,9); maiores quantidade de defeitos; altitude; chuvas nos meses da safra (178mm); temperatura máxima no mês de colheita (26,7ºC). As caracterização sensorial por equipe treinada mostrou: MCTUP (6,8) e FRMNA (7,2): sem diferença estatística, porem FRMNA (7,2) estatisticamente melhor que FRMNS (6,5), todas caracterizadas por qualidade global superior, de acordo com a legislação do Estado de São Paulo-Brasil. A amostra MCTUP também se caracterizou por grau de torra mais claro, região com maior temperatura média na safra (24ºC) e temperatura máxima no mês de floração (30,8ºC). Destaca-se que a qualidade de bebida do café, como a MCTUP, próxima a qualidade gourmet (score 7,3 ou acima) identificada por equipe treinada, não é a que os consumidores mais gostam.

Keywords: Café cultivar Mundo Novo, Café cultivar Tupi, Café cereja, Consumidores, Qualidade da bebida, Condição climática, Classificação do grão de café

Aceitação de bebida fermentada à base de castanha-do-Brasil saborizada com frutas

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Os “leites vegetais” são uma tendência mercadológica e de consumo em virtude do aumento de intolerantes à lactose, alérgicos às proteínas do leite, vegetarianos e veganos. Ainda que não nomenclatura não seja permitida, a mesma é amplamente utilizada comercialmente. Sua elaboração, consiste na utilização de grãos, cereais, tubérculos e oleaginosas para a fabricação de extratos hidrossolúveis, visando a substituição do leite. Contudo, sua comercialização ainda é limitada e há pouquíssimas opções de bebidas vegetais com alegação funcional. Ainda que as pesquisas apresentem diversidade nos micro-organismos e na matérias-primas utilizadas para obter tais bebidas, os estudos ainda ocorrem de forma discreta no que se refere na utilização de matrizes vegetais nativas. A castanha-do-Brasil destaca-se por ser uma noz típica da Amazônia, que apresenta elevados teores de lipídios e proteínas de alto valor biológico e é uma reconhecida fonte de selênio. O sabor e aroma de um produto podem ser afetados negativamente por componentes produzidos durante o processo fermentativo por probióticos. A aplicação de técnicas de mascaramento, como a saborização com frutas, beneficiam a qualidade sensorial, podendo ofertar itens com efeitos terapêuticos e que atendam os anseios do consumidor. Mediante ao exposto, o presente trabalho teve como objetivo avaliar sensorialmente uma bebida fermentada à base de castanha-do-Brasil, saborizada com diferentes frutas. O processo fermentativo teve os seguintes parâmetros: 37 °C/12 h e anaerobiose, tendo como micro-organismo o Lactobacillus casei. A castanha-do-Brasil foi adicionada de água e triturada. O líquido obtido foi submetido à fermentação. A bebida fermentada foi saborizada com cinco frutas: morango, banana, mamão, manga e abacaxi. Foi aplicado um teste de aceitação para os cinco sabores e a bebida sem saborizar, com 60 voluntários, onde foram avaliados os seguintes atributos: Aceitação Global (AG), Aroma de Fermentado (AF), Doçura (D), Sabor de Castanha (SC) e Sabor de Fermentado (SF). Os scores obtidos apresentaram variação entre 5,49 e 6,81 (AG), 5,45 e 6,82 (AF), 5,63 a 6,90 (D), 5,80 a 6,58 (SC) e 5,42 a 6,45 (SF). Os escores para as bebidas saborizada foram maiores do que os atribuídos à bebida não saborizada. Os resultados obtidos mostram que a saborização da bebida aumentou sua aceitabilidade, promovendo assim, uma possível oferta de produtos que estejam de acordo com os anseios dos consumidores, além de propiciar o consumo de um produto livre de compostos de origem animal sensorialmente aprazível. Também foram avaliadas a viabilidade do Lactobacillus casei e a composição centesimal das bebidas.

Keywords: Castanha-do-Brasil, Lactobacillus casei, Probiótico, "dairy free".

Consumers' conceptualization of rice and rice with low glycemic index: inputs for the development of a new rice product

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Current consumption trends, especially those dictated by health and well-being, have been influencing the consumption of rice. Portugal has the largest rice consumption rate in Europe, with 21.3 kg/capita/year and the highest prevalence of diabetes in Europe. Thus, under the scope of the research project ArrozBIG and with the objective of developing a rice product with a low glycemic index (GI), this qualitative study aims to evaluate the consumers' associations with rice and rice products with low GI, through the application of a projective free word association methodology. To evaluate this conceptualization, two stimulus words, "rice" and " rice with low GI" were used. A total of 256 individuals (64% female), aged 18-73 years (40 ±12.8), residing in the Great Porto area were surveyed. The response words were screened and categorized following triangulation. The frequency of the words/categories was counted, and chi-square test of independence was used to determine if there is a significant relationship between the emergent categories and the sociodemographic characteristics. Nutrition and health categories were common to all stimuli, evidencing practical perception of the satisfaction of biological needs. A sensory related category was also built for all stimuli showing how important these attributes are even for foods with a major functional character. "Rice" and "rice with low GI" differed in the "convenience" evoked only in the first stimulus, and in the "naturalness" and "lack of knowledge" found in the second one. The "naturalness" category may be seen as a desired requirement in the product. Sex, age, and education influenced the association's nature, with income and household size less expressive. "Rice with low GI" is seen as innovative and interesting, associating hedonic and acceptance terms. These results are important to assist in the planning and design of this new product, enclosing consumer's perception.

Keywords: Consumer conceptualization, New product development, rice, Rice with low glycemic index, word association

Potential use of aqueous extracts of *Saccharina Latissima* in cream cracker biscuit formulation

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Seaweeds are a good source of several nutrients such as proteins, dietary fibers, vitamins (e.g. B12) and minerals (e.g. iodine) as well bioactive compounds as polyphenols and polyunsaturated fatty acids (omega-3). The production of secondary metabolites with biological activities lead to health-benefits with neuroprotective, cardioprotective and anti-inflammatory impacts. So, the use of seaweed in functional food development has been promoted. The aims of this study were to evaluate the use of seaweed, *Saccharina Latissima*, as natural source of natural antioxidants for (1) extending food shelf-life as natural additive, (2) promoting health due to richness of bioactive compounds and acting as substitute of salt and (3) improving overall quality of one product widely appreciated by global population – biscuits. So, five concentrations of aqueous extracts from *Saccharina Latissima* (1%; 5%, 7%, 10% and 15% with ID: B1; B5; B7, B10 and B15, respectively) were assessed into a modified biscuit formulation. Also, biscuits without aqueous extracts (ID: CTR1), with synthetic additive (ID: CTR2) and without salt addition (ID: CTR3) were considered for comparison with previously samples prepared with seaweed extracts. All biscuits samples were analysed in terms of colour (L*, a*, b*, ^{o}h and total difference colour (TDC)), texture (maximum force, crispiness), antioxidant capacity (total phenolics content - TPC, DPPH scavenging activity) immediately after preparation and after 7, 15, 21, 27 and 35 days of storage at room temperature (in sealed bag and protected from light). Immediately, after cream cracker preparation, a slight darkness was observed on surface of all enriched samples, compared to CTR samples (without seaweed extract). Also, an increase of colour parameter a*, was observed, between the enriched samples (B15>B10>B7>B5>B1). This behaviour was accentuated throughout storage period. Regarding cracker texture, the seaweeds extracts contributed to a good and structuring effect on samples, revealing, a similar maximum force between CTR, B1 and B5, at day 0 (≈ 7.0 N). However, during storage, a decrease of maximum force was denoted in all cream cracker samples (≈ 20%). The cream crackers samples enriched with seaweed denoted a significant and highest content of TPC and DPPH activity (B15>B10>B7>B5>B1), which can lead to a positive effect on health consumer. Overall, this study, demonstrates the potential in use the seaweed extracts from a natural source, *Saccharina Latissima*, as new ingredient of the cream cracker formulation which promotes the health-benefits and food shelf-life extension.

Keywords: Seaweed, Biscuit, Quality, Antioxidants

Hydroponic-cultivated lettuce marketed with root: postharvest quality evaluation and Portuguese consumer perception

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Lettuce is a leafy vegetable very consumed worldwide but extremely perishable. After harvest, the metabolic processes of respiration and transpiration lead to a rapid deterioration of the leaves. The cultivation of lettuce in hydroponic systems allows a clean product and the root maintenance throughout its postharvest chain. It is expected that a hydroponic-cultivated lettuce marketed with root will have a lower microbial spoilage load and a longer shelf life. The objectives of this work were to evaluate: i) the influence of root maintenance on postharvest quality of lettuce; and ii)the consumer perception about this new form of marketing lettuce.
Quality parameters of hydroponic-cultivated lettuce were evaluated over refrigerated storage at 5°C. Colour, chlorophyll content, mass loss, respiration rate and sensory quality (browning, wilting and appearance) were determined in lettuce with no root, lettuce with water-bag root and lettuce with air-root at days 0,3,6,8,10 and 13. Throughout the storage it was verified that both time and root treatment have clear influence on the quality parameters. During postharvest, the lettuce with water-bag root significantly maintained a more intense green colour (CIE a* value -15,4±0,3) reflecting a significantly higher chlorophyll content (SPAD 25,1±1,2) as compared to the other lettuce types. Moreover, these showed a significantly lower rate of mass loss, less leaf browning and wilting and a higher overall appearance than the other treatments. Additionally, a survey was conducted in Portugal, using a convenience sample of 138 individuals segmented by gender, age and academic qualifications. The survey consisted of free association questions, asking to write 4 words associated with the terms 'hydroponics', 'lettuce', 'hydroponic-cultivated lettuce' and 'hydroponic-cultivated lettuce marketed with root', and multiple-choice questions about lettuce consumption/acquisition habits. It was found that the youngest age group (18-34) associates 'hydroponics' more strongly with sustainability and less with negative emotions (sickness, neophobia, fear) than the other age groups. Respondents with low academic qualifications considered 'hydroponics' an unfamiliar term. When assessing the respondents' associations to 'hydroponic lettuce commercialized with root', younger consumers were the ones who most strongly associate with convenience, economy and innovation. It is also highlighted that respondents who report a higher consumption of lettuce are those that most associate this concept with positive attitudes and emotions (quality, tasty, interesting). Therefore, it is considered that hydroponic-cultivated lettuce with root has a high market potential due to the longer retention of product quality and the positive associations generated by consumers with this product.

Keywords: Hydroponic-cultivated Lettuce, Quality retention, Consumer perception

Last minute included communications

Transferencia de masa en la osmodeshidratación con soluciones de tres dulcorantes del pseudofruto del marañón (*Anacardum occidentale*)

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Esta investigación tuvo como objetivo el estudio de la cinética de transferencia de masa del seudofruto del marañón (*Anacardum occidentale*) deshidratado osmóticamente con tres agentes edulcorantes. Se tomaron muestras cúbicas de 2±0,1cm de lado con 10±0,5^{o}Brix y acidez de 1,4±0,3%p/p (expresado como ácido cítrico). Se utilizó un diseño experimental completamente al azar con arreglo factorial 3x3x2. Los factores fueron: tipo de edulcorante (sacarosa, maltosa y azúcar invertido), concentración de la solución osmótica {40, 55, 70}%p/p y temperatura de la solución {30, 50}^{o}C. Las muestras de marañón fueron deshidratadas osmóticamente en un sistema de agitación a 120 rpm, con una relación jarabe /fruta de 2:1 y un período de inmersión de 8 horas. El análisis de varianza arrojó que las variables tipo de edulcorante, concentración de la solución osmótica y temperatura tuvieron efecto significativo ($p<0,05$) en las variables respuestas pérdida de agua y ganancia de sólidos. Para la evaluación de los parámetros de transferencia de masa se utilizó un modelo basado en la ley de Fick y la ecuación de Arrhenius. Los valores de la difusividad efectiva del agua estuvieron entre $8,626x10^{-9}$ y $6,475x10^{-8}$ m^2/s y de energía de activación entre 44,54 y 50,47 kJ. En conclusión, los mejores resultados de osmodeshidratación se obtuvieron con sacarosa al 70% p/p y una temperatura de 50 ^{o}C, alcanzándose una humedad final en base seca del 42,6 %p/p.

Keywords: Osmodeshidratación, Marañón, Azúcar Invertido, Maltosa, Sacarosa

Effect of chemical modifications of rice starch on the structural and hydrophilic characteristics of films

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Starch is a polysaccharide of biodegradable, renewable and low cost source. However, the use of starch for the production of packaging is limited because of its hydrophilic characteristics. Modification of the polymeric structure may be an alternative to improve the properties of the starches consequently influencing the packaging produced. The aim of this study was to evaluate the effects of starch modifications (hydrolyses and esterification) on the characteristics of the films made from them. Rice starch was subject to the hydrolysis process using hydrochloric acid (HCl) at concentrations of 0.1 M and 0.5 M and to the esterification process using citric acid (CA) at the concentrations of 2 and 10% (m/v). Standard starch and hydrolyzed and esterified starches were used for the preparation of the films. The films were produced using 3% (m/v) starch and 30% (m/m starch) glycerol by the casting method. The relative crystallinity (RC) of the films was obtained using X-ray diffractometer and the hydrophobicity of the films was evaluated by measuring the contact angle (CNA) of a drop with the film surface. The film produced with standard starch (SRS) presented RC of 69.0%, the films products from hydrolyzed starch with 0.1 M HCl (RS1) and 0.5 M HCl (RS2), showed RC of 72.4 and 71.5%, respectively, films produced from starches esterified with 2% CA (RS3) and 10% CA (RS4) showed RC of 73.6 and 71.2%, respectively. The hydrolysis process carried out with lower HCl concentration increased RC of the films, since the hydrolysis can increase the RC of the polymer by breaking the structures present in the amorphous region of the granule. The esterification process with lower CA concentrations increased RC due to the ability of CA to crosslinking the polymer making the starch chain more resistant. Regarding hydrophobicity the results obtained for the CNA were SRS, 45.8°; RS1, 51.9°; RS2, 56.0°; RS3, 72.6° and RS4, 58°. Modification of the polymers interfered in the hydrophobicity of the films showing the RS3 treatment as more hydrophobic. The esterification process increases the amount of ester bonds in the starch structure, thereby increasing the hydrophobicity of the film. The polymer modification strategy used was able to increase the crystallinity and the hydrophobicity of the films. This extends the future possibility of industrial use of starch as a source for packaging production.

Keywords: Hydrolysis, Esterification, Crystallinity, Crosslinking

Novel electrospun nanofibrous membranes with improved adsorption capability for the removal of food contaminants

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Satisfactory strategies to effectively remove mycotoxins from food commodities are scarce. Certain food processing practices can reduce mycotoxin levels by physical removal and/or decontamination by chemical or enzymatic reactions, yet with limited efficiency and with other associated food safety concerns.
Degradation methods have also been tested based on the promising biological detoxification using enzymes and mainly whole cells of yeast and lactic acid bacteria. In any case the success made so far is limited and several drawbacks have been identified, such as difficulties in recovery and reuse of the decontaminating agents and detrimental changes of the organoleptic and nutritive attributes of the food product.
The aim of the present study was to develop nanofibrous polymeric membranes with improved and selective adsorption capability for the retention and removal of mycotoxins. Preliminary target compounds were analogues of patulin, a mycotoxin produced by several fungi common to fruit- and vegetable-based products, most notably apples. The fibrous membranes were obtained by electrospinning and consisted of polymer sub-micro fiber arrays of poly(vinyl alcohol-*co*-ethylene), as the main polymer responsible for fibre formation, blended with a polysaccharide with high adsorption capability for the target compounds (chitosan or yeast cell wall polysaccharides). The optimized process allowed to obtain nanofibrous membranes with a large surface-to-volume ratio, tunable fiber size, porosity and composition. The fiber size and morphology, membrane porosity and surface properties were studied by SEM and contact angle measurements and were shown to be influenced by the polymer concentration and the composition ratio of each polymer and solvent mixture. Mechanical properties of the fibrous membranes were studied by uniaxial extension. We also report preliminary results on the binding/adsorption behavior of these membranes towards patulin analogues, for different pH values and temperatures.

Keywords: Electrospinning, Nanofibers, Adsorption, Mycotoxins

Characterization of Portuguese attitudes towards innovative food technologies

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The development of new food products and technology that satisfies consumers' demand may contribute positively to a competitive tool for food companies. Understanding consumer acceptance towards innovative food technologies is crucial to the development of successful food products. Segmentation is a crucial tool that allows a population to be divided into groups of people with similar characteristics. Namely, it allows the attitudes and behaviours of each of these 'segments' or groups to be better understood. The aim of this work was to evaluate Portuguese consumer attitudes towards new food technologies and to segment them into specific groups. This investigation used a survey methodology. Consumers were interviewed at their households and a total of 704 questionnaires were completed in Oporto and Lisbon metropolitan areas, Portugal.

Random route combined with quota sampling was employed, controlled by sex, age group and location. The questionnaire presents a set of seven groups of questions with the following dimensions: i) Sensory Appeal and Food Convenience subscales from the Food Choice Questionnaire, ii) Domain Specific Innovativeness, iii) Concerns about price/cost of food, iv) Food and Nutrition Knowledge, v) Food Neophobia Scale, vi) Food Technology Neophobia Scale, and vii) Suspicion regarding novel foods. An exploratory factorial analysis was carried out using the Principal Components method to reduce the original items into different factors, with *Varimax* rotation. Internal reliability was tested using Cronbach's Alpha. K-means clustering was applied over the resulting factors. All factors yielded high consistency, with Cronbach's-alpha ranging from 0.669-0.948.

Clustering analysis yielded five segments of consumers. appeal, price and convenience were the most important dimensions regarding food choice. Portuguese consumers were risk aversion towards food innovations The data also indicate that there is little adoption of innovation among Portuguese people, besides indicating a high level of neophobia in relation to new food technologies, although it presents a low level of neophobia in relation to novel foods but associated with high levels of suspicion.

Keywords: New product development, Emerging food technologies, Consumers' attitudes, Psychological traits

Consumers' acceptance of gluten-free sorghum-based cakes

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Nowadays there is a crescent demand for gluten-free foods, especially from people with wheat allergy, celiac disease, non-celiac gluten sensitivity or from people who took out foods with gluten from their diets. Sorghum is a cereal that can be used as a starch source to prepare gluten-free flours to be used in baking and confectionery products. In many food products, the use of pregelatinized flour is necessary to upgrade their quality and the extrusion process can be used for this purpose. Thus, this study investigated the acceptance of 5 gluten-free cakes including a cake with gluten (CG) as well. Chocolate and orange flavored gluten-free cakes were prepared differing only in the proportions of sorghum flour (S), rice flour (R), and extruded flour (E, containing 87.8 % of sorghum, 7.2 % of orange fiber and 5 % of whey powder): 100E, 3S+97E, 20S+80R, 40R+60E and 3S+39R+58E. Two sensory evaluation techniques were applied to cakes: CATA (Check-all-that-apply) and acceptance testing (9-point structured hedonic scales for overall impression, from "dislike extremely" to "like extremely"), samples coded with three-digit random numbers, monadically presented in a complete balanced block design. Statistical analyses for acceptance data included ANOVA, followed by Fisher test ($p<0.05$), agglomerative hierarchical clustering using Euclidean distance by the Ward method; for CATA data, Cochran's Q test, followed by McNemar test, and correspondence analysis. Penalty analyses were applied to evaluate the influence of the sensory attributes on the acceptance. Consumers were segmented into 2 groups with different sensory acceptance profiles among groups. As expected, CG attained the highest ($p<0.05$) acceptance mean among samples in both groups. Among the developed gluten-free cakes, the highest acceptance means were found for samples 20S+80R and 40R+60E (group 1, n=72) and for samples 20S+80R, 40R+60E and 3S+39R+58E (group 2, n=79). Correspondence analysis ($p<0.05$ for test of independence between rows and columns; 85.0% (group 1) and 88.74% (group 2) of variance retained in the first two dimensions) showed that samples with more E (100E and 3S+97E) were characterized by the attributes which decreased the overall impression, resulting in the lowest acceptance means. Furthermore, comparing all sample's results between groups, acceptance was higher ($p<0.05$) for group 1 than group 2 for all samples, besides the discriminatory capacity was greater in group 1. Higher concentrations of E seem to decrease the sensory quality of gluten-free cakes. However, other studies have the potential to find the limit of E without reducing consumers' acceptance.

Keywords: Acceptance testing, Check-all-that-apply, Drivers of liking, Extruded flour, Gluten-free cake

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