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Pursuing ways to increase number and production efficiency of glandular trichomes in *Artemisia annua* by applying physical and chemical stresses

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S07

EMERGING HEALTH ISSUES IN FRUITS AND VEGETABLES

S07.001

Optimising the (poly)phenolic composition of crop plants

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Plants and their products are generally known for their high levels of antioxidants, which may contribute to the positive effects of dietary plant products for human health. Plants produce these compounds to cope with the oxidative stress environment they are growing in (e.g. UV-light, air and soil pollution, pathogens) as well as for their reproduction (e.g. pollination, pigmentation of flowers and fruits). Depending on plant species, variety and tissue, high levels of health-protecting antioxidants, such as vitamin C and E, phenolic compounds including phenylpropanoids and flavonoids, and/or carotenoids such as lycopene can be found. Flavonoids comprise a large and diverse group of polyphenolic plant secondary metabolites. They are widespread among the plant kingdom and form an integral part of the human diet. There is increasing evidence that dietary flavonoids are likely candidates for the observed beneficial effects of a diet rich in fruits and vegetables on the prevention of chronic diseases. We aim to elucidate the regulation of the flavonoid pathway in crop plants and employ different strategies to optimise the composition of flavonoids in target crops, such as tomato and strawberry. Using a metabolomics approach we observed interesting variation in both the levels and composition of flavonoids in germplasm collections of tomato, pepper and strawberry. In order to unravel the molecular mechanisms underlying the observed metabolic variation, we used different approaches to isolate and identify the key genes regulating these pathways. These genes can be turned into markers to assist in classical breeding programs, but are also used to optimise the composition of health-related compounds through genetic engineering. Several examples of the strategies used will be discussed.

S07.002

Super-Domestication of Fruits and Vegetables Lead to Improvement of Human Health

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Vaughan *et al* (2007) introduced the term super-domestication to refer to the processes that lead to a domesticate with dramatically increased yield that could not be selected in natural environments from naturally occurring variation without recourse to new technologies. Super-domesticates can be constructed with knowledge led approaches using a wide range of current technologies, including fine resolution mapping and gene cloning of domestication-related genes, orthologues of domestication genes and their action, genome evolution, gene and genome duplication using any kind of new techniques. The array of genome manipulations that have been developed, mainly from the eighties, enable barriers to gene exchange to be overcome and have led to super-domestication with dramatically improved quality. This high technology which gave a boost for plant breeding manifested in high nutritional value fruit and vegetables. Some of these achievements include the biofortification of bananas, the efficient selection for healthful nutritional components, the genomics of fruit and vegetable quality and the production of vitamin rich fruits and vegetables to combat nutritional deficiencies. Selection for high antioxidant content fruits and vegetables will serve better nutrition for humans.

Exploring the biological diversity of fruits and vegetables with high tech biotechnology could be the basis for improving human health.

S07.003

The Integration of Human Health and Soft Fruit Breeding

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The agricultural policies of the developed world have meant that, for these countries at least, food is plentiful but changing eating patterns have seen an increase in the consumption of ready-made meals and food elevated with respect to sugar and fat. The knock-on effect of this is evident in the rapidly increasing level of obesity in the western world with 20% of males and 25% of females now classified as obese in the United States. Associated with this and the related dietary shift are increases in the incidence of degenerative diseases such as atherosclerosis, some cancers etc. Fundamental, clinical and epidemiological research into the basal causes and consequences of these diseases has highlighted the gross and specific benefits of including a significant level of fruit and vegetable within the diet. Polyphenols are ubiquitous in plants and, with respect to dietary plant sources, particularly prevalent in many fruit species and in particular in the common soft fruit such as strawberries, blackcurrant, raspberries etc. As a result of the putative potent health benefits of these compounds, crop (including fruit) breeding has undergone a paradigm shift with the adoption of global metabolite screening rapidly becoming an integral part of the process. Evidence will be presented to show that soft fruit extracts and components exhibit beneficial health effects in model and real systems. In addition a strategy for integrating these targets into new and ongoing breeding programmes will be outlined using a joint molecular genetic and metabolomics approach.

S07.004

Metabolic Engineering of Carotenoid Biosynthesis in Orange Fruits

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Carotenoids are an important group of isoprenoid-derived pigments responsible of the typical coloration of many fruits and vegetables, and then determining their quality and consumer acceptance. Carotenoids have long been recognized as essential nutrients for human nutrition and health, providing protective effects against certain cancers and cardiovascular, aging-related and degenerative diseases due to their potent antioxidant capacity and the pro-vitamin A activity of some of them (mainly b-carotene). Moreover, some of the oxidative cleavage products of carotenoids, referred to as apocarotenoids (norisoprenoids), could contribute to generation of flavor and aromatic compounds in these plant products. Citrus is the most important fruit tree crop in the world and orange fruit is an excellent natural dietary source providing health-promoting compounds such as vitamin C, flavonoids and folic acid, in a combination and concentration unique among fruits and vegetables, but it has low provitamin A content. Recent advances in the isolation and identification of the genes responsible for carotenoid biosynthesis in citrus fruits combined with the availability of genetic engineering tools have made feasible a metabolic engineering approach to improve the content and composition of certain carotenoids in orange fruits. The goal of this work was to enhance provitamin A (b-carotene) content in orange fruit by blocking the expression of the endogenous b-carotene hydroxylase gene (b-CHX), involved in the conversion of b-carotene into xanthophylls, using either antisense or RNA interference (RNAi) technology. Transgenic plants were obtained and important changes in carotenoid content and composition was observed in both fruit peel and pulp. The increase in b-carotene in transgenic fruit was accompanied by a general decrease in the accumulation of downstream xanthophylls and also an enhanced production of flavor-related apocarotenoids. Implications of these changes in the nutritional value and volatile composition of transgenic oranges will be discussed.

S07.005

Nutrient Rich CMS Hybrid Breeding in Tropical Carrots (*Daucus carota* L.)

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Tropical carrot is most extensively grown vegetable crop in north Indian plains. It is cherished by one and all, rich and poor for its colour, flavour and taste in various forms like raw, cooked, pickle, candy, puddle, juice etc. Traditionally, red carrots are popularly grown for commerce by the farmers for high markets from their own retained and maintained special specific maturity variety seeds. Of late, through systematic breeding for about a decade now, we have developed strains individually high in lycopene, anthocyanin, β -carotene and lutein. These pigments represent different colours in carrot like red due to lycopene, black due to anthocyanin, yellow due to lutein and orange due to carotene. These are very powerful antioxidants which can go a long way in curbing malnutrition and fight diseases. In order to develop biofortified carrots with two pigments, cytoplasmic male sterility was integrated through backcross breeding into improved breeding lines for exploiting them in hybrid combinations. This paper reports about the prospects of new bioactive compound rich high yielding hybrids' suitability for fresh market and fusion food industry.

S07.006

Breeding Onion and Garlic Cultivars with Higher Levels of Functional Compounds

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Allium species have been cultivated for thousands of years for its therapeutic properties, religious significance, taste, and aroma. Nowadays, the basic concept of nutrition is changing, including the potential of foods to enhance health, to improve welfare and reduce the risk of diseases. In this context appear the functional foods. Garlic and onion have phytochemicals categorized as functional foods; some of them are fructans, flavonoids and organosulfur compounds. Garlic (*Allium sativum* L.) and onion (*Allium cepa* L.) are the main vegetable crops exported by Argentina. More than 90% of the cultivars that are cropped in the country were originated by breeding programs carried out by INTA. One of the main goals of these programs is the diversification of the cultivar offer. The characterization of nine garlic and eight onion cultivars according to its organosulfur, flavonoid and fructan composition, variables related to the flavor of these species, like pungency, solids content, and functional properties, in special its antiplatelet activity, has been recently completed; as well as the correlations among these traits. Also our group carried out *in vivo* studies using animal models that confirmed the potential health benefits of Argentinean germplasm. This characterization allow choosing garlic clones for fresh consumption (with lowest pungency); to obtain pharmacological products (with highest allicin content), and for dehydration industry (with high solids content). Besides several crosses between selected onion lines have been done to produce segregating progenies for breeding purposes. The results achieved provide valuable information that will contribute to breed new onion and garlic cultivars which may contribute to reduce the incidence of cardiovascular disease among other human diseases.

S07.007

Breeding for Phytonutrient Content; New Strategies, Pitfalls, and Benefits

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Visible phytonutrient compounds and compounds which are simple to quantify can be easily selected for in breeding populations. Lycopene in tomatoes and wa-

termelon is one such compound, since the amount of red corresponds well with the quantity of lycopene produced. Because of this, breeders have developed high lycopene varieties. High antioxidant concentration in these vegetables creates new marketing tools for improved sales, premium price options, and health packed produce. Unfortunately, testing for many health promoting compounds is labor intensive and expensive. These compounds are often overlooked in breeding lines and are thus not selected for. Preliminary experiments on watermelon breeding lines showed a wide range for a specific compound within open pollinated fruits. Using new strategies and methods, it is now fairly easy to test for many of these compounds to insure health packed products for the market place. Some of these new methods allow for the easy in screening for amino acids, vitamins, and carotenoids.

S07.008

Breeding Vegetables and Fruits to Improve Human Health: A Collaborative Effort of Multidisciplinary Scientists, Stakeholders and Consumers Using a Systems-Based Approach

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Traditionally, breeding of fruits and vegetables (FAV) was mostly the effort of plant breeders and in some cases pathologists and entomologists were involved. Due to the consumer paradigm shift, and awareness of health benefits, breeders have been changing their objectives. In recent years, breeding programs of FAV are not only involving breeders but also multidisciplinary collaborators. While most breeding programs involve a range of experts such as breeder, molecular marker expert, physiologist, crop management expert, pathologist, and entomologist, very few breeding programs have a systems approach of trans-disciplinary research, including analytical, bioactivity derived assays and biological activities including human clinical trials. In order to improve human health, modern breeding programs must develop a strategy to increase consumption of fruits and vegetables by developing cultivars that meet diverse stakeholder needs – that is, cultivars with enhanced quality (flavor and human health benefits) using sustainable crop management practices. This type of systems-approach is only possible through multi-disciplinary centers such as the Vegetable and Fruit Improvement Center. This presentation will include examples of successful breeding of certain vegetables and fruits from field to consumer including clinical trials by the partnership efforts of multidisciplinary scientists at the VFIC. Future breeding programs will have to be developed with the consumer based concept, that enhancing quality traits (flavor, health promoting bioactive content) using a systems-based approach involving breeding, genomics, and sustainable crop management practices, will promote increased consumption. Further, the belief is that enhancing bioactive content will result in system-wide benefits to fruit and vegetable producers, processors and distributors, and end-users. The concept of bridging agriculture and medicine encompasses a systems-based approach supporting producers, consumers, and society at large. Quality and consumer studies (including human clinical trials), and socio-economic impacts of new cultivars released will have to be evaluated by the social scientists' team, in order to meet the consumer needs of the future.

S07.009

Enhancing the Health Benefits of Broccoli

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Epidemiological studies and experimental data from cell and animal models have provided a substantial body of evidence that diets relative rich in cruciferous vegetables such as broccoli can promote health. While these vegetables contain many compounds of potential relevance to health, they are characterised by the accumulation of sulphur-containing glycosides known as glucosinolates. These compounds degrade to produce isothiocyanates and indoles, and it is these metabolites that have been widely implicated in the health promoting properties of these vegetables. In this talk, I will provide an overview of a research programme that has led to an

enhancement of putative health-promoting glucosinolates in broccoli through conventional breeding and marker assisted selection. I will discuss the consequences of enhancing glucosinolates for other aspects of sulphur metabolism which has led to a positive effect on flavour, and then briefly comment on progress towards commercialisation of these cultivars, and regulatory aspects of health claims. I will then describe our on-going human intervention studies that have sought to obtain experimental evidence that these new cultivars will deliver health benefits, particular with regard to reducing the risk of vascular disease and prostate cancer.

S07.010

Phytochemicals: Shelf Life and Disease Resistant Elicitors

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High dietary intake of fruits and vegetables rich in phytochemicals has been linked to reduced risks of many chronic diseases including cancer and cardiovascular diseases. Value-added foods and nutraceuticals containing such bioactive phytochemicals have been popular and made available in the market. Many factors affect the phytochemical concentration in fruits including farming practices, environmental factors and microclimate including the production methods, fruit maturity, pre- and post-harvest handling of the fruits and processing but the genetic factor has the greatest effect on the biosynthesis of antioxidant secondary metabolites. A large variation of antioxidant concentrations exist within apple, strawberry and raspberry cultivars and breeding lines and it is possible to use this as a marker to design specialty fruits for niche marketing. The phytochemical profiles and chemical content of fruits not only affect the fruit quality and its shelf life but also have an important function in the plant's defense mechanisms, coping with biotic and abiotic stresses. The increase and/or decrease in phytochemical can both be useful in designing fruits: Elevated concentration of antioxidants could extend the shelf life and reduce the incidence of post harvest diseases; and modulation of specific antioxidants can be used as a tool to change the specific quality characteristics of a fruit for example reduce the incidence of browning during or after processing. New developed raspberries and strawberries rich in phytochemical and non browning apples will be presented and discussed.

S07.011

How to Optimize Content of Bioactive Compounds – Effects of Cultivar and Processing in Root Vegetables

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Groups of compounds, or individual compounds, in fruit and vegetables have been pointed out as the plausible reasons for the well established connection between a diet rich in fruit and vegetables and lower risk of some common diseases. Antioxidant effects, or other bioactive action, such as influence on some human enzyme activities, have been suggested as their possible mode of action. Since the health promoting effect has been attributed to certain compounds, individually, or in synergistic combination, it is of interest to increase knowledge of which factors that influence the levels of these compounds. The differences in the content of vitamin C, polyacetylenes and carotenoids in a range of orange, red and yellow cultivars of carrot have been analysed. In addition, the effects of different processing steps were investigated in carrot, kohlrabi, parsnip, turnip and Swedish turnip. Large differences were found in the content of polyacetylenes and carotenoids between cultivars. Different processing steps were found to affect the content of vitamin C, polyacetylenes and carotenoids to different extent. In addition, the processing did not affect the different cultivars in a similar way, which might implicate a possible interaction among the investigated compounds. The results will be discussed in terms of how bioactive compounds can be optimized.

S07.012

Effect of Photoselective Nets on Phenolic Composition in Apple Fruits

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Apple fruit are rich in phenolic compounds such as pigments (anthocyanins), flavonoids, and other polyphenols with bioactive capacity against cardiovascular and cancer diseases. In the apple, the synthesis of these compounds is at least partially regulated by sunlight quantity and quality. Photoselective nets is an emerging technology for physical protection and manipulation the light quantity and quality in horticultural crops, but poor information exists about the potential uses of this technology as tool to modify the synthesis of these bioactive compounds in apple fruit. This research reports on the effect of photoselective coloured nets on major pigment, flavonoid and polyphenol levels in apple. Photoselective red hail (RH), red shade (RS), pearl shade (PS), blue shade (BS) and grey shade (GS) nets were placed on “Fuji” apples grown under commercial orchard conditions and arranged in a random block design with mini-plots. At harvest, twenty fruits for each block and treatment were randomly picked for color evaluation, while a sample of skin was collected for later biochemical analysis. Fruit color indexes (Hue angle and a^*/b^* ratio) were quantified using a portable tri-stimulus colorimeter. The a^*/b^* ratio was significantly highest and Hue angle lowest on apples covered by the RH net, while the a^*/b^* ratio was slightly increased by GS net compared to RS, BS and PS nets. Preliminary results indicate that photoselective nets affect differentially the fruit pigmentation in apples. Biochemical analysis of phenolic compounds such as anthocyanins, quercetin-3-glycosides and chlorogenic acid are currently being assessed. Results of these analyses will be also presented.

S07.013

Impact of Cultivation Conditions and Postharvest Treatment on the Polyacetylene Contents of Carrots and Parsnip

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Naturally occurring polyenes, also referred to as polyacetylenes, are found throughout the plant kingdom. C17 polyacetylenes are a group of bioactive compounds found in the *Apiaceae* family, e.g. in carrots, parsnip, parsley, and have obtained scientific attention due to their antifungal, antimicrobial, cytotoxic and neurotoxic properties. Moreover, polyacetylenes are known to cause bitter off-tastes in carrots and carrot-derived products. With regard to their ambivalent characteristics much interest has been devoted to intrinsic and extrinsic factors affecting polyacetylene levels in plants. In the present study the isolation of authentic polyacetylene standards faltarinol, faltarindiol and faltarindiol-3-acetate from various apiaceous plants was shown. The procedure, consisting of several extraction and purification steps, afforded the isolation of the three compounds with purities of $\geq 98\%$. The obtained compounds were characterized by Fourier transform-IR (FT-IR) spectroscopy, GC-MS, HPLC-MSn in positive ionization mode, 1H NMR and 13C NMR spectroscopy. Furthermore, the impact of agricultural practices (irrigation, harvest date), postharvest treatment and stress conditions (storage, mechanical injury) on polyacetylene production in carrots and parsnip was investigated. For this purpose, the contents of individual poly-

acetylenes in the edible parts of the aforementioned plants were determined by HPLC-DAD using the isolated reference compounds. The results demonstrate the dependence of polyacetylene levels on some of these factors. As an example, polyacetylene contents significantly increased upon abiotic stress as a result of aridity or wet conditions during plant growth. The data obtained in the present study contribute to a better understanding of polyacetylene accumulation and help to develop strategies for the production of plants particularly rich in these potentially health beneficial compounds and of crops devoid of polyacetylenes which are undesired in juices, purees and food colorants from a sensory point of view.

S07.014

Effect of Supplementary Pre-Harvest Led Lighting on the Antioxidant and Nutritional Properties of Green Vegetables

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We report on the application of supplementary solid-state lighting within an industrial greenhouse for pre-harvest treatment of various green vegetables (spinach, parsley, dill, mustard, rocket, and onion leaves) grown under high pressure sodium lamps and natural solar illumination. For 3 days before harvesting, supplementary lighting from red 638-nm light-emitting diodes (LEDs) was applied within a 19-h photoperiod in such a way that the net photosynthetically active flux density of at least $\sim 300 \mu\text{mol m}^{-2}\text{s}^{-1}$ was maintained. Such a pre-harvest treatment was found to remarkably enhance antioxidant and nutritional properties of green vegetables due to the increased activity of the metabolic system for the protection from a mild photooxidative stress. However, the effect of supplementary red light was found to be species dependent. The sensitivity of a species to the lighting conditions was determined by the natural level of phenolic compounds accumulated in the leaves. Supplemental lighting evokes a metabolic disbalance in green vegetables that accumulate low amounts of antioxidative compounds, therefore the flux of red light even diminish the nutritional value of spinach and rocket. Meanwhile, application of supplemental LED lighting to dill and parsley results in the accumulation of vitamin C and carotenoids of violoxanthin cycle and in the enhancement of free radical binding activity and the activity of nitrate-reducing enzymes.

S07.015

Antioxidant Activity, Phenolic and Free Arginine Content of Twelve Nuts

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Limited comparative information is available concerning the antioxidant substances (e.g. phenolics) and healthful biological factors (e.g. arginine) in nuts. Therefore, the present study aims to assess the total antioxidant activity, total phenolic content, and free arginine content of twelve common nuts. The results of this screening experiment demonstrated that there were remarkable differences in the antioxidant-related properties and free arginine content among the nuts evaluated. Walnuts, and especially the 'Milotai' variety, had the highest antioxidant activity and phenols content, following by pecan, and pistachio. Antioxidant activity was positively correlated with phenolic content in the plant material tested. In addition, hazelnut, pecan and walnut showed the highest content of free arginine among all the nuts examined. The comparative data presented here could be providing new knowledge about health function of nuts.

S07.016

Glucosinolates Content and Yield of Broccoli Cultivars in Different Growing Periods

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Among the functional food of plant origin, cruciferous vegetables are the abundant natural source of essential minerals, vitamins and phytochemicals. In broccoli (*Brassica oleracea* L. var. *italica* Plenck.), the concentration of glucosinolates and their bioactive hydrolysis products depend on the genetic, environmental and agronomic factors. Research with the aim to select promising hybrid broccoli cultivars, suitable for growing in agroecological conditions of northwestern Croatia, with high values of agronomic properties and bioactive compounds, was conducted during the spring-summer (SSGP) and summer-autumn growing period (SAGP). The field trials including 13 hybrid broccoli cultivars were laid out according to four-replication randomized complete block design. Planting dates were 19 April for the SSGP and 17 July 2007 for the SAGP, while harvest period started between 57 and 62 days after planting. During harvest period basic morphometric values of broccoli top inflorescence were determined. For analysis of total and individual glucosinolates content (HPLC system), samples of top inflorescence were freeze-dried. Mass of marketable top inflorescence during the SSGP ranged from 257 ('Agassi') to 403 g ('Parthenon') and from 321 ('Agassi') to 506 g ('Montop') in SAGP. The highest values of top inflorescence yield were achieved by cultivars: 'Parthenon' (1.33 kg \times m⁻²) in SSGP and 'Montop' (1.5 kg \times m⁻²) in SAGP. In both growing periods, prevailing indolic glucosinolates in all tested cultivars were glucobrassicin and 4-methoxyglucobrassicin. The highest glucobrassicin concentrations achieved 'Ironman' (13.2 $\mu\text{mol}\times\text{g}^{-1}$ DW) in SSGP and 'General' (9.5 $\mu\text{mol}\times\text{g}^{-1}$ DW) in SAGP, significantly higher than other cultivars. The main aliphatic glucosinolate was glucoraphanin. There were significant differences among cultivars in total glucosinolates concentration which ranged from 12 to 22.5 $\mu\text{mol}\times\text{g}^{-1}$ DW in SSGP and 5.4 to 15.5 $\mu\text{mol}\times\text{g}^{-1}$ DW in SAGP. 'General' and 'Marathon' achieved high values of agronomic and chemical properties in different environmental conditions.

S07.017

Changes in Metabolites of *Corchorus olitorius* during Storage - Comprehensive Analysis by Orbitrap MS

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Moloheiya (*Corchorus olitorius*) is a vegetable attracting human interest because it contains various useful components such as vitamins, phenolic compounds and polysaccharides with unique viscosity. After harvesting, the quality of moloheiya should change during storage. Although the previous study reported the changes in amounts of a few vitamins during the storage of moloheiya, analysis of numerous compounds or metabolites are necessary to evaluate the effect of the storage on the quality of moloheiya. In this study, the LC-Orbitrap MS system was used for the comprehensive analysis of compounds in moloheiya stored at 5 degrees Celsius. Methanol extracts from moloheiyas were prepared periodically for 7 days and applied to the analysis by LC-Orbitrap MS system. Many metabolites in moloheiya could be identified, and the amounts of several metabolites of them were found to change clearly during storage. These changeable metabolites should be key compounds determining the quality of moloheiya.

S07.018

Influence of Nitrogen Supply and Storage Temperature on the Vitamin C, Folic Acid and Glucosinolate Content of Baby Leaf Rocket Species *Diplotaxis tenuifolia* and *Eruca sativa*

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Rocket is an important new crop for the processed and fresh salad market where the leaves of the perennial and annual forms are in high demand for their characteristic flavour and attractive appearance. The impacts of nitrogen supply (0, 100, 200, and 300 kgN×ha⁻¹), and postharvest storage temperatures (0, 4, and 7 °C) on the content of vitamin C, folic acid and glucosinolates were studied over a range of varieties for *Eruca sativa* (annual garden rocket) and *Diplotaxis tenuifolia* (perennial wall rocket). After 15 days' storage, the lowest nitrogen supply (0 kgN×ha⁻¹) resulted in significantly higher vitamin C levels in *E. sativa* compared to all N application rates. The vitamin C levels were 76.6, 68.5, and 48.7 mg×100g⁻¹ after 15 days' storage at 0, 4 and 7 °C respectively. There was no effect of nitrogen supply for *D. tenuifolia*. The vitamin C content of both rocket species for all nitrogen treatments was significantly higher at 0 °C than 4 °C or 7 °C. Folic acid concentration of *E. sativa* was significantly higher (2.5-2.7 mg×kg⁻¹) at low rates of nitrogen supply, compared to high nitrogen supply where the folic acid concentration was 1.8-2.0 mg×kg⁻¹. Storage for 15 days at 0 °C resulting in 10% higher folic acid concentrations than storage at 7 °C. No significant differences were observed for *D. tenuifolia* response to nitrogen, however concentrations were maintained for 15 days at 0 °C. Total glucosinolate concentration was strongly influenced by nitrogen supply for *E. sativa*. Nitrogen applied at 100, 200 or 300 kg×ha⁻¹ resulted in glucosinolate concentrations of 3-4 g×kg⁻¹ compared to 0.8 g×kg⁻¹ for nil nitrogen application. The glucosinolate levels in *D. tenuifolia* were not significant influenced by nitrogen however in both species storage at 0 °C was effective in maintaining glucosinolate concentrations for 15 days after harvest.

S07.019

Glucosinolates in Chinese *Brassica* Vegetables and its Regulatory Mechanisms

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Glucosinolates, a group of plant secondary metabolites, are mainly found in the family of *Brassica*. Their enzymatical degradation products are responsible for the characteristic flavor, pathogen defense system and insect attractants, and have been shown to possess anti-carcinogenic, cholesterol-reducing and other pharmacological effects. Plenty of species and cultivars of Chinese *Brassica* vegetables are largely produced and consumed in China. In this article, we summarize our recent research results about glucosinolates as following: 1) Identification and analysis of glucosinolates in pakchoi (*Brassica campestris* ssp. *chinensis* var. *communis*, choysum (*Brassica campestris* ssp. *chinensis* var. *utilis*), turnip (*Brassica campestris* ssp. *rapifera*), leaf mustard (*Brassica juncea*), Chinese broccoli (*Brassica alboglabra*) and Chinese cabbage (*Brassica campestris* ssp. *pekinensis*); 2) Genotypic difference of glucosinolates in pakchoi and Chinese broccoli; 3) Influence of developmental stage and different organs on glucosinolates in pakchoi; 4) Effects of nutrient status (nitrogen, sulfur and phosphorus supply levels and nitrogen form) on glucosinolates in pakchoi; 5) Influence of elicitors (jasmonates and salicylic acid) on the concentration of glucosinolates in pakchoi; 6) Cloning and characterization of glucosinolates metabolism related genes in pakchoi.

S07.020

Cell-Based Bioassays Reveal Novel Metabolic and Anti-Inflammatory Actions of Resveratrol and Abscisic Acid in Insulin Target Cells and Macrophages: Potential for the Development of Novel FAV-Derived Anti-Diabetic Treatments

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The emerging epidemic of type 2 diabetes calls for the development of new therapeutic avenues and novel nutritional interventions. Compelling research supports the beneficial effects of fruit and vegetable consumption for the prevention of the insulin resistance syndrome and type 2 diabetes. Among the many valuable fruit and vegetable components, we looked further into the mechanism of action of resveratrol, a polyphenol enriched in red grapes, and of the plant hormone abscisic acid (ABA). We first investigated the anti-inflammatory potential of resveratrol, ABA and two chemical derivatives of ABA (A1 and A2) in myocytes, adipocytes and macrophages *in vitro*. Indeed, it has been clearly established that a pro-inflammatory state is involved in the development of obesity-linked insulin resistance and type 2 diabetes. We found that resveratrol, ABA and the ABA derivatives all potently inhibited iNOS, a key inflammatory enzyme and mediator of insulin resistance. Furthermore, resveratrol also inhibited iNOS protein expression in skeletal muscle and adipose tissue of mice challenged with endotoxin, a model of acute systemic inflammation. We also made the interesting observation that ABA and its derivatives stimulate glucose uptake in muscle cells. This is of particular interest since muscle glucose transport is known to be defective in human type 2 diabetic subjects. Finally, all tested compounds were found to be potent activators of AMP-activated protein kinase (AMPK). Since activation of AMPK is involved in the mechanism of action of several anti-diabetic drugs, this could likely explain the valuable effects of these natural compounds and ABA derivatives. These results provide further scientific validation for the beneficial effects of fruit and vegetable consumption and are paving the way for the development of new nutraceuticals or functional foods containing polyphenolic and ABA-based compounds for the management of type 2 diabetes.

S07.021

Modulation of Digestive Enzymes by Berry Polyphenols: Potential Health Benefits

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Berries are rich dietary sources of polyphenols, easily providing 100 mg/ 100g polyphenols, of which a large portion survives gastric conditions and is available in the small intestine. We are interested in the possible beneficial effects of this high polyphenol dose in the gut, especially as many berry polyphenols have low serum bioavailability and may not cause systemic effects. Certain polyphenols can inhibit digestive enzymes *in vitro* at levels easily achieved in the gut. A range of berry extracts rich in polyphenols inhibited the crucial starch digestion enzymes, alpha-amylase and alpha-glucosidase, *in vitro* (1). However, different berry extracts were more effective against the different enzymes suggesting specific enzyme-inhibitor interactions. By comparing the polyphenol composition of effective and less effective extracts, we identified candidate inhibitory components and suggested potential mechanisms for amylase and glucosidase inhibition. The candidate components were partially purified and retested to confirm inhibition. We also carried out human studies that suggest that berry extracts can modulate acute glycaemic responses

after ingestion of starch-rich foods, perhaps through inhibition of these enzymes *in situ*. Berry polyphenols also showed potential for the inhibition of pancreatic lipase activity, which is a proven therapeutic target for the control of obesity and hyperlipidemia through reduced fat digestion (2). We present evidence for the identification of key components. We also assessed the ability of berry polyphenol-rich extracts to inhibit protease activities at levels which could affect protein digestion in the gastrointestinal tract. Taking into account the potential synergies for inhibition of starch and lipid digestion by the diversity of polyphenol components present within berry species, the inhibition of digestive enzymes may be another important mechanism for the health benefits attributed to a diet rich in fruit and vegetables.

S07.022

Ethyl Linoleate from Garlic Attenuates Lipopolysaccharide-Induced Pro-Inflammatory Cytokine by Heme Oxygenase-1 in Murine Macrophages

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Garlic is a member of the lily family that has been cultivated by humans as a food plant for over 10,000 years and a folk remedy for thousands of years. Ethyl linoleate (ELA) were isolated from the clove of garlic. The structure of ELA was elucidated by spectroscopic methods including 2D-NMR techniques. In the present study, we demonstrated that ELA suppressed iNOS and COX-2 expression and thereby reduced NO and PGE2 production in LPS induced RAW264.7 cells. ELA significantly suppressed LPS induced production of pro-inflammatory cytokines (TNF- α , IL-1b, IL-6 and IL-12), and then these effects were mediated by the impaired translocation of NF- κ B and inhibition of the phosphorylation of p38, JNK, ERK and Akt. Interestingly, we found that ELA exerts anti-inflammatory activities in macrophages by inducing HO-1 expression. In addition, snPP (HO-1 inhibitor) abrogated the inhibitory effects of ELA on the production of NO, TNF- α , IL-1b and IL-6 in LPS induced RAW264.7 macrophages. These results suggest that induction of HO-1 by ELA may be important in the understanding of a novel mechanism for the anti-inflammatory activity of ELA.

S07.023

Antimicrobial and Antipathogenic Activities of Different Extracts of Fruits and Vegetables and their Metabolites

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Bacterial infections remain an important problem for human health. The control of bacterial infections has been traditionally treated by inhibiting microbial growth using different types of antibiotics. However, the ability of different bacteria to resist the inhibitory action of antibiotics has become a global problem. In fact, there is an important need for the development of new antimicrobials that act on novel bacterial targets. Many pathogenic bacteria control their population and regulate gene expression in response to their cell population density using diffusible signaling compounds. This type of communication has been referred to as "quorum sensing" (QS). This phenomenon can be essential for the synchronization of the virulence production factors which make it an attractive therapeutic target. Therefore, the search of non-toxic compounds which inhibit QS and so, the virulence of pathogenic bacteria can bring new alternatives for the treatment of bacterial infections in humans. In this work, we made an attempt to screen the anti-QS activity of 15 bioactive compounds extracted from fruits and vegetables using the biosensor strain, *Chromobacterium violaceum* and the antimicrobial activity against a pathogenic strain, *Yersinia enterocolitica*. The anti-QS activity was determined quantify-

ing the violacein production of the biosensor strain at three concentrations (50, 100 and 200 μ g/mL). At least six of the tested compounds (gallic, cinnamaldehyde, daidzein, resveratrol, chlorogenic and pomegranate extract) showed anti-QS activity against the biosensor strain using 50 or 100 μ g/mL. These extracts also showed antimicrobial activity against the pathogenic bacteria *Y. enterocolitica* when higher concentrations were applied (\geq 200 μ g/mL). The obtained results showed the potential of bioactive compounds extracted from fruits and vegetables to be used as a new category of anti-pathogenic compounds against bacterial infections.

S07.024

Designed Phytochemical Synergies for Functional Foods of the Future

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In the search for functional health-promoting compounds from plants, techniques including high throughput *in vitro* assays and activity-guided fractionation are commonly used. *In vitro*-active compounds are then tested in animals, or go directly into human intervention trials, which mostly fail to show specific or realistic health-promoting activity. This is primarily because phytochemicals are poorly absorbed and rapidly metabolised. Further, *in vitro* screening fails to detect the bioactivity of metabolites, and shows false activities of parent compounds, which may never reach circulation or their target organs at appreciable doses. Researchers have attempted to mimic the processes of phytochemical absorption and metabolism using *in vitro* digestion systems but these are technically challenging and although they may mimic some limited and disparate mechanisms, none has convincingly modelled *in vivo* digestion. Amongst consumed phytochemicals, polyphenolic compounds tend to be the most bioactive. Consumed polyphenols, similarly to most pharmaceuticals, are regarded as xenobiotics by the body and must overcome many barriers, including extensive enzymatic, chemical and microbial modification during digestion and absorption. Interestingly, many polyphenols can also modify some of the processes that govern their bioavailability. Therefore, the opportunity exists to increase the bioavailability and bioactivity of beneficial polyphenols by designing specific synergistic interactions with other polyphenols. For example, the activity of plant-derived monoamines can be enhanced by the co-consumption of phytochemical monoamine-oxidase inhibitors. Likewise, bioactives that are cytochrome P450 (CYP) or multidrug efflux pump (MDR) substrates may have their bioavailability significantly increased by the co-consumption of phytochemical CYP and MDR inhibitors. Other designed synergies, especially those commonly used in modern pharmacology, may be utilised in the design of functional foods in order to improve bioavailability and bioactivity. These hypotheses will be discussed, along with examples of further mechanisms that may be targeted by designed phytochemical synergies.

S07.025

How Can we Modulate the Bioavailability of Fruit and Vegetables Phytochemicals?

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The health effects of fruits and vegetables are often related to their content in phytochemicals. Bioavailability of these phytochemicals is a key factor to understand the health effects of fruits and vegetables *in vivo*. It is known that bioavailability depends on the food matrix, and therefore fruit and vegetable processing produce relevant effects on phytochemical bioavailability. Fruit and vegetable processing technologies (pressure, temperature, enzymes, etc.) can modulate bioavailability and in some cases they can help increasing phytochemical absorption. Phytochemicals are often poorly absorbed in the gut, and they need to be metabolized by colonic microbiota before absorption. Often, absorption depends on the presence of specific microbial strains in the colon, and therefore the health effects of these phytochemicals depend on the presence of specific microorganisms in the intestinal tract. This can be one of the explanations for the large inter-individual variability

observed in the human intervention studies with fruits and vegetables or extracts obtained from them. In the present work, the bioavailability of some fruit and vegetable phytochemicals will be presented as well as the effect of colonic microbiota metabolism on their bioavailability and the effect of technological treatments to modulate this bioavailability and potentially their health effects.

S07.026

In vitro Bioaccessibility of the Carotenoids of Leafy Vegetables

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Composition data on bioactive compounds should be accompanied by information on bioavailability. Human studies are ultimately required for this purpose, but such studies are time-consuming and complex, limiting their use to few food samples. Thus, simple and rapid *in vitro* methods have been developed for the initial screening of the relative bioavailabilities of carotenoids. The *in vitro* bioaccessibility of commercial and uncultivated native Brazilian leafy vegetables (chicory, coriander, kale, lettuce, New Zealand spinach, mint, roquette, water cress, “caruru”, “seralha”, “taioba”) was determined. The method was that of Garrett *et al.* (1999), modified by Reboul *et al.* (2006), Chitchumroonchokchai and Failla (2006), and Thakkar *et al.* (2007). It consisted of the oral phase (3 g homogenized vegetable + α -amylase solution, incubated in water bath with agitation for 10 min at 37 °C), gastric phase (pH adjusted to 4 + pepsin solution, incubated for 30 min) and intestinal phase (pH adjusted to 6 + a solution of bile extract, pancreatin, lipase, cholesterol esterase, incubated for 30 min). Centrifugation at 5,000 g, 4 °C, 45 min followed; the aqueous phase was collected and filtered. The carotenoids were extracted, identified and quantified, using our validated HPLC method. Among the raw leafy vegetables analyzed, New Zealand spinach had the highest bioaccessibility (14% for β -carotene, 46% for lutein), correlated with the lowest dietary fiber content (2.1 g/100 g). “Caruru”, rich in dietary fiber (4.5 g/100 g), had the lowest bioaccessibility (2.3% β -carotene, 6.9% for lutein), although it had the highest carotenoid levels (122 μ g/g β -carotene, 136 μ g/g lutein). Boiling increased the bioaccessibility. Micellarization of β -carotene and lutein was 3.3% and 18%, respectively, in raw kale, increasing to 16% and 38%, respectively in boiled kale. The corresponding percentages in New Zealand leaves were 14% and 46% in the raw and 15 and 59% in the boiled form.

S07.027

The Cooking Method of Tomatoes Influences the Particle Sizes of the Puree and Modifies the Capacity of the Carotenoids to Diffuse to an Oil Phase

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The bioavailability of active metabolites is defined by the proportion that leaves the food matrix and reaches their cellular target. Thus, the real nutritional benefit of one metabolite depend more on its bioavailability than on its total amount. For lycopene, the major tomato carotenoid, bioavailability is enhanced in cooked products. We made the hypothesis that this is due to the processes which render them more easily extractable. Tomatoes is often consumed with oil, either fresh in salads or processed as food bases mixed with ingredients to prepare sauces. Interestingly, the behaviour of the carotenoids in sauces containing oil mimics the very first step of the bioavailability: the easier carotenoids transfer to the lipid phase, as happen in the bolus, the more available they can be. We compared the diffusion of carotenoids from fresh, hot-break (HB) and cold-break (CB) purees toward an oil phase. Heat-treatment was achieved using microwave cooking either directly on fresh tomatoes (HB) or on crushed tomatoes (CB). Oil was added to each preparation and after 30 min of gentle shaking, carotenoids were measured in the oil phase. Inactivation of cell-wall degrading enzymes was verified for pectin methyl esterase by measuring

methanol liberation, and particle sizes of the purees were measured using a particle analyser. The HB purees contained roughly twice less lycopene than the fresh and CB puree. Surprisingly, results for the diffusion were inverted as oil contained three times more lycopene when mixed to HB (around 0.9 μ g \times ml⁻¹) than when mixed to fresh and CB (around 0.3 μ g \times ml⁻¹). The Methanol in HB was very low, indicating that PME was deactivated early during the microwave heating. HB puree contained a higher number of small particles than CB and raw puree. Lycopene bioavailability will be discussed regarding these physical properties of the purees.

S07.028

Fruits, Vegetables and Antioxidants

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Fruits, vegetables and products derived from them play a key role in the human diet, especially in health maintenance and disease prevention. There are many constituents that could contribute to such effects, including antioxidants and (seemingly paradoxically) pro-oxidants. These agents can affect physiology and pathology both within the gastrointestinal tract and also systemically after absorption. The care that is needed to establish the true effects of fruit- and vegetable-derived antioxidants and pro-oxidants in cell culture studies and *in vivo* will be illustrated by a range of data from our recent studies.

S07.030

Phytochemicals as Antioxidants: Chemistry and Health Effects

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Epidemiological evidence demonstrates that diets rich in fruit and vegetables promote health, and attenuate or delay, the onset of various diseases, including cardiovascular and neurodegenerative diseases, cancer, and diabetes. The chemical components involved, and the physiological and molecular mechanisms by which fruits and vegetables act on disease, are matters of intensive investigation. For example, backed by their chemical structure, plant polyphenols can in an organism interact with a number of chemical species. The reaction of these polyphenols with reactive oxygen species has been the concept behind studies of their *in vivo* antioxidant actions. In this regard, the understanding of the factors governing polyphenols absorption and metabolism, has reduced the enthusiasm for “direct” antioxidant reactions (free radical termination or metal chelating reactions), and has prompted the consideration of biological events that can occur at concentrations of polyphenols that are of physiological relevance. As an example of these biological events we have observed that oxidant- and inflammation-related events, as the activation of NF- κ B and intracellular calcium regulation, can be modulated by polyphenols by mechanisms that do not necessarily involve an upstream free radical scavenging action.

S07.031

Postharvest Variability in Fruit and Vegetable Composition and its Impact on Dietary Recommendations

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A diet rich in fruit and vegetables is known to reduce the risk of cardiovascular disease. Specific fruit and vegetables are now being linked to specific medical conditions, such as reducing the risk of developing type II diabetes or colorectal cancer. Some of the phytochemicals responsible for these effects and the mechanisms by which they may work are now reasonably well understood, but in general nutraceutical extracts or supplements do not have the same beneficial effects as a diet

rich in fruit and vegetables. The proliferation of knowledge in this area is causing consumer confusion. Simply saying that a fruit or vegetable 'contains' something is not enough; consumers need to know whether that compound is present in a bioavailable form and at a concentration that may do them good if they eat a normal serving of the particular fruit or vegetable once every few days. Better understanding of how the whole 'package' of phytochemicals, vitamins and dietary fibre varies after harvest and during food preparation and digestion is required if we are to give sound dietary advice to consumers anxious about their health. This paper will present data on changes in flavonoid composition in asparagus, broccoli, watercress and limes during postharvest storage. Few generalisations about compositional change after harvest are possible and it is important that optimal harvest maturity, storage and food preparation methods are developed for each fruit or vegetable variety if consumer guarantees of composition are to be offered.

S07.032

Antioxidant Activity of Pulp and Peel Apples Extracts Evaluated by Bacteriophage and DNA Protection Methods

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Free radicals are endogenous initiators of degenerative processes, as they damage lipids, proteins and DNA, thus favoring the development of a number of degenerative diseases. Apple contains many different dietary phytonutrients with strong antioxidant capacities, such as phenolics, carotenoids, and vitamins, which may protect against free radicals. The aim of this work was to evaluate the antioxidant activity of pulp and peel apple extracts, from Portuguese cultivars — Casa Nova, Gala, Granny Smith, Reineta, Starking, Golden, Fuji and Jonagored. The antioxidant capacity was evaluated by ABTS + method and *in vitro* biological methods — inhibition of DNA oxidative damage and protective effect of phage P22 oxidation by H₂O₂. The pulp and peel extracts were obtained by mashing pulp (directly) and peel (1:10 in HCL 0.1%) to obtain a concentrated juice of each part. The results confirm, for all cultivars, that antioxidant activity in the peel is higher than in the pulp, which is a valid argument for the consumption of apple with peel. Cultivars Casa Nova and Reineta possess higher antioxidant activity in the pulp and Starking revealed the best antioxidant activity in the peel. The lower antioxidant activity of the peel extracts was recorded in cultivars Golden Delicious and Granny Smith. It was found that apple extracts showed no protective action upon oxidation of DNA. However, the results ensure that neither extract has pro-oxidant activity. The evaluation of antioxidant activity by bacteriophage P22 and Salmonella typhimurium system showed that the pulp and peel extracts alone (without oxidant) do not affect phage infection over time, however no antioxidant effect was observed in the presence of the oxidant; some extracts even potentiate the oxidant effect upon the phage. This was probably due to the high content of ascorbic acid that, at low pH, could potentiate the oxidant effect of the H₂O₂ used as oxidant.

S07.033

Maple Sap and Syrup Are a Rich Sources of Abscisic Acid and Polyphenols with Potential Benefits to Health

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For centuries maple sap and syrup have been a staple of North-American native people and are consumed now-a-days throughout the world as edulcoration produce and natural sweeteners, appreciated for their quality and delicate taste. Maple sap is collected in the Spring when freeze/thaw cycles causes the sweet sap to rise in the tree and flow from especially made taps in the trunk for collection. The sap is boiled to concentrate the sugar and forms a rich 66 °Brix syrup. Apart from sugar, the natural sap contains minerals, oligosaccharides, some proteins, polyphenols and phytohormones. We hereby present original results on the content of maple sap and

syrup in phytohormones and especially in abscisic acid (ABA), in ABA-conjugates and its metabolites. We show that this sesquiterpene can be traced in large concentration in both the sap and the syrup. The metabolites thus resist heat and technological process leading to the consumable produce. Moreover, the largest form of sesquiterpene in the sap and syrup were phaseic acid and dihydrophaseic acid accounting for almost 90% of this class of molecules while ABA and its 7'-OH form accounted for close to 10% of this terpenoid in the sap and syrup. Recently ABA and their metabolites have been suggested to act as autocrine cytokine molecules in human granulocytes and were shown to stimulate the release of **insuline by pancreatic Langherans Islets** (Guri *et al.* 2007, Clin. Nutr. 26:107-116). The high titer of ABA in maple products may explain why they are better tolerated by those suffering from diabetes and metabolic disorders that those consuming other sources of sugars.

S07.034

Grapefruit Degreening Influences Health Promoting Limonoids and Flavonoids

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Grapefruit (*Citrus paradisi* MacFad.) is a rich source of various health promoting bioactive compounds such as vitamins, organic acids, limonoids, sterol, coumarins and flavonoids. Degreening early season grapefruits with ethylene is common commercial practice followed to accelerate change in peel color by destruction of chlorophyll and accumulation of carotenoids. While degreening of citrus fruits has received considerable attention, very little information is available on influence of ethylene treatment on bioactive compounds such as limonoids, flavonoids and vitamins in grapefruit juice. In the present study, degreening and storability influence on bioactive compounds of star ruby grapefruit were investigated. Fruits were degreened in commercial packing shed and both degreened and non degreened fruits were stored under simulated market conditions at 10 °C for 3 weeks and 21 °C for 2 weeks. No significant difference was found in β-carotene and lycopene levels among non-degreened and degreened grapefruits. In both treatments, β-carotene and lycopene levels increased gradually up to 35 days of storage. Ascorbic acid was retained during the storage period with no significant difference between the treatments. Four limonoids and five flavonoids were quantified by HPLC. Nomilin content was significantly higher in degreened fruits than non-degreened fruits at 35 days of storage. In summary, while certain flavonoids and limonoids were reduced during storage due to degreening, carotenoids and ascorbic acid content were not affected. Therefore, degreening can be used to maximize fruit quality and enhance certain limonoids while only minimally affecting bioactive compounds present in grapefruit.

S07.035

Modelling Health Aspects of Fruit and Vegetables

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Dealing with the health aspects of fruit and vegetables is a complex task. Epidemiological studies relating intake of fruit and vegetables with health are positive but not always consistent in their results. Fruit and vegetables contain a huge number of components that can contribute to their potential health benefits. The level and bioavailability of these components is strongly affected by processes in the supply chain. To use the various sources information for design of healthier processes and products various challenges remain to be solved, like: How to deal with uncertainty and variability in the results of epidemiological studies? How to estimate the health impact of individual components? How to optimize processes and preparation methods for health? In this presentation the use of mathematical modeling for these issues will be shown by various examples. Different modeling approaches are needed for specific areas: Mechanistic Kinetic Models for process simulation, Monte Carlo Simulations for modeling epidemiological results, Bayesian Belief Networks for linking consumer aspects to product and processing variables. By these examples it will be shown that modeling can be used to use experimental data more efficiently and to improve the decision making process by combining expert knowledge and data.

S07.036

Comparative Effects of Dietary Plant Extracts and Phytochemicals in Cellular and Biochemical Assays with Potential Relevance to Neurodegenerative and other Chronic Diseases

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Numerous studies have provided evidence for decreased risk of some chronic diseases — e.g., some types of cancer, cardiovascular and neurodegenerative disorders — with increased dietary intake of vegetables, fruits, teas, spices and other plant-based foods and supplements. Two major objectives of our research are to examine (1) the relation of such diseases to plant-based dietary components at the population-public health level, and (2) the potential mechanisms by which phytochemicals (PhC; including PhC combinations, metabolites, and plant extracts) may provide protection against the initiation and development of such diseases at the molecular-physiological level. In terms of the 1st objective, we have provided evidence for an inverse relation between flavonoid consumption, especially flavonols, and risk of Alzheimer's and other dementias among the populations of developed countries. In terms of the 2nd objective, the main topic of this report, various flavonoid and non-flavonoid PhC were tested in cellular and biochemical assays with potential relevance to such chronic diseases; in particular, potential neuroprotective effects were assessed against the pro-oxidative action of beta-amyloid (bA) and transthyretin aggregates (TTRag), two pathological factors that contribute to some amyloidogenic diseases. Quercetin — a flavonol abundant in dietary plants such as onions, apples, tea — was a potent antioxidant in assays that included bA or TTRag; e.g., 25-35% inhibition at 10 microM ($p < 0.05$ relative to controls without PhC). Various plant extracts were also tested in these and other (e.g., anti-bA aggregation) assays; the relatively potent effects of bilberry, *Vaccinium myrtillus* (L.) will be discussed and compared with other *Vaccinium*, *Citrus*, *Capsicum*, and other plant species. Overall, the current results of our ongoing studies provide novel insight into activities of plant-based products in different potential neuropathological contexts, and insight into chemical structure-function relationships of various PhC.

S07.037

Understanding Perceptions of Risk: The Outrage Factor and Fruit and Vegetable Consumption

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Fear of pesticide residues has been identified as a contributing factor to inadequate fruit and vegetable intake in Australasia. This appears irrational: in a country like New Zealand, when 60,000 food samples were tested for a possible 240 chemical residues in 2009, 200 chemicals were undetectable and just two samples were found that moderately exceeded the maximum residue limit for one of the residues. In contrast, it has been calculated that 1,559 deaths could be attributed to inadequate fruit and vegetable intake in New Zealand in 1997. Cardiovascular disease, diabetes and colorectal cancer are amongst the major killers in most Western countries and inadequate fruit and vegetable intake is a contributing factor to all of these conditions. Peter Sandman in 1987 put his finger on the missing factor that helps us understand this extraordinary irrationality: the risk that people perceive equals the hazard itself, plus an 'outrage' factor. The more familiar something is, and the more control I have over it (e.g. choosing to smoke), the lower the outrage factor; the less familiar, or the less control I have over it, the higher the outrage factor. Arguably, this behaviour has contributed to human evolutionary success. There is an enormous science community devoted to understanding and manipulating the behaviour of fruit and vegetables after harvest in order to deliver fresh produce that is demonstrably high in health-promoting nutrients, bioactive compounds, minerals and fibre. Millions of dollars have been spent on "5-plus a day" public health campaigns attempting to promote fruit and vegetable consumption. What is lacking is a co-ordinated attempt to manage the 'outrage' factor in the public mind. This

paper discusses the roles and responsibilities of scientists in their relations with the media, the Government, the private sector and the public with respect to this topic.

S07.038

Study on the Separation and Determination of Capsanthin in Capsicum (*Capsicum annuum* L. Syn. *C. frutescens*)

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Capsanthin is a fat soluble red pigment and is synthesized during carotenogenesis and enhances liposolubility by esterifying with short-chain saturated fatty acids. Capsanthin is regarded as a functional material by antioxidative activity and anti-tumor-promotion activity. Therefore, increased intake of capsanthin rich foods may be helpful for the improvement of health. In this paper, the separation and determination of the capsanthin in capsicum was conducted. The capsanthin is separated and identified by High Performance Liquid Chromatography (HPLC) using Inertsil OD-3 (4.6×250mm, 5μm), mobile phase: Methanol-Dichloromethane, flow rate: 1ml/min, wavelength: 474nm, oven temperature: 30 °C, injection volume: 10μl. Good linear relationship between peak area and concentration of capsanthin was obtained. The regression equation of capsanthin standard curve is $Y = 11426990X + 15313.26$, the correlation coefficient is 0.9982. The regression equation of Dihydrocapsaicin standard curve is $Y = 6386890X + 2962.65$, the correlation coefficient is 0.9999. Moreover, the purification of capsanthin was studied from hot pepper, and the effect of KOH, ether and the extract time was observed. The orthogonal & rotatable experimental design, together with statistical analysis and response surface graph analysis is also performed to get the upmost purity and optimal condition: the quantity of KOH is 5.39ml, the quantity of ether is 15.57ml, the extract time is 2.34h, the purity of capsanthin could reach 17.2%. This method could be used for rapid separation and determination of capsanthin in capsicum.

S07.039

Antioxidant Capacity and Mechanisms in Tomato Fruit at Different Ripening Stages

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Fruits and vegetables consumption is important for human health, among other reasons because of their high content of antioxidant compounds. Antioxidant molecules protect the organism from the damage caused by free radicals, which have been associated with the development of chronic degenerative diseases such as cancer. Carotenoids, particularly lycopene, vitamin C, phenols and tocopherols are among the antioxidant substances present in tomato fruit. Fruit ripening has been described as an oxidative process; therefore, a balance between production of reactive oxygen species (ROS) and its removal by antioxidant systems is essential to prevent oxidative damage to macromolecules such as lipids, proteins, etc. Antioxidant systems are classified in enzymatic (e.g. ascorbate peroxidase (APX) and glutathione reductase (GR)) and non-enzymatic (e.g. citric acid and carotenoids among others). It is well known that the antioxidant content in tomato fruit depends on ripening stage, harvesting time, geographic location, environmental factors and storage conditions. In this study, antioxidant capacity, oxidative damage of proteins and enzymatic (APX and GR) and non-enzymatic (citric acid) antioxidant systems were determined during ripening of Saladette tomato var. 7705. The results showed that antioxidant capacity was low in mature green (MG) tomato and increased as ripening progresses. On the other hand, GR and APX enzyme activities were high in MG tomato and decreased as tomato ripens, suggesting that these enzymes are essential for the MG tomato antioxidant capacity, probably by regenerating reduced antioxidants. But, their importance seems to decrease as fruit ripens and carotenoids, which have antioxidant capacity, are synthesized. Oxidative damage of proteins and citric acid levels during tomato ripening will also be discussed.

S07.040

Extraction and Quantification of Betaine in Azorean *Beta vulgaris* by HPLC. Effect on Human Health

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Sugar beet produces sucrose and many other water-soluble components that are extracted from the beets as juice. The main product is sucrose, but betaine, inositol, amino acid mixtures and individual amino acids have also been commercially separated from molasses. The extraction of betaine (sulphydryl-containing amino acid derived from metabolic demethylation of dietary methionine) from sugar beet can be divided into three main stages: production of sugar beet molasses, extraction of betaine using water as an eluent, and finally its purification by crystallisation. In the plants, betaine acts as an osmoprotectant by adjusting the osmotic balance inside of the plant cells and tissues. By this natural defence mechanism, betaine helps plants to overcome the environmental stresses caused by cold, salinity and heat, which are the worst enemies of plant productivity. Recent research on cardiovascular diseases has shown that betaine could potentially help in the reduction of arteriosclerotic cardiovascular diseases that can eventually be caused by excess of homocysteine (Hcy) in the blood. Elevated Hcy levels are an independent risk factor for atherosclerotic cardiovascular diseases, coronary heart disease and strokes. Betaine works by donating methyl groups to Hcy to convert into methionine, consequently lowering the level of blood Hcy. Betaine is considered a safe and effective therapy to lower total Hcy in patients with inborn errors in the enzymes involved in Hcy metabolism. Another important function of betaine is acting as an osmoprotectant having stress relieving properties under various kinds of gastrointestinal stress. Betaine has also been used in some pharmaceutical applications, particularly in the treatment of human homocystinuria for several months without any harmful effects. The objective of our study is the extraction of betaine from Azorean *Beta vulgaris*, the quantification by HPLC/ELSD, and the investigation of the industrial production feasibility.

S07.041

Optimising Quality and Anthocyanin Yield of Purple (Black) Carrots

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High anthocyanin content (black or purple) carrots are a new phytonutrient source that can be processed into an anthocyanin juice concentrate to supply the rapidly expanding health drink market. High anthocyanin carrots (*Daucus carota*) were studied over three seasons. Exposure to low growing temperature early in crop development resulted in up to 40% of plants heading prematurely (bolting) and consequent effects on anthocyanin yield could be significantly reduced by manipulating planting density. Planting densities from 40 to 160 plants×m² were evaluated in the field under cool growing conditions. Bolting was logarithmically correlated to planting density (R² = 0.93) at 10 weeks from sowing and at harvest (115+ days). The lowest rate of bolting (6%) occurred at the highest plant density of 133 and 160 plants×m² and increased to a maximum rate of 24% at the lowest density of 40 plants×m², 74 days after planting. At harvest (115 days after planting) bolting had increased to 11% and 40% for high and low density respectively. The combined effects of plant population and the indirect effect on bolting resulted in a highly significant effect of plant density on the yield of carrots and anthocyanin under cool premature-heading inducing conditions. Total yield of carrots increased significantly from 18 to 40 t×ha⁻¹ at plant densities of 40 and 160 plants×m² respectively. Total anthocyanin yield per ha decreased proportionally with plant spacing as a consequence of total carrot yield. There was a strong tendency for plants at the ends of rows or blocks to have a greater frequency of bolting suggesting that exposure of the apical meristem to light or cold may play a part in the density x temperature effect on premature heading.

S07.042

The Influence of the Adsorption Drying Technology on Stability and Availability of Glucosinolates in Broccoli (*Brassica Oleracea* var. *italica*)

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Consumption of Broccoli (*Brassica Oleracea* var. *italica*) is known to be associated with health benefits. The compounds responsible for this health effect are called isothiocyanates which are formed by the reaction between glucosinolates and the myrosinase enzyme during the disruption of broccoli tissues (chewing, chopping etc.). Isothiocyanates make Broccoli one of the most promising vegetable in cancer prevention. Drying technologies can have a strong impact on processed foods quality i.e. decreasing the content of naturally occurring health promoting compounds. During drying of broccoli, glucosinolates can be broken down by means of heat or oxidation, the enzyme myrosinase can be inactivated and cellular structures can be altered. All these modifications might reduce the formation of bioactive isothiocyanates from glucosinolates, compromising the health-protective effects of broccoli. Absorption drying is a novel technology which uses low or moderate temperatures preserving the target compounds of broccoli with a limited ecological impact deriving from low energy consumption and CO₂ exhaust. The aim of this study is to set up the most suitable drying conditions that preserve the health protective effect of broccoli by using the adsorption drying technology. For this purpose broccoli batches with different water content/activity (obtained by using freeze drying process) have been thermally treated in order to investigate the influence of the water content/activity and temperature on glucosinolates content, myrosinase activity, degree of cell lysis and, as a consequence of these changes within the product, to predict the ability to form isothiocyanates upon dehydration. Based on this research the conditions during the drying process can be optimized to increase the health promoting potential of the dried product.

S07.200

Indian Fruits as Nutraceuticals

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Fruits are 'protective foods' since they are rich source of phytochemicals and provide the body with capacity to fight disease since they provide vitamins and minerals like Ca, Fe, P, and Vit. A, C, B, etc. In India, many naturally growing or cultivated horticultural crops, especially dark green and bright coloured fruits and vegetables, which are hitherto underutilized and under exploited, are rich sources of antioxidants. Fruit juices of Pomegranate (*Punica granatum*), Citrus (*Citrus* sp.), Pineapple (*Ananas comosus*), Wood apple (*Feronia limonia*), Grape (*Vitis vinifera*), Litchi (*Litchi chinensis*), Seabuckthorn (*Hippophae* sp.) etc., are effective in preventing many diseases like scurvy, night blindness, asthma, bronchitis, fever, anaemia, ulcer, angular stomatitis and diabetes, cancer etc. Leaves, flower, bark and root, etc of various other fruits viz. Singhara (*Trapa natans* Roxb.), Makhana (*Euryale ferox*), Barhal (*Artocarpus lakoocha*), Karonda (*Carrisa carandas*), Mahua (*Bassia latifolia*), Kamrakh (*Averrhoa carambola*), Khirni (*Manilkara hexandra*), Amra Paniyala (*Flokarina indica*), Halpahari (*Phyllanthus acidismus*), Lasooda (*Cordia mixa*), Wood apple (*Feronia limonia*), Cape gooseberry (*Physalis peruviana*), Goolar (*Ficus glomerata*), Kadam (*Anthocephalus kadamba*), Imli (*Tamarindus indica*), Kaphal (*Myrica nagi*), Seabuckthorn (*Hippophae* sp.), Rasperry (*Rubus* sp.), Chilgoza (*Pinus gerardiana*), and Burans (*Rhododendron* sp.) etc, are used widely in therapeutics. Thus, it is important that the potential of fruits for their therapeutic value be recognized and their use as nutraceuticals be promoted to overcome malnutrition and for improving the socio-economic status of the society at large.

S07.201

Selecting Varieties of Broccoli for Optimal Bioactive Components: The Influence of the Saline Stress

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Broccoli is an important agri-food product produced in SE Spain and is well referenced as source of health-promoting bioactive compounds. Commercial quality and bioactive components of broccoli cultivars ('Parthenon', 'Naxos' and 'Nubia') were studied in plants grown in hydroponics and administered 0, 40 and 80 mM of NaCl in the nutrient solution. Physical characteristics of the flowering heads were determined (weight at harvest, global and base head diameter and circularity of the head, and length and diameter of the stalk) and health-promoting bioactives (glucosinolates and vitamin C). 'Naxos' variety performed better than 'Parthenon' and 'Nubia' in quality parameters and the glucosinolate content as determined by HPLC-DAD, specially at 0mM NaCl. In the 40mM NaCl treated plants the glucosinolate contents were significantly increased. The 80mM NaCl stress increased the concentration of glucosinolates with respect to the control, but not if compared to the 40mM NaCl treatment, indicating the biphasic response to salinity observed in early studies with 'Marathon' broccoli. The vitamin C content in the three varieties was very similar and not affected by the NaCl in the florets, but highest in the leaves of the untreated controls (0 mM NaCl). 'Parthenon' and 'Naxos' are current better-performer varieties and clear substitutes to classical varieties not adapted to the current adverse conditions of climate and water resources, demonstrating a positive influence of the variety on the levels of health-promoting bioactive compounds and the modulatory effect of the abiotic stress on the quality and nutritive composition of broccoli.

S07.202

Regulation of Vitamin C Biosynthesis Using Transient Expression of Vitamin C Pathway Genes in Tobacco Leaves

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Kiwifruit are an excellent dietary source of vitamin C for humans, with 80 to 120 mg/100 g FW in commercial cultivars. To test how flux is altered when biosynthetic enzyme levels are changed, we cloned the kiwifruit genes for five sequential enzymatic steps in the L-galactose pathway of vitamin C biosynthesis; namely phosphomannose mutase, GDP-mannose pyrophosphorylase, GDP-mannose 3',5'-epimerase, GDP-L-galactose transferase:phosphorylase and L-galactose 1-P phosphatase and then transiently expressed them in tobacco leaves. All genes produced enzymatically active proteins when expressed in *Escherichia coli* and transiently in tobacco leaves. The genes were expressed transiently either individually or in combination using pGreen vectors in *Agrobacterium*. Enzyme activity as well as vitamin C level measurements showed >7 fold increase in vitamin C in leaves expressing GDP-L-galactose transferase:phosphorylase alone. Whereas expression of GDP-mannose 3',5'-epimerase alone did not result in increased vitamin C levels, combination with GDP-L-galactose transferase:phosphorylase acted synergistically to increase the level by more than 17 fold. No other combination of genes resulted in increased vitamin C. This assay system has the potential to identify elite alleles as well as screening for combining ability potential of selected crosses, thus aiding parental selection for this important trait.

S07.203

Composition of Chemical and Antioxidant Properties of Pomegranate Juices from Eight Iranian Cultivars

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Pomegranate (*Punica granatum* L.) is an important Iranian-native fruit, which many varieties are cultivated. The objective of this work was to analyse and compare the chemical composition and antioxidant activity of eight pomegranate juices including 'Shirin Pust Ghermez', 'Shirin Dane Ghermez Ferdows', 'Malas Save', 'Malas Yazdi', 'Torsh Shahvar Kashmar', 'Torsh Shahvar Ferdows', 'Khazar Bajestani' and 'Dom Amberoti'. Total soluble solids, pH, titrable acidity, ascorbic acid, total anthocyanins, total phenolics and antioxidant activity were the traits measured. This study showed that there were significant differences ($p < 0.05$) among the cultivars in all measured parameters. Total soluble solids content varied from 11.67 to 15.07 (°Brix), pH values from 3.16 to 3.09 and titrable acidity concentration from 0.33 to 2.44 (g/100 g). The level of ascorbic acid was observed in pomegranate cultivars between 19.91 ('Malas Save') and 18.42 ('Malas Yazdi') (mg/100 g). The highest and lowest level of total anthocyanins was recorded in 'Malas Yazdi' and 'Dom Amberoti' (30.11 and 5.72 mg/100 g), respectively. The values of total phenolics varied from 295.94 ('Shirin Pust Ghermez') to 916.60 ('Malas Yazdi') (mg gallic acid /100 g). Antioxidant activity of pomegranate cultivars was found between 18.41 ('Shirin Pust Ghermez') and 48.85% ('Malas Yazdi'). There was a strong correlation between antioxidant activity and total phenolic content ($r = 0.957$). These data demonstrated that cultivar is the main parameter that determines the chemical composition and antioxidant activity in pomegranates and this provides important knowledge on how to make the best use of the pomegranate cultivars evaluated.

S07.204

Screening of Mono and Poliglutamic Folates in Different Lettuce Varieties

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Folate is a generic term for the various biochemical forms of the B9 vitamin or folic acid. Folates are essential micronutrients in a variety of biological processes, and seem to play a crucial role in the prevention of a number of diseases (e.g. megaloblastic anemia, neural tube defects, cardiovascular diseases, cancer, Down syndrome, and impaired cognitive function in adult). Since folates are only synthesized by plants and microorganisms they must be part of a balanced diet (400µg/day). In this regard, leafy vegetables (e.g. spinach or lettuce) are good folate sources in the diet but their folate content is markedly affected by varietal or agronomic conditions. In plant-foods, folates are mainly found as conjugated forms, a fact that may limit their intestinal absorption. The aim of this work was to study the content of mono- and poliglutamic forms of folates in different varieties of lettuce (*Lactuca sativa* L.). Sixteen varieties of lettuce grown under the same fertilization conditions were analyzed for their folate content. For that, samples were extracted with or without the use of folate conjugase in order to determine the mono- and poliglutamate forms of folates, respectively. Folates in the extracted samples were analyzed by HPLC-FL. The total folate content of the varieties studied showed wide variations and ranged from 20 to 60 µg/100 g. The only monoglutamic folate form detected without conjugase addition was free 5-methyl tetrahydrofolate (5-MTHF), which ranged between 15-30 µg/100 g. Conjugase addition allowed the release of further 5-MTHF and tetrahydrofolate (THF), which were comprised in the ranges 19-54 µg/100 g and 2-8 µg/100 g, respectively. Poliglutamic forms accounted for 15 to 65% of total folates, lower than previously reported for lettuce (80%). Mono- to poliglutamate ratios were between 0.5 and 3.3 suggesting that bioavailability of folates from the varieties studied would not be compromised.

S07.205

Wild Edible Fruits Traditionally Used in Spain: Nutritional Aspects and Bioactive Compounds

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Plant domestication has led to a progressive decline of wild food plants consumption. Nevertheless, wild plant resources have been a good complement to the diet in periods of food shortages, mainly in rural populations. Some authors even report that wild species may contain higher amounts of bioactive compounds than their cultivated relatives. The aim of this research was to evaluate the nutritional value and the content of certain bioactive compounds in four wild fruit species of popular use in Spain. We selected the fruits of strawberry tree (*Arbutus unedo* L.), blackberry (*Rubus ulmifolius* Schott), blackthorn (*Prunus spinosa* L.) and hawthorn (*Crataegus monogyna* Jacq.). Samples were collected in two different locations of central Spain during two consecutive years. They were analysed for proximate composition and vitamin C, in both ascorbic acid (AA) and dehydroascorbic acid (DHA) forms. *Arbutus unedo* stood out for its low moisture (51.71%) and ash content (0.88%), while carbohydrates and fiber levels were high. *Rubus ulmifolius* had high values of carbohydrates (17.86%), proteins (1.55%) and insoluble fiber (10.15%). *Prunus spinosa* showed a similar proximate composition to *Rubus ulmifolius*. The fruits of *Crataegus monogyna* were characterized by high moisture, ash and soluble fiber content: 70.24%, 2.49%, and 3.45% respectively. Proteins showed the more stable pattern among species and locations, and no significant differences among species were found ($p < 0.05$). *Arbutus unedo* has to be emphasized for its significant values of total vitamin C (133–259 mg/100 g), higher than many of the fruits usually included in the diet. Vitamin C content of the other species ranged between 5.85 mg/100 g, in (*Crataegus monogyna*), and 21.18 mg/100 g in (*Rubus ulmifolius*). The two active forms of vitamin C showed different distribution among species, being AA the major form in *Arbutus unedo* and *Rubus ulmifolius*, and DHA in the other ones.

S07.206

Nutritional Approach of Some Wild Edible Plants from Asteraceae Family

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Wild plants have been traditionally used for human consumption. In the last decades, the intake of wild plants, especially wild vegetables, has decreased, being replaced by other vegetables easily found in markets. However, due to their important nutritional properties and the presence of bioactive compounds, the attention toward wild edible plants as potential contributors to the benefits of the Mediterranean diet has grown significantly in Europe. Recent studies supported by the European Commission have found that a high number of wild edible species have contributed markedly to total fruit and vegetable intake and have positive effects on human health, many of them belong to the *Asteraceae* family. In this study, six *Asteraceae* species have been analyzed: *Chondrilla juncea* L., *Cichorium intybus* L., *Scolymus hispanicus* L., *Silybum marianum* (L.) Gaertner, *Sonchus oleraceus* L., and *Taraxacum* sp. In these samples, a proximate composition analysis has been performed. Moisture content was measured by desiccation; total mineral content by mineralization at 450 °C and Atomic Absorption Spectroscopy for macro and microelements analysis; Kjehldal method was used to determine total protein content; fat content was determined by Soxhlet extraction; anthrone method was used to determine available carbohydrates; soluble sugars were quantified by HPLC; and total fiber was determined by AOAC enzymatic-gravimetric methods. Regarding their chemi-

cal composition, the different analysed species presented a wide variation. Moisture ranged between 72 and 90%, and major components of the dry matter were available carbohydrates (1.2-5.6%), proteins (0.20-0.80%), mineral fraction (1.03-2.7%) and fat (0.8-2.5%). Sugar composition is formed by fructose, glucose y sucrose, and major mineral elements were K (552-1300mg/100g), Ca (200mg/100g), Mg (20-51mg/100g), Na (300-1300mg/100g), Cu (0.01-0.27mg/100g), Mn (0.10-0.57mg/100g), Fe (0.50-2.78mg/100g) and Zn (0.21-0.55mg/100g). For all these reasons, the analysed species of the *Asteraceae* family have important nutritional properties and they are a good choice for a normal diet.

S07.207

Characterization of Apple Cultivars in Terms of Allergenicity

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Growing of different apple cultivars is widespread in the territory of Central Europe. Apples are recommended by nutritionists because of its high content of vitamins and dietary fibres. Unfortunately the presence of several allergens in apple pulp and skin causes allergy problems for some consumers. Allergen Mal d1, which causes swelling of lips and oral cavity, is the most important. At present, the cultivar Golden Delicious is commercially very successful. Unfortunately a high content of allergen Mal d1 was detected in this cultivar. Using 17 selected apple cultivars, the allergenicity was studied by prick to prick tests in patients with clinically detected apple allergy. Pressed apple juice was used for basophil activation testing. Intensity of patient's allergic reaction to particular cultivars was confirmed by SDS-PAGE electrophoresis and immunity reaction of blood serum by Western blot method.

S07.208

Old and New Apple Varieties at the Service of Health in South Tyrol (Northern Italy)

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South Tyrol (Northern Italy) is the largest continuous apple producing area in Europe. The annual apple production amounts to more than 1.1 million of metric tons, 95% of which are made up of only eight global cultivars. Consequently, many old, regional apple varieties with unique characteristics have disappeared from this area. In order to prevent further loss of local genetic variability, several projects were carried out in the past or are still underway. The project "Health and Nutrition – Old and New Apple Varieties at the Service of Health", granted within the EFRE 2007-2013 programme, deals not only with the exact molecular genetic identification of a large number of old and new apple cultivars, but also focuses on the analysis of fruits to assess components relevant to human health, such as minerals, sugars, acids or polyphenols. The ultimate goal will be to identify cultivars suitable for agricultural niche production or the generation of specialised high-quality foodstuffs. The presentation will give a detailed overview of the project and show first results of the chemical analyses of apple cultivars grown in South Tyrol.

S07.209

QTL Analysis of Traits Linked to Flavour and Nutritional Quality in Lettuce

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Lettuce is an important salad crop in the *Asteraceae*, and comprises a major part of the Western diet, especially as the population becomes increasingly concerned with salad as part of a healthy diet. Its health benefits can be attributed to the analgesic,

anti-inflammatory and sedative effect of some sesquiterpenoid lactones, and to a range of flavonoids with emphasis on quercetin, chicoric acid and chlorogenic acid. Primarily these act as antioxidants, but also show other health benefits such as potential anti-human immunodeficiency virus functions, raising uric acid levels and acting as transcription factors. Using a population of 102 RILs (Recombinant Inbred Lines), the progeny of a wild type (*Lactuca serriola*) and a domesticated lettuce (*L. sativa*) we employed Quantitative Trait Loci (QTL) analysis to identify regions of the genome which contain alleles likely to be responsible for high and low flavonoid content. The population was selfed and propagated to the F10 generation by single seed decent in order to fix genes into each line and render the majority of alleles homozygous. The plants were grown to baby leaf stage, harvested into liquid nitrogen and homogenised before analysis. Parameters linked to flavour and nutritional quality, such as total antioxidants, were assayed and the QTL subsequently mapped onto the lettuce genome. Results of these analyses and on-going work to identify QTL relating to individual metabolites will be presented. Such information can be utilised in molecular breeding programs, using marker assisted selection (MAS) to more efficiently select for genes of interest. It is hoped that this will ultimately allow new lettuce varieties that are high in flavonoids and other beneficial metabolites to be produced, reducing the risk of oxidative-stress and its related diseases in the consumer.

S07.210

Antioxidant Capacity in the Peel of Eleven China-Grown Pomegranate Cultivars

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In this research, the content of total polyphenols, flavanoids, and procyanidins in the peel of eleven China-grown pomegranate cultivars were investigated with the methods of Folin-Ciocalteus, NaNO₂-Al(NO₃)₃-NaOH, and HCl-Vanillin, respectively, and total antioxidant capacity was determined using ferric reducing antioxidant capacity (FRAP) assay. The results showed that Fentian had the highest polyphenols content (71.1 mg·g⁻¹ FW) followed by Danhong, Chuanhui, Xingzi, DRF-1, D3, Chonghuang, Chongfen, Baiyue, Dasuan, and Damo. By comparison of the flavanoids content in the peel of different cultivars, the following trend was observed: DRF-1 > D3 > Chuanhui > Fentian > Chonghuang > Xingzi > Danhong > Dasuan > Chongfen > Baiyue > Damo. For the procyanidins content, the order of the cultivars was Fentian > Danhong > DRF-1 > Chuanhui > D3 > Xingzi > Chongfen > Damo > Dasuan > Chonghuang > Baiyue. This evidence indicates that the three antioxidants content in pomegranate peel may be cultivar-specific. Among the eleven cultivars, the trend of total antioxidant capacity in the peel was Fentian > Danhong > Xingzi > D3 > Chuanhui > DRF-1 > Chonghuang > Dasuan > Baiyue > Damo > Chongfen. Correlation analysis showed that the total antioxidant capacity in the peel had a strong linear relationship with both the polyphenols ($r=0.90$) and procyanidins content ($r=0.68$), indicating the antioxidant capacity of pomegranate peel might be attributed to the content of total polyphenols and procyanidins. This study may help in the cultivar selection and application of pomegranate peel.

S07.211

Quantification of Carotenoids in Zucchini (*Cucurbita pepo* L. subsp. *pepo*) Varieties Cultivated in Almeria by Liquid Chromatography

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The scientific literature is consistent in evidences that it is possible to reduce the risk of acquiring some types of cancer, cardiovascular diseases, diabetes, stroke, obesity, diverticulosis, and cataracts by eating a variety of vegetables and fruits. This has been attributed to their content of antioxidants, such as carotenoids, flavonoids,

and vitamins C and E. Carotenoids are natural pigments which are synthesized by plants and are responsible for the bright colors of various fruits and vegetables as *Cucurbita* species. The genus *Cucurbita* includes the cultivated species *Cucurbita pepo* L. subsp. *pepo* (zucchini). Zucchini is easily grown in the agricultural and climatic conditions of Almeria (Spain), and it is part of the everyday food of their inhabitants. The objective of this study was to determine the content of carotenoids in pulp and peel in six varieties of zucchini currently cultivated in Almeria (Spain) by means of HPLC. The varieties of zucchini studied were Cavili, Dante, Cora, President, Cronos and Consul. Zucchini varieties were grown in controlled conditions in the greenhouse. Pulp and peel of immature fruit were weighed, frozen in freeze-dried. Extraction of carotenoids and HPLC analyses were carried out using the method described by Tadmor *et al.* (2000). In dependence of the variety different concentrations and distributions of α -carotene, β -carotene, violaxanthin, neoxanthin, all-trans-lutein were obtained. The total carotenoid content (expressed as dry weight) of the zucchini peel and pulp depends on the variety. Differences for quantitative and qualitative carotenoid contents have been found between the varieties of zucchini studied being some varieties valuable sources of carotenoids.

S07.212

Bioactive Components from the Black Sea Area Traditional Foods

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The three years collaborative research program BaSeFood (Sustainable exploitation of bioactive components from the Black Sea Area traditional foods) is funded by the 7th Framework Programme and it was launched on 1st April 2009. This Consortium consists of 13 partners namely Italy (2), United Kingdom, Greece, Portugal and Serbia and six Black Sea Area countries (BSAC): Russia, Ukraine (2), Romania, Bulgaria, Turkey and Georgia. BaSeFood will contribute at scientifically studying bioactive compounds of BSAC traditional foods by means of rigorous analytical and biological assays, in the context of unifying methodologies and data acquisition, but also considering a vast array of characteristics of traditional foods and consumers issues, in order to put health claims in a favourable context, to be properly understood by people and exploited by processor stakeholders. Foods were categorized in groups: (1) cereals and cereal based foods; (2) fruits; (3) vegetables; (4) products from oilseeds; (5) herbs, spices, aromatic plants and (6) fermented products. Thirty-three foods have been selected for nutritional and proximate analyses (about five foods from each BSAC), many of which have fruits or vegetables as main ingredients. In addition, other specific fruits, vegetables and herbs will be considered for bioactive components determination and retention during food preparation. Different nutrients and key bioactive compounds such as phenolics, glucosinolates, tocopherols, carotenoids and terpenoids were selected to be analysed, depending on the plant matrix. Guidelines for sampling and sample handling have been developed to establish a common approach for all countries and to ensure that representative food samples are analysed. The bioactive components, nutritional and microbiological characterization of traditional foods will contribute to create the knowledge base for a sustainable economic development in the area of production and processing of tradition-based healthy foods.

S07.213

Variation of Thermal Stability of Glucosinolates in a Segregating *Brassica* Population

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Epidemiological studies show negative associations between the consumption of *Brassica* vegetables and the incidence of certain cancers. The protected effects of *Brassicaceae* have been attributed to high levels of health-promoting phytochemicals

such as glucosinolates (GLSs). The underlying protective mechanisms of GLSs are mainly ascribed to the induction of phase I and phase II enzymes, involved in the detoxification and excretion of carcinogens, and inhibition of cell proliferation. Plant breeders are developing *Brassica* vegetables richer in specific GLSs. Next to the initial GLS concentration, the ingested amount of GLSs is affected by industrial and domestic processing and storage. The described mechanisms of GLS losses are: a.) enzymatic degradation by the endogenous enzyme myrosinase, b.) leaching into the cooking water and c.) thermal degradation. Previously, thermal treatment of five different *Brassica* vegetables (two *B. napus* and three *B. oleracea* types) revealed differences in the degradation velocity of GLSs. These results show that the chemical stability is influenced by the plant matrix, which is (partly) genetically regulated. Crossing of two different *Brassica oleracea* sub-species varying in various traits of interest, results in a segregation in the F1 generation. It is hypothesized that thermal stability of GLSs segregates as other phenotypic traits, like e.g. flowering time. Thermal degradation rates were studied in a segregating population, obtained by crossing broccoli and Chinese kale. In order to determine rate constants for the reaction velocity, homogenates of microwaved leaves were heated at 100 °C over various times and the GLS concentration was analyzed. The obtained kinetics data will be combined with molecular marker data (QTL analysis) in order to unravel the genetic regulation of thermal GLS degradation during food processing. Preliminary data showed different rate constants among the plant lines of the segregating population, which proves the hypothesis of segregation of thermal stability of GLS.

S07.215

Quality and Nutritional Composition of Dried Figs: A Traditional Calabria Region (Italy) Product

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Figs (*Ficus carica* L.) are a widespread species commonly grown, especially in warm, dry climates and it is an important crop worldwide for dry and fresh consumption. As a seasonal food, figs represent an important constituent of the Mediterranean diet. This type of diet is considered one of the healthiest and is associated with longevity. Fruit and vegetable are an important source of essential elements. Mineral nutrients and phenolics are natural component of many fruit and play an important role in maintaining fruit quality and determining nutritive value. Dried figs are an excellent source of minerals, vitamins and dietary fiber; they are fat and cholesterol-free and contain a high number of amino acids. Similarly to other fruit species, figs contain sugars and organic acids that influence their quality. They also contain phenolic substances, which contribute strongly to their quality, especially because it has been demosted that their consumption may have a positive effect on human health. Calabria, south Italy, is an important area for cultivation of figs and in particular for the traditional skill in dried fig productions. The aim of this study was determine the variability of chemical attributes (sugars, organic acids, total phenolic, fibre and vitamins) content in dried figs grown in different Calabrian areas. The results showed a very high quality of dried figs analyzed. Chromatographic, spectrophotometric and gravimetric analysis has been used to determine dried figs composition. The data obtained shown dried figs are good source of soluble fiber (25% DRI) and carbohydrate (38% DRI), and also are source of vitamins. The organic acids and phenolics contents detected in dried figs show a high content of these nutritionally important compounds. The results form a good basis for evaluating the quality and nutritional importance of dried figs by physical-chemical analysis.

S07.216

Characterization of Different 'Tropea' Red Onion (*Allium cepa* L.) Ecotype by Aroma Precursors, Aroma Profiles and Poliphenolic Composition

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Epidemiological studies have indicated that the consumption of fruits and vegetables is associated with a reduced risk for the development of chronic diseases, such as cardiovascular disease and cancer. Phytochemicals, including phenolics and flavonoids, are suggested to be the major bioactive compounds of fruits and vegetables contributing to the health benefits. Onion bulbs (*Allium cepa* L.) are among the richest sources of dietary flavonoids and contribute to a large extent to the overall intake of flavonoids. A particular sweet red onion, 'Tropea Red Onion', characterized by a large red envelope and internal white tunics and grown on Tyrrhenian Calabrian's coast (south of Italy), for the excellent organoleptic characteristics (tenderness, crispness, sweetness), is considered the pride calabrian's horticultural products. Because of the few available scientific studies on this particular red onion, a large-scale study to characterize different Tropea red onion ecotype was initiated. Onions are characterized from two main chemical groups. These are the flavonoids and the alk(en)yl cysteine sulphoxides (ACSOs). Two flavonoid subgroups were found in onion, the anthocyanins and flavanols such as quercetin. The ACSOs are the flavour precursors, which, when cleaved by the enzyme alliinase, generate the characteristic odour and taste of onion (thiosulphinates, thiosulphonates, mono-, di- and tri-sulphides). The quantitative content of anthocyanins in Tropea red onion cultivars has been reported to be approximately 8% of the total flavonoid content. Altogether at least more than 25 different flavonols have been characterized, quercetin derivatives are the most important ones in onion ecotype. Analogous derivatives of kaempferol and isorhamnetin have been identified as minor pigments. The dihydroflavonol taxifolin and taxifolin 7-glucoside have been identified bulbs of the 'Tropea' ecotype. The profile of aroma components corresponded with the related pattern of aroma precursors (cysteine sulfoxides). GC/MS, SPME/GC/MS, HPLC and e-nose had been used to classify different 'Tropea' red onion ecotypes.

S07.217

Binding Affinity of Selected Flavonoids to Bovine Serum Albumin by Fluorescence Quenching and Chromatographic Retention Factor

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The interaction between biomacromolecules and remedies has attracted great interest among researchers for several decades. Among them, serum albumins are the major soluble protein constituents of the circulatory system with many physiological functions. Bovine serum albumin (BSA) has been studied extensively in particular because of its close structural homology with human serum albumin. The interaction between protein and bioactive compound results in formation of a stable protein and bioactive compound complex, which may be considered as a model for increasing essential knowledge into bioactive compounds-protein binding mechanisms. Fluorescence spectroscopy is an appropriate method to determine the interaction between the small molecules and biomacromolecules. Low-molecular-weight bioactive compounds from a variety of sources represent unique structural diversity. Flavonoids are widely distributed secondary plant constituents with great structural variety and various pharmacological properties such as antibacterial, anti-proliferative activities, anti-metastatic, antioxidant activities, increase oxidative stress-resistance and longevity. Favonol (quercetin) and isoflavonoids (rotenone and degueline) were studied for their ability to bind BSA by quenching the protein inherent fluorescence. The fluorescence parameters such as the dynamic quenching constant and the binding constant were attained whereas chromatographic retention factor was determined by high-performance liquid chromatography method. Chemical structure significantly affected the binding/quenching process and results showed that hydrogen bond force play an important role in binding of flavonoid to polar groups at the BSA surface. The lipophilicity of flavonoides was less important in the binding affinity.

S07.218

The Biological Effect of Saffron Extract on the Various Forms of Retinal Degeneration

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In this report experimental dates of the biological activity of saffron (*Crocus sativus* L.) extract at the treatment of various eye pathology processes are presented. It was carried out the comparative experiments on the study of curative properties of saffron extract. At the study of acute toxicity of saffron extract was found that at a single intramuscular administration of a 0.5% solution of saffron extract at a dose 5 ml did not have any toxic effect. In experiments on the chronic toxicity of saffron extract (0.5 % solution administered two times a day for two weeks at a dose 0.5 ml) it was found that the weight of the animals, the count of red cells and biochemical indices of the blood were not altered in during of whole experimental period. A treatment with 0.5% solution of saffron extract stimulated blood circulation and metabolism in the retina, thus delaying the development of dystrophic changes. It was found that granules in the pigment epithelium of the macular area is contains two carotinoids - lutein and zeaxanthin, which play a key role in the protection of the retina diseases. The research of cardiotoxic properties of saffron extract at oral administration of one at a dose of 250 mg/kg is showed its anti-ischemic and anticoagulant effect: bioelectric stability is restored and the degree of myocardial hypoxia is reduced. It is studied the action of impact saffron extract on the dynamic of the electrical activity in several structures of the brain, the heart rhythm and behavioral responses a cross-correlation assay in experimental animals (rats, rabbits). We are observed a certain change in the electrical activity of the brain towards to stimulation of the brain structures - sensomotor, visual cortex, and hypothalamus.

S07.219

Acquirement of Anticancer Activity and Improved Quality of *Gastrodia elata* Blume by Fermentation with *Phellinus linteus*

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Gastrodia elata enlarged by symbiotic *Armillaria mellea* has been known for an important oriental medicinal herb in Korea, Japan, and China. Even though its distinctive functions for treating diseases such as palsy, numbness in limbs, epilepsy, fresh *Gastrodia* has sickening, bitter, savory even sweet tastes, which becomes the most reluctant medicinal herb. Fermentation technique was applied to eliminate these unfavorable taste and smells. *Inonotus obliquus*, *Phellinus linteus*, and *Aspergillus oryzae* were selected as putative candidates for fermentation. When fungi grew on *Gastrodia* containing agar plates (1, 2, 3%) in order to investigate their interaction with *A. mellea*, *I. obliquus* and *P. linteus* grew well regardless of the contents. Rice bran content was important as well (50, 70, 100, 130, 150, 170, and 200%). When freeze-dried *Gastrodia* was incubated with *P. linteus* for 5 days at 32 °C with less than 100% (v/v) rice bran, it was fermented very well. With the results, *P. linteus* was very useful for *Gastrodia* fermentation and the unpleasant taste were dramatically reduced by fermentation. In addition, fermented *Gastrodia* showed extreme inhibition of rat liver cancer cell Hepalcl7 amplification. Thus, this fermented *Gastrodia* can be used for anticancer treatment in the future.

S07.220

Application of BTH and Methyl Jasmonate during the Ripening of Grapes (*Vitis vinifera* L.) and its Effects on the Stilbene Content

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Pre-harvest treatments of grapevine (cv. Monastrell) with the plant activator benzothiadiazole (BTH, 0.3 mM) and methyl jasmonate (10 mM), an important intracellular regulator, were applied to check whether these compounds could enhanced stilbene content in berries at the moment of harvest, due to the interesting health properties of the stilbenes in grapes and wines. Both compounds were sprayed on clusters at veraison. Both compounds enhanced the level of stilbenes in grapes, the highest increase being found with the use of methyl jasmonate. Since a highest presence of stilbenes in grapes could be a protection against mould infection, the application of these compounds could, not only improved the healthiness of grapes, but also limit the use of fungicides

S07.221

Effects of Environmental Stress on Ascorbic Acid Content in Baby Leaf Spinach (*Spinacia oleracea* L.)

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The consumer demand for ready to eat bagged baby leaf spinach (*Spinacia oleracea* L.) in the U.K. has increased markedly over the last 10 years. Shelf-life of spinach is a key quality factor, which may be influenced by the content of antioxidants present in the leaves at harvest. One of the main antioxidants in spinach leaves linked to post harvest quality is ascorbic acid (AA). The amount of AA in spinach has been shown to be influenced by a wide variety of external growth factors. In a two year project, a range of environmental stress treatments has been applied pre harvest to glass house grown spinach cv. Revere F1. The spinach was harvested at different growth stages. The content of AA as well as dehydro ascorbic acid (DHA) in the leaves at harvest was analysed using HPLC. Short and mild heat stress, or cold stress, in close connection to harvest was found to alter the AA content. Nutritional status of the soil, as well as salt stress of the leaves, was also found to affect the AA content of spinach leaves. Some differences could be explained by changes in leaf water content due to the treatments (higher or lower dry matter content). However, a shift in the ratio of AA:DHA as well as actual increase in total AA content was also observed. The findings suggest that altered growing practise may produce spinach leaves with increased AA content. This may have benefits for shelf life as well as human nutrition.

S07.222

Health Claim Labelling for Baby Leaf Spinach and Rocket Relative to Vitamin C and Folate

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Consumers want food to be healthy and more recently some consumers want food to add "more" to their health. Marketing can take advantage of these desires and mislead consumers. New food labelling guidelines currently being developed by FSANZ (Food standards Australia and New Zealand) are tightening the guidelines in relation to health claim labelling on food. Our research looked at how these new guidelines could be applied to fresh cut baby leaf spinach and rocket. Our experiment collected data on the content of Vitamin C and Folate in baby leaf spinach (*Spinacia oleracea* L.), wild rocket (*Diplotaxis tenuifolia*) and cultivated rocket (*Eruca sativa*) grown in different districts and seasons in Australia. The aim of this project was to generate data that would substantiate a health claim label on the packaging of these fresh cut products. Preliminary results show that baby leaf spinach could be labelled as a source of Vitamin C and Folate with more than 10% of the recommended daily intake (RDI) of these nutrients per serve and that wild rocket could be labelled as a good source of Vitamin C as it had more than 25% of the RDI per serve and that rocket was also a source of folate. Our results show that for these

products the concentration of Vitamin C and Folate declines with time in storage and when stored at temperatures above 0 °C. In our experiments the levels of these nutrients remained above 10% of the RDI per serve under the storage regimes we trialled. This work also included a focus group study with consumers to gauge their knowledge and interest in health claim labelling on baby leaf spinach and rocket. An overview of this data will also be presented.

S07.223

Flavonoids, Antioxidant and Anti-Inflammatory Activity in Sweet Cherries (Ferrovia Variety)

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Sweet cherries (*Prunus avium* L.) are one of the most popular fruits of the temperate zone, representing an important commercial resource; they are consumed mainly non-processed as well as an ingredient in fruit cocktails, maraschino, yogurt, etc. Sweet cherries, as all the fruits and vegetables, contain polyphenolic compounds which seem be responsible of different healthy effects. In fact, different epidemiological evidences suggest an inverse correlation between high intake of plant products and cardiovascular diseases and occurrence of some cancer types. Phenols and anthocyanins, a group of flavonoids largely present in the sweet cherries, contribute to the bioactivity of this fruit, principally for antioxidant and anti-inflammatory properties. The aim of the work was to determine the total phenols, the qualitative anthocyanins composition, the antioxidant and anti-inflammatory activity of *Prunus avium* cv. Ferrovia extracts, typically cultivated in Apulia (Sud Italy); anti-inflammatory activity was also compared with two synthetic anti-inflammatory drugs (Ibuprofen and Nimesulide). The total phenols (TP) were determined by the Folin-Ciocalteu methodology and expressed as gallic acid equivalents (GAE). HPLC-diode array detection (DAD) –mass spectrometry (MS) analyses were performed for the measuring the qualitative composition of anthocyanins. Antioxidant activity (AA) was determined by the ABTS test, while the anti-inflammatory activity (AI) was measured determining the cicloxygenase activity (COX) by a enzyme immunoassay kit (Caiman, Ann Arbor, USA). Results obtained showed that TP was 142.9 mg GAE/100 g of fresh weight (FW), while the anthocyanins was 36.4 mg/ 100 g FW and cyanidin-3-glucoside was the pigment most abundant. AA was equal to 48 μmol Trolox/g FW and 70% was in relation to the anthocyanins content. AI, reported as percentage of inhibition of the COX, was 40% comparable with the Ibuprofen 10 μM, a commercial and synthetic anti-inflammatory.

S07.224

Improvement the Nutritional Quality of Industrial Tomato and Lettuce Using Novatec® Solub Fertilization Technology

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Nitrogen management in plant nutrition is an agronomic and environmental key factor. Under soil conditions the main fraction of N available for the plant is nitrate, independent of the N form applied by fertilisers. Nitrification inhibitors reduce the nitrification rate and increase the ammonium absorbed by the plant. This effect reduces the risk of groundwater pollution by nitrates and produce interesting effects in plant nutrition. Nitrate is dangerous for human health and can increase oxalate concentration (anti-nutrient for humans and animals: kidney stones and reduction of Fe absorption) and decrease vitamin C content in vegetables. This paper presents the results of two trials in fertigated industrial tomato and lettuce performed by the official research centre CTAEX (Badajoz, Spain). In both trials a conventional ammonium + nitrate fertilization is compared with the application of ammonium + nitrate + nitrification inhibitor 3,4 dimethylpirazole phosphate (DMPP, trademark NOVATEC®), using similar rates of N applied. The trial performed in industrial tomato shows that a moderate supply of ammonium stabilised with the nitrification inhibitor increase yield an average of 8% and also increase the lycopene concentration (also colour a/b

ratio) from 32 mg×kg⁻¹ with conventional fertilization to 45 mg×kg⁻¹ with a mixture of nitrate + ammonium +nitrification inhibitor. The trial in fertigated lettuce compare different N doses and the use or not of the nitrification inhibitor DMPP. Results show that this technology can modify metabolic routes in plants, reducing nitrate and oxalate in leaves. Vitamin C, A and B2 were not affected by the different treatments. Conclusions of the trials are that important nutritional parameters, as nitrates, oxalates, vitamin C or lycopene can be influenced by the quantity and characteristics of the N fertilizer applied, and that a mixed nutrition nitrate / ammonium with DMPP (NOVATEC Solub®) improves the nutritional quality of this vegetables.

S07.225

Effect of Variety, Position, Fertilizer Quantity and Low Temperature Storage on the Antioxidant Activity of Cabbages

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The aim of this study was to investigate the antioxidant activity of cabbage with different variety, head position, fertilizer quantity and low temperature storage duration measured by scavenging DPPH (1,1-diphenyl-2-picrylhydrazyl) free radical ability and ferric reducing antioxidant power (FRAP). The rank of 34 cabbages according to scavenging DPPH free radical ability was ornamental cabbage, leafy cabbage, purple cabbage, seedling cabbage, sprout cabbage, savoy cabbage and green cabbage which valued from 25.13% to 4.78%. The rank of FRAP analysis was familiar with the result of DPPH which valued from 1.66 to 0.80 μmol FeSO₄/g f.w., and the positive correlation existed between these two methods. Cabbage 'K-Y Cross' had the higher antioxidant activity in interior stem and the lower in outer leaves of head while purple cabbage 'Scarlet' got the opposite result. The antioxidant activity of cabbage with recommendable fertilizer quantity is higher than those with conventional quantity. Beside it, the antioxidant activity and vitamin C content dramatically increased after 1 week at 2 °C, dark storage and then decreased with the duration elongated; however, the values were still higher than non-storage cabbage.

S07.226

Gastrointestinal Digestion Affects the Phenolic Content of Fruit Juices Enriched with Pycnogenol®

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The consumption of fruit and vegetables has been shown to be associated with lower risk of cancer, cardiovascular disease, and other chronic diseases such as inflammatory bowel disease. The enrichment of foods with phenolics compounds can be considered an expedient way to obtain "functional foods" with beneficial effects on human health. Pycnogenol®, a standardized extract from the bark french maritime pine (*Pinus pinaster* Ait.), consists of a concentrate of water soluble polyphenols. Pycnogenol® has been reported to have strong antioxidant capacity owing to its phenolic content. However, during gastrointestinal digestion, polyphenols can undergo substantial changes affecting its biological properties including antioxidant capacity. The aim of this study was to investigate the effect of *in vitro* gastrointestinal digestion on the phenolic profile of fruit juices enriched with Pycnogenol®. The results indicate that *in vitro* digestion process decreased the total phenolic content of fruit juices without Pycnogenol® addition by 50% with respect to the initial non-digested matrix. On the other hand, enriched fruit juices maintained their phenolic content by 70% and 100% with respect the samples before gastrointestinal digestion. Regarding the different phenolic compounds, chlorogenic acid content of digested samples increased by 8% compared with the samples before digestion. Caffeic acid content of both enriched and not fruit juices showed a decrease by 4% after gastrointestinal digestion. Our results suggest that fruit juices enriched with Pycnogenol®, could be a good source of phenolics compounds with a high stability to gastrointestinal digestion conditions.

S07.227

Cytoprotective Activities of Tomato Extracts Against Induced Oxidative Stress in HepG2 Cells

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Tomato provides an optimal mix of hydro- and lipophilic antioxidant compounds such as phenolic compounds, ascorbic acid, vitamin E and carotenoids, mainly lycopene, which might be responsible for the proposed health benefits upon tomato consumption. The aim of this study was to evaluate the ability of hydro- and lipophilic tomato extracts to prevent tert-butylhydroperoxide (tBOOH)-induced cellular oxidative stress. For that, the human hepatoma (HepG2) cell line was incubated with tomato extracts and tBOOH. We used both lipophilic and hydrophilic tomato extracts, as well as their combinations to study possible synergistic effects between antioxidants. The extent of oxidative damage was evaluated by measuring cell viability and the intracellular reactive oxygen species (ROS) generation. Both hydro- and lipophilic tomato extracts prevented tBOOH-induced cell death in a dose dependent manner. Hydrophilic extracts were more effective in preventing cell death than lipophilic extracts. Also, extract combinations afforded protection against induced cell death but no synergistic effect was observed. As regards ROS generation, a similar behaviour was observed with hydrophilic extracts being the most effective in preventing induced ROS generation. Importantly, lipophilic tomato extracts prevented ROS generation at a physiologically attainable lycopene concentration (1.3 microM), whilst in the case of hydrophilic extracts cytoprotection was afforded at the concentration 11 microM of total phenolic compounds.

S07.228

Content of Phenolic Compounds in Apples from Organic Versus Integrated Fruit Production

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Organic fruit production is considered to be stricter compared to integrated production because of limitation in use of pesticides and mineral fertilizers. Fruit plants therefore grow in conditions where often different forms of stress occur. This reflects also on their metabolism, because they have to protect themselves from harmful ecological influences as well as from pathogen attack. We tried to evaluate the influence of different growing technologies (organic vs. Integrated) on the content of phenolic compounds in apple fruits. Apple trees are one of the most wide-grown species in the world and their phenolic content is considered as highly health beneficial. Our results show that apples grown according to organic guidelines contain higher amounts of certain groups of phenolics as well as higher content of total phenolics. The phenolic content was much higher in apple peel than in apple pulp regardless of the type of fruit production. This is probably due to the fact that apple peel is the outer barrier towards the environmental influences and therefore the substances used for protection from unfavoured conditions are synthesized in higher amounts. Phenolic compounds supposed to act as antioxidants also in human body, therefore eating unpeeled apples, either from integrated or organic production, should be beneficial for human health.

S07.229

Initial *in vitro* Evaluations of the Antibacterial Activities of Phytochemicals against *Listeria monocytogenes*

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Plants synthesize a diverse array of secondary metabolites (phytochemicals) known to be involved in plant defence against microbial and fungal pathogens and insect pests, and in the last few decades several classes of phytochemicals have been shown to help reduce the risk of various diseases e.g. cancer and coronary heart disease. More recently antimicrobial properties for phytochemicals, and especially essential oils, have been extensively investigated due to the increase in multi-resistance of important pathogenic microorganisms to antibiotics. New sources of effective antimicrobial compounds need to be discovered and developed. The Gram-positive bacteria *Listeria monocytogenes* is one of the major causes of death due to food-borne illness, and has recently been recognized as an important public health problem. Frequently implicated vehicles include foods that are ready to eat, highly processed, and cold stored. In the present study the antibacterial activity of 12 phytochemicals (glucosinolate hydrolysis products [GHP] and phenolic compounds) were tested using a modification of the disc diffusion method, against one relevant pathogenic bacteria, *Listeria monocytogenes* (ATCC 15313). Each product was tested at a concentration of 1000 µg/mL. Sterile filter paper discs were impregnated with 10 µL test phytochemical. Discs of antibiotics (gentamycin, ciprofloxacin, nalidixic acid and streptomycin) were used as positive controls and blank discs with DMSO were used as negative controls. All tests were performed in triplicate and antibacterial activity was expressed as the mean of inhibition diameters (mm) produced. Some phytochemicals were more efficient than the antibiotic controls in inhibiting the growth of *Listeria monocytogenes*, namely benzylisothiocyanate and 2-phenylethylisothiocyanate when compared with the antibiotics gentamicin and ciprofloxacin. In addition high antimicrobial efficiencies were seen with caffeic acid, gallic acid, ferulic acid and allylisothiocyanate, when compared with nalidixic acid. Interestingly, the phytochemicals chlorogenic acid and (-) epicatechin had no effect on *Listeria monocytogenes* ATCC 15313.

S07.230

Pursuing Ways to Increase Number and Production Efficiency of Glandular Trichomes in *Artemisia annua* by Applying Physical and Chemical Stresses

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The medicinal herb *Artemisia annua* produces several bioactive compounds e.g. artemisinin which is used to treat human malaria. The bioactive compounds are believed to be part of the plants defence mechanisms, and are produced and stored in glandular trichomes, situated primarily on the surface of the leaves. The aim of the present study was to test the possibility of inducing *A. annua* plants to upgrade the defence mechanisms and thus change the immediate and long term production capability as well as the composition of bioactive compounds. During field experiments in 2009 a number of *A. annua* (cv. Artemis) plants were exposed to 11 different stress-related treatments, e.g. application of oligochitosan and the phytohormones jasmonic acid and salicylic acid in different concentrations. Other treatments included leaf cutting or physically scorching selected parts of the plants. Sample harvests were conducted 5 times during a 4 week period, and consisted of picking one old leaf and one newly developed leaf. The harvested leaves were photographed under fluorescence microscope. Lateral length and number of trichomes per leaf area were recorded. The amount and composition of bioactive compounds were analyzed by HPLC (UV detection at 210 nm) and correlated to the treatments as well as the density and size of trichomes. Results include relations between the stress-related treatments, the composition and amount of secondary metabolites, and the trichome size and density in *A. annua*.

S07.231

Phytochemical Composition and Antioxidant Properties of Portuguese Kale and Portuguese Tronchuda Cabbage Produced in a Sustainable Agriculture Production System Are Affected by Climate Conditions

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The aim of this study was evaluate the biological role of Portuguese kale and tronchuda cabbage comparing with broccoli inflorescences, one of the *Brassica* plants with biological role already well established. Understand which the main components are directly associated with antioxidant activity and how the different climate conditions affect their average levels is another objective. The plant material used in this research was produced under field conditions in two different climate seasons, Spring-Summer (SS) and Summer-Winter (SW) during two consecutive years. The average content of total phenolics, total flavonoids, L-ascorbic acid (vitamin C), glucosinolates and minerals (Fe, Zn and Se) directly associated with the antioxidant activity were evaluated. Spectrophotometric, spectrometry and HPLC system methods were used to measure the average contents of the above components. The antioxidant activity was evaluated using the DPPH method and respectively IC50 values were estimated by a curve dose-response. Our results showed that Portuguese kale and Portuguese tronchuda cabbage exhibited high antioxidant activity with 80.6 and 82.2 of % inhibition of DPPH radicals respectively, and 1.49 and 1.97 mg×mL⁻¹ of IC50 average values respectively. These values were very similar to those obtained for broccoli (81.9 % of inhibition of DPPH radicals 1.97 mg×mL⁻¹ of IC50 average level). Our results showed that climate seasons affected directly (P<0.001) the concentration of the bioactive components and thereby the antioxidant activity. Based on IC50 average values, all brassicas showed high antioxidant activity in SS seasons. In this season the high antioxidant activity were directly assigned to high levels of total flavonoids (P<0.001), total phenolics (P<0.01), glucoiberin (P<0.01), glucobrassicin (P<0.01), total glucosinolates (between P<0.05 and P<0.001) and zinc (P<0.01). Based on our results we can state that *Brassica* plants can provide considerable amounts of bioactive components and may constitute an important source of natural dietary antioxidants.

S07.232

Effects of Temperature and Light/Dark Cycle on the Growth and Vitamin C Concentration of Lettuce

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Vitamin C present in plant foods acts as line of defence against oxidative stress. As a result, it protects cells against oxidative damage, and may therefore prevent chronic diseases, such as diabetes, cancer and cardiovascular disease. The content of vitamin C, measured as the sum of ascorbic acid (AA) plus dehydroascorbic acid (DHAA), is used as an index of health-related quality of vegetables, so that interest in the simultaneous analysis of AA and DHA emerged. On the other hand, vitamin C is extremely sensitive to environmental factors such as temperature and light. The objective of this study was to determine the effect of temperature and light/dark cycles, on growth and vitamin C concentration of lettuce (*Lactuca sativa* L.). Plants were grown in a growth chamber with controlled-environment conditions under different temperatures day/night (23/15,

20/12 and 15/8 °C) and different light/dark cycles (16/8, 12/12 and 8/16 h). Vitamin C (AA and DHAA) was analysed using liquid chromatography tandem-mass spectrometry (LC-MS-MS) with triple quadrupole in selective reaction monitoring (SRM) mode for the simultaneous determination of AA and DHAA. Negative ion mode of ESI and MS/MS transitions of m/z 173→143 and m/z 173→71 for AA and m/z 175→115 and m/z 175→87 for DHAA were used. Lettuce growth was influenced by both light and temperature. The increase of the day/night temperature from 15/8 to 23/15 °C and the increase of the light period from 16 to 8 h led to increases in weight by 45% and 32%, respectively. The effect of temperature and amount of light during the growing period on vitamin C concentration is discussed on the basis of their effect on availability of sugars for AA synthesis.

S07.233

Soluble Sugar and Organic Acid Concentration in Lettuce as Affected by Temperature and Light/Dark Cycle

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Several metabolic processes involved in carbon metabolism, such as the synthesis and accumulation of sugars and organic acids, may be affected by environmental factors including temperature and light. The aim of this work was to determine the effect of temperature and light/dark cycles, on sugars and organic acid accumulation in lettuce (*Lactuca sativa* L. cv. Little Gem Ferro). Plants were grown in a growth chamber with controlled-environment conditions under different temperatures day/night (23/15, 20/12 and 15/8 °C) and different light/dark cycles (16/8, 12/12 and 8/16 h). Soluble sugars were analysed by liquid chromatography (LC) equipped with a refraction index detector (IR). Organic acids were analysed by LC tandem-mass spectrometry (MS-MS) in negative ion mode of ESI. Sucrose, glucose and fructose were the main sugars found in lettuce. Citric, malic, tartaric and succinic acids were detected among other organic acids. An increase of the light period led to an augment in the concentration of soluble sugars, attributable to the fact that light increases photosynthetic capacity of lettuce leaves and therefore the accumulation of soluble sugars. On the other hand, the increase in day/night temperature slightly increased the concentration of glucose and fructose, while there was a slight decrease in the concentration of sucrose. As far as organic acids are concerned, their concentration decreased when the light period was extended and increased when the temperature day/night was higher than 15/8 °C.

S07.234

Phosphorus Sources Influence Celosia Nutritional Qualities in the Tropics of Africa

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Celosia is process into many food items, supplements and additives. Thus important for diversification and improving the food basket, thereby contributing to food security and industrial usage in sub Saharan Africa where poverty is endemic. Celosia is also drought tolerant and highly adaptable as a potential crop in the tropics. This experiment was therefore carried out to elucidate the influence of phosphorus (P) sources on amaranth productivity in the African tropics. The experiment was RCBD design with four replications. The P sources treatment: control with no phosphorus (P), single super phosphate (SSP), ogun rock phosphate (ORP) and sokoto rock phosphate (SRP) were randomly allocated. Results revealed that SSP had significant higher 1000 grain weight, protein and starch contents in the seedbut compared to the control with no P; ORP and SRP. ORP and SRP had similar no significant 1000 grain weight, protein and strach contents in seed. Percent fat and sugars contents in grain follow the order: ssp>orp>srp sources. Percent fibre, vitamins D and E decreased among P sources in the order control>ssp>orp>srp. SSP was therefore recommended for optimal quality value in Celosia productivity.

S07.235

Potential Nutraceuticals of Mediterranean Diet: Antiageing, Antitumoral and DNA Protecting Activities

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The distinctive elements of the Mediterranean Diet (MD) ie: monounsaturated fats, omega-3 polyunsaturated fatty acids, antioxidants (vitamins and phenols), as well fibre, show a DNA protective effect because they either help to eliminate the reactive oxygen species or prevent their elimination. The present study develops different genetics, cytological and lifespan approaches to assess the idea that some components of them. Tomato, red-grape, rocket and oils as well as some of their distinctive components were included in the pilot project. Antigenotoxicity assays were performed using the SMART Test in imaginal discs of *Drosophila melanogaster*. This mutagenicity/antimutagenicity short-term test detects genetic damage or its inhibition between the two markers *mwh* and *flr* by mean of loss of heterozygosity. Longevity assays were carried out by treating at least 3 groups of 10 individuals of *Drosophila* for each substance and concentration during their complete life span. Median and survival curves are analyzed and compared. Cytotoxicity assays were established using the HL60 promyelocytic cell line and obtaining the viability curves. This study is implemented by assessing on the degree of DNA fragmentation occurred in the chemotreated cells which is an index of the induced apoptosis. Results.- (i) all the substances are safe with respect to keep the genetic integrity in *Drosophila* cells, not showing mutagenic activity; (ii) a different degree of antigenotoxicity is observed for the substances being the grape skin and resveratrol the most effective agents to detoxify the reactive oxygen species derived from the mutagen hydrogen peroxide; (iii) Low-moderate concentrations of single molecules such as lycopene can increase the life span in *Drosophila* transheterozygous *mwh/flr* flies and (iv) most of the food and single compounds that show antigenotoxic activities are also cytotoxic inducing DNA fragmentation in the apoptotic way (i.e. resveratrol).

S07.236

Effect of Fe and Zn Treatments on Phenolic Compounds in Spinach Leaves

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Both minerals and phenolics play a crucial role in maintaining and promoting human health. Although many studies to enhance the concentration of minerals or phenolic compounds in plant-based foods have been conducted, there are few studies elucidating the relationship between minerals and phenolics in plants. Thus, the objective of this study was to monitor the variation of phenolic concentration in spinach (*Spinacia oleracea* cv. Melody) when grown hydroponically with high Fe or Zn concentration. One week-old spinach seedlings grown with water were cultivated with normal nutrient solution for another week and then transferred and cultivated with nutrient solution containing 5 to 200 μM Fe(III)-EDDHA or 2 to 50 μM ZnSO₄ for 2 additional weeks. Elevated Fe application inhibited Fe acquisition in spinach roots and subsequently did not have a significant impact on the accumulation of Fe in spinach leaves. In addition, no significant differences in growth characteristics were observed between control and high Fe treated plants. However, the concentration of total phenolics and individual phenolic compounds decreased along with elevated Fe treatments. Dissimilar with Fe, spinach plants subjected to high-Zn nutrient solution significantly accumulated Zn in the leaves compared to controls. The Zn concentration (1784 $\mu\text{g/g}$ DW) of spinach leaves, following a 50 μM ZnSO₄ treatment was over 6 times higher than that in control. With treat-

ments up to 8 μM Zn, Zn concentration of spinach leaves increased without a reduction in growth or phenolic compounds. However, significant growth reduction and chlorosis were observed with Zn treatments ≥ 20 μM . In conclusion, these results suggest that Fe concentration of spinach leaves was highly regulated by roots, and certain Zn treatments induced Zn accumulation without growth reduction and did not affect phenolic concentration in spinach leaves.

S07.237

Effect of Iron-Chelate Treatments during Imbibition on the Concentration of Minerals and Phenolic Compounds in Three Edible Sprouts

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Fe is an essential micronutrient involved in fundamental biological processes in humans as well as in plants. In particular, Fe is known as a very important mineral due to its frequent deficiency in humans. The objectives of this study were to increase Fe concentration in three species of sprouts (alfalfa, broccoli and radish) by soaking the seeds with high Fe solution and subsequently to monitor the concentration of other minerals and phenolic compounds which are rich in sprouts and also beneficial for human health. Seeds were soaked in either Fe(III)-EDTA or Fe(III)-citrate in concentrations of 2.5 mM, 5.0 mM, or 10 mM for 5-8 hours and then were maintained with distilled water in a commercial sprouter for 5 days. Soaking treatment significantly increased Fe concentration in 5-day-old alfalfa sprouts. Alfalfa sprouts soaked with 10 mM Fe(III)-EDTA or Fe(III)-citrate had 1.8 or 1.7 times higher iron concentration compared to control, respectively. For broccoli and radish sprouts, there was a trend towards higher Fe concentration, but no significant difference was observed between control and Fe treatments. The accumulated Fe in alfalfa sprouts by soaking seed with high iron solutions was negatively associated with other minerals such as Ca, Mg, Mn, Na or Zn. Alfalfa sprouts soaked with either Fe solution showed 8.0-36.4% significant increase in total phenolic concentration compared to control sprouts. Broccoli and radish sprouts did not accumulate additional phenolic compounds in response to the iron treatment. In conclusion, soaking seeds with Fe-chelates enhanced the Fe concentration of sprouts, especially alfalfa sprouts, and also had a positive or no adverse impact on the concentration of phenolic compounds suggesting that this can be a potential strategy to improve the mineral nutritional quality of certain species used for sprouts.

S07.238

Effect of Potassium Fertilization on Agronomic, Functional and Antinutritional Characteristics in Vegetable Soybeans

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The production and quality of soybeans depend on proper fertilization and utilization of nutrients and adequate doses, among other factors, favoring the accumulation of elements essential for the production of dry matter and of functional nutrients. Therefore, the aim of the present study was to evaluate the response of vegetable soybeans with respect to agronomic, functional and antinutritional characteristics, under different doses of potassium. The experiment was conducted in the field, at UNESP-FCAV in Jaboticabal-SP. A randomized block design was adopted with five treatments (doses of potassium), and five repetitions. Each experimental plot consisted of four planting rows 6 m long, with 0.60 m between rows and 0.15 m between plants, where 20 plants per plot were evaluated. The genotype used for study was JLM019. The doses of potassium were calculated in accordance

with soil analysis, which were: 0, 50, 100, 150 and 200% of that recommended. Seeding was carried out on January 13, 2009, directly in the field. Harvesting was on April 28, 2009, when the vines were in reproductive stage R6. The following parameters were determined: plant height, height of insertion of first vine, mean number of vines per plant, fresh weight of vines per plant; length of vines, mean number of seeds per vine, fresh weight of 100 seeds, total estimated productivity of immature grains ($\text{kg}\times\text{ha}^{-1}$), and levels of moisture content, proteins, lipids, ash, carbohydrates, isoflavones and Kunitz soybean trypsin inhibitors (KSTI). For all the characteristics evaluated, there was no significant difference, except for the number of seeds per vine and carbohydrates. The results showed that an increase of 50% to 100% of the recommended dose is viable, since the increase in cost of production is small in view of a 25% increased in production.

S07.239

Yield, Nitrate and Steviol Content of Stevia (*Stevia Rebaudiana* Bertoni) Leaves as Affected by Fertilization Rate

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Stevia (Stevia rebaudiana Bertoni) is cultivated for the sweet taste leaves, which are, after drying and grinding used as a substitute for artificial sweeteners. The aim of a study was to determine the effect of fertilizer dose on the fresh leaves yield, nitrate and steviol content. Plants were grown in a 5 L pots on the two types of acid soil (pH 4.0 and 5.0), which were different supplied with major nutrients. Five doses (0 to 1.6 g per plant) of mineral fertilizer Multi-Comp Base 14:13:20+2MgO+ME were applied. The highest fresh leaves yields (30.28 and 30.98 $\text{g}/\text{plant}^{-1}$) were achieved by application of 1.6 and 0.8 g of fertilizer on soil with pH 4.0 and 5.0, respectively. These yields were 21.6, and 39.8 % higher than the yield achieved at unfertilized control. Increased fertilization intensity resulted with increased amount of total nitrogen in stevia leaves. Depending on the soil type, amounts between 14.32 and 20.61 $\text{g}\times\text{kg}^{-1}$ of dry matter (DM) were determined. At the soil with pH 4.0, fertilization rate increasing, caused decreasing of N-NO_3^- amount in leaves from 18.16 to 10.05 $\text{mg}\times\text{kg}^{-1}$ DM. At pH 5.0, only the fertilization with 1.6 $\text{g}/\text{plant}^{-1}$ resulted in a higher nitrate amount in leaves than the unfertilized control (14.14 compared to 13.69 $\text{mg}\times\text{kg}^{-1}$ DM). The amount of N-NH_4^+ in the leaves showed the opposite trend. Increased fertilization rates resulted with higher ammonia amounts in leaves, from 214.55 to 387.83 $\text{mg}\times\text{kg}^{-1}$ DM. Average steviol content was between 42.56 to 46.18 $\text{mg SE}\times\text{g}^{-1}$ of dry leaves. Stevia cultivation on the soil with higher pH value and medium fertilization rate resulted with economically effective yield of leaves which contained significant steviol amount.

S07.240

Antioxidant Activity of Major Herb Essential Oil

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The study measured EDA% of quality followed by antioxidant activity of essential oil of lavender, rosemary, eucalyptus and peppermint collected in Korea through DPPH method and examined their quality. As the results, lavender (2.6-94%), rosemary (4.8-96%), eucalyptus (3.5-76.4%) and peppermint (5.7-97.8%) had remarkable differences by each specimen. In the event of lavender, essential oil with a lot of content of linalool and linalyl acetate had high antioxidant activity of 53-94%, essential oil from Australia had antioxidant activity of more than 50%. In the event of rosemary, essential oil collected in domestic offline and essential oil from Switzerland had high antioxidant activity. In the event of eucalyptus, essential oil collected in Europe offline and essential oil from Australia had high antioxidant activity. In the event of peppermint, essential oil collected in domestic offline and essential oil from England had high antioxidant activity.

S07.241

Master Document: Criteria and Benchmarks for the Evaluation of Food Included in the Spanish Recommendations of Fruit and Vegetable Consumption "5 a Day"

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The new foods based on fruit and vegetables (FAV) and the reality of current consumers, are a confounding factor for people, when following the recommendations of eating FAV marked by WHO on 5 servings a day (600g/day) and promoted in Spain by the Association for Promoting the Consumption of Fruits and Vegetables "5 a day". The Master Document, prepared by the Scientific Committee, is made to facilitate the association and the food industry, the promotion of consumption of FAV in line with a healthy diet. Set qualitative and quantitative parameters to include food on the recommendations "5 a day." - Establish dietetics and nutritional criteria to evaluate recipes and menus. - Facilitate relationship between the Association and the food industry. The Scientific Committee of "5 a day" after reviewing the scientific literature and numerous nutritional profiles, and based on legal, technological, nutritional, dietetics and health promotion criteria, has agreed the basic parameters to categorize foods included in the recommendations of consumption of FAV in Spain. The consumer can thus recognize foods with the logo "5 a day" as a portion of FAV. Also frequency and presence criteria of foods groups have been established for recipes. Have been distinguished 3 categories of foods: category I includes fresh unprocessed FAV, the II groups processed FAV with 100%, included juices, no added sugars and controlled-sodium (<120mg/100g), and finally, category III includes foods that contain a portion of FAV with <200mg sodium/100g, <400kcal per serving, <30% of its energy from fat and <10% from saturated fatty acids, among other parameters. Since its adoption in Valencia (April 2007) have been evaluated 12 creams of vegetables, 3 sauces, 2 jams, 7 juices, 1 milkshake, 2 concentrates and 4 smoothies.

S07.242

Acceptance among Children of White Asparagus Modified by Increased Bitterness and Sweetness

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Trained descriptive sensory panellists assessed the flavour, mouthfeel and after-taste profile of white asparagus ("Gijnlim") pieces marinated for two hours with solutions of sugars (fructose, glucose and sucrose) and Epsom salt. Resulting sugar concentrations in the asparagus pieces ranged from 2.5 to 4.8 $\text{g}/100\text{g FM}$, the concentration of Epsom salt ranged from 0 to 93 $\text{mg}/100\text{g FM}$. As expected, increased amount of bitter substances increased bitter sensations of asparagus. Additional sweetness led to a lowering of perceived bitter intensity, but only at low bitter levels. In very bitter samples even increased bitterness was perceived with addition of sugars. Sweetness was clearly dependent on sugar concentrations; increased concentration of bitter compounds lowered the sweetness intensity. Each of 100 children invited to the sensory acceptance test received 9 asparagus samples with 3 levels of sugars and 3 levels of bitter compounds. Samples without additional bitter

components were liked well, added sugars (1.2 g) further increased liking, another 1.1 g resulted in intermediate liking results. At the second level of the bitter compound concentration no lower acceptance was found when no sugar was added. With added sugars acceptance was lower with increased sugar amount. The reason probably was an impairing of the flavour sensations. This assumption is supported by the fact, that simultaneously higher values for too sweet and too bitter tastes were assessed partly at both: higher bitter and sweet levels. In addition to the acceptance of the asparagus pieces mixtures of bitter and sweet solution were ranked by the children for their liking. Comparison of solution and sample liking can give insights on individual preferences and their consequences for asparagus, vegetable and fruit appreciation, which was assessed using a questionnaire.

S07.243

Treatments with Natural Compounds to Maintain Quality and Bioactive Compounds during Postharvest Storage of Sweet Cherry

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Sweet cherry (*Prunus avium* L. cv. 'Cristalina') was harvested at commercial ripening stage and then treated with oxalic acid, salicylic acid or acetyl salicylic acid at concentration 1 mM by dipping in solutions for 5 minute and allowed to dry at room temperature. Then, fruits were stored at 2 °C during 5, 10, 15 and 20 days. All treatments significantly delayed the ripening process during storage, manifested by higher firmness and acidity retention, lower accumulation of soluble solids and colour changes. Control cherries were considered as unacceptable after 15 days of storage, while treated fruits maintained acceptable organoleptic quality after 20 days, especially for salicylic acid treatment. The bioactive compounds, such polyphenols, anthocyanins, as well as the antioxidant activity increased along storage in treated fruits, while significant reductions were obtained for control cherries from day 10 of storage. In conclusion, these innovative treatments based on natural compounds, could be a promising postharvest technology to preserve the sweet cherry organoleptic and functional compounds with antioxidant activity.

S07.244

Biological Activities in the Extract of *Lythrum salicaria* L.

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In this study, we investigated the biological activity of anti-cancer, anti-inflammatory, anti-oxidative, anti-microbial, anti-diabetic of *Lythrum salicaria* L., which, using water and ethanol were extracted. The growths of both human prostate cancer (DU145) and in human colonic carcinoma cell (HT29) were inhibited up 60% by adding 10 mg/ml of ethanol extracts (EELS) from *Lythrum salicaria* L., Anti-inflammatory activity of water extracts (WELS) and ethanol extracts (EELS) from *Lythrum salicaria* L., have been evaluated on lipopolysaccharide (LPS) induced release of nitric oxide (NO) by the macrophage RAW 264.7 cells. WELS and EELS inhibited inflammatory by 57.3% and 46.9% in 10 mg/ml, respectively. In the anti-oxidative activity, SOD-like activity was 75.7% by adding 10 mg/ml of EELS and DPPH radical scavenging activity was respectively 72.9% and 68.6% by adding 10 mg/ml of WELS and EELS. On the paper disc assay, on detectable antimicrobial activity in WELS and EELS was shown. In the anti-diabetic activity, α -amylase inhibitory activity was respectively 62.4%, 32.6% and α -glucosidase inhibitory activity was 5.4%, 88.3% by adding 10 mg/ml of WELS and EELS. In the anti-obesity, lipase inhibitory activity was 4.1%, 11.4% by adding 10 mg/ml of WELS and EELS. It suggests that *Lythrum salicaria* L. could be potentially used as a resource of bioactive materials for health functional foods.

S07.245

Ascorbic Acid Accumulation, Biosynthesis and Recycling during Tomato Fruit Ripening

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L-Ascorbic acid (AsA, vitamin C), is known for its vital role in plant antioxidant stress defence metabolism and for its important nutritional and health benefits for the consumer. In the last decade, studies on plant AsA biosynthesis and metabolism in several plant species have indicated that biosynthesis proceeds primarily via a pathway involving L-galactose. Alternative biosynthetic routes utilising myo-inositol, D-galacturonate, and/or GDP-L-gulose have also been suggested, but their potential contribution in planta still has to be clarified. Additionally though our understanding of the genetic factors underlying the regulation or accumulation of AsA in plant species and different tissues – particularly fruit – and during development is still far from complete. In principle these differences could be due to variations in the relative AsA biosynthetic capacities, the rate of degradation and/or the capacity for AsA regeneration. The aim of the present work was to determine the relative contribution of these different processes in fruit of two tomato cultivars differing substantially in their AsA contents (cv. Santorini and Ailsa Craig). Feeding experiments with nonlabelled and radiolabelled precursors of AsA biosynthesis were carried out at different ripening stages. This data was compared with changes in fruit AsA contents, and the activities of key related enzyme activities. Results demonstrate that fruit AsA contents vary significantly between these cultivars throughout ripening and that the observed differences between the genotypes can at least partly be explained by the differences in the relative biosynthetic and recycling capacities of the tissues. Interestingly though, the variety with the higher AsA and glutathione (GSH) contents exhibits a greater capacity for AsA recycling, but a lower rate of AsA biosynthesis. This data supports the importance of AsA-GSH recycling pathway in maintenance of AsA pools, and the possible existence of feedback control of AsA biosynthesis during ripening.

S07.246

Biological Activities of the Extracts of Beaked Hazelnut (*Corylus cornuta*) Twigs

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Beaked hazelnut (*Corylus cornuta*) is an indigenous species of Quebec. The Native American tradition claims the calming effects of wearing the necklaces made with hazel twigs. The effects of hazelnut twigs extracts (teas) have been demonstrated on several pathologies. The participation of reactive oxygen and nitrogen species (ROS/RNS) in the etiology and pathophysiology of many diseases is well documented. ROS/RNS play an important physiological role. However, beside their beneficial biological functions, the high reactivity of the reactive species adds important toxic properties to these reactive oxygen species. The overproduction of ROS/RNS which is called "oxidative stress" is responsible for oxidative damages to various biomolecules including proteins, lipids, lipoproteins and DNA. Moreover, ROS/RNS play an important role in the initiation, progression and amplification of inflammatory response. Many studies have shown that phenolic compounds display strong antioxidant activity as a result of their capacity to scavenge free radicals, to chelate metal ions and to improve the antioxidant endogenous system. The aim of our study was to evaluate various biological activities of *Corylus cornuta* twigs extracts rich in polyphenols. Extractions were carried out with "green" solvents, water and ethanol, and following properties of the extracts were determined: a) antiradical and antioxidant capacities *in vitro* against several reactive species involved in oxidative stress; b) capacity to inhibit enzymes involved in different pathologies: the elastase which participates in skin aging by causing a loss of skin elasticity (responsible for wrinkle formation), the α -amylase and α -glucosidase which are involved in diabete II (polysaccharide hydrolysis). Phenolic composition of the most active extracts was determined by

chromatographic methods. The development of health products containing *Corylus cornuta* twig extracts could represent therefore an interesting way to valorize the by-products of hazelnuts harvest.

S07.247

Effects of 5-Aminolevulinic Acid on Chlorophyll, Photosynthesis, Sugar and Flavonoids of *Ginkgo biloba*

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The effect of 5-aminolevulinic acid (ALA), a key precursor in the biosynthesis of porphyrins, at low levels (10 and 100 mg·l⁻¹) on photosynthetic rate, chlorophyll and soluble sugar contents, flavonoid accumulation and flavonoid enzyme activity in *Ginkgo biloba* leaves were investigated. The results showed that photosynthetic rates of leaves that treated with both concentrations of ALA, increased significantly at day 4 compared with that of the control, and remained so for 12 days. ALA at concentrations of 10 and 100 mg·l⁻¹ significantly increased the contents of chlorophyll and soluble sugar (P<0.05) at day 4 and these increments keeping increase tendency until day 16, while the ratio of Chl a/b remained constant after ALA treatment. ALA-treatment enhanced the contents of total polyphenols, flavonoids and anthocyanins, as well as phenylalanine ammonia-lyase, chalcone synthase and chalcone isomerase activities from day 4 to 16. These results suggest that foliar treatment with a low concentration of ALA might provide a useful means of improving pharmacological properties in *G. biloba* leaves.

S07.248

Antioxidant Dietary Fibre (ADF) in Lipid-Rich Fruits: Adapted Methodology for Quantification and Characterization

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It is well known that there are a large variety of fruit species growing in tropical areas which offers an almost unfishable source of phytochemical and bioactive compounds. Some of these, as Palm (*Arecaceae*) fruits, are lipid-riches. The development of methodologies to evaluate and quantify the bioactive compounds content of tropical fruits has a high relevance for health research, but also as a base for sustainable business opportunity in developing countries. Therefore, in this work we propose an alternative methodology to analyze the dietary fibre (DF) content of tropical lipid-rich fruits, using Açai Palm (*Euterpe oleracea*) as model. It should be pointed that standardized DF methodology was designed based on cereal DF analysis (since cereals are the main source of DF in many western diets). Nevertheless, the use of this standardized methodology to analyze fruit DF, and more particularly in lipid-rich, like palm fruits, may provide under or sub estimated results. In this work a methodology was designed to prevent the degradation of antioxidant compounds (as polyphenols) associated to DF due to the use of non physiological temperatures. Moreover, as lipids may interfere with enzymatic activity, several strategies to avoid exceeds of fat during the analysis should were considered. In conclusion, the methodology proposed, offers two alternatives to avoid lipid interference: i) include an enzymatic step with pancreatic lipase or ii) a sample preparation step that remove the fat content. The methodology proposed uses physiological temperature during the whole process to ensure the activity of bioactive compounds associated to antioxidant dietary fibre (ADF).

S07.249

Physiological Activity of Rakkyo (*Allium chinense* G. Don) against a Zinc-Induced Neuronal Cell Death

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This study was carried out to clarify the physiological functions in Rakkyo (*Allium chinense* G. Don) (*R. A. chinense*). Rakkyo (*A. chinense*) that one of plants *Allium* species are contained many physiologically active components such as organosulfur compounds and saponin. Anticoagulation, cardiotoxic activities and anticancer have been reported as physiological function of *R. A. chinense*. There are various kinds of *R. A. chinense* processed goods like pickled, and aged to improve the functionality, now. In our research, it is clarified that bulbs, leaves and roots of *R. A. chinense* and *R. A. chinense* processed goods have high functionality such as antioxidative activity and anti-hypertension. The anti-aging function in *R. A. chinense* processed goods was considered. Especially, we paid attention to the dementia. Zinc is an extremely most abundant trace element in the brain, and plays a significant role in the central nervous system. This time, we have investigated about the effect of *R. A. chinense* which controls zinc induced type nerve cell damage by used rat adrenal pheochromocytoma cells (PC12) which are the model neurons for neurochemical study. Our results suggest that Zinc-induced apoptosis of PC12 cells are protected by Rakkyo (*Allium chinense* G. Don).

S07.250

The Effect of Selenium on Yield Quality of Leaf Vegetables

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In human and animal cells Se plays an essential role in antioxidative defense system, but it is toxic at high dietary intake. In many countries as well in Latvia soils are low in bioavailable Se. Selenium enters the food chain through the plants which take it up from soil. Se concentration in plants depends on the chemical form of Se, its concentration and bioavailability in soil. The aim of the study was to detect the effect of sodium selenite and selenate on physiological properties of lettuce, garden cress and spinach. Two varieties of lettuce plants (*Lactuca sativa*): iceberg lettuce 'Tarzan' and lettuce 'Riga', garden cress (*Lepidium sativum*) and spinach (*Spinacia oleracea*) were grown in 1L pots with peat substratum. All vegetables during growth season were once treated with 50 mg·m⁻², 100 mg·m⁻² or 200 mg·m⁻² of sodium selenite or selenate. Control- without treatment. Fresh and dry weight of plants, pigment content, ascorbic acid content and antiradical activity were tested three times during vegetation period. Plants treated with selenium had higher leaves pigment content in comparison with untreated ones. The correlation between selenium concentration and antiradical activity was observed. Ascorbic acid content depended on vegetable and sampling time. No effect of selenium was observed on plant weight.

S07.251

Modelling the Processing of Brassica Vegetables to Predict the Level and Bioavailability of Phytonutrients

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The bioavailability of many nutrients is known and the healthy daily intake estimated. In contrast the bioavailability of most phytonutrients and some vitamins is poorly understood and more research is carried out on this field at the moment. Bioavailability includes different processes in the human body: liberation,

absorption, distribution, metabolism and excretion. Only the liberation and absorption can be influenced by the food structure and composition, which in turn can be controlled by food processing. Because the processes of bioavailability are so complex and the influence of the food matrix and composition is not totally understood, many studies are carried out on the effect of a single component in specified controlled conditions. Often it is complicated to compare such studies due to their different experimental set-ups. Instead mathematical modelling based on experimental results could be used to simulate the actual content of components after different ways of food processing. Such a model could include the different processing factors and plant tissue characteristics which influence the liberation and absorption of the phytochemical and therewith the bioavailability. This will be a very useful tool for the food research and industry to make predictions about the nutritional quality. In the EU project DREAM realistic physical and mathematical models for different types of foods are developed: plant-based foods, meat, dairy and bakery products. For the plant based foods a model will be developed to predict the glucosinolate content and availability in *Brassica* vegetables such as broccoli, cauliflower, Brussels sprouts or cabbage after different processing methods. With the results further *in vitro* and *in vivo* studies could make more precise assumption about the influence and amount of glucosinolates, which breakdown-products are assumed to have anticarcinogenic properties, in food on humans.

S07.252

Nutritional and Organoleptic Characterization of Nectarine and Peach of Organic and Integrated Production Systems in Lleida (Spain)

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Nectarines (*Prunus persica* (L.) Batsch var. Nucipersica) of the 'Big Top' cultivar and peaches (*P. persica*) of the 'Rich Lady' cultivar, of organic (OP) and integrated production (IP) obtained in Lleida (Spain) under similar conditions of soil and climate, were evaluated at harvest and after 7, 14 and 21 days of conventional cold storage at 0.5 °C plus 3 days at 20 °C, respectively for each output. The parameters evaluated were ethylene production, weight, diameter, colour, firmness, titrable acidity (TA), and contents of soluble solids (SS) and ascorbic acid (AA). The content of macro and micronutrients was also determined at harvest. The ethylene production was lower in OP fruits. IP nectarines showed higher values in weight and diameter than OP ones; conversely, firmness, SS and TA were higher in OP fruits. There were no significant differences in mineral content, except for Cu, Fe, Mg, and N where OP was greater than IP. In both production systems there was a sudden drop of firmness from the first cold storage period while TA decreased progressively and SS content was remained practically constant. There were no differences in the AA between IP and OP fruits, except after 14 days of storage where the content was lower in the OP system. In peaches no differences in weight, diameter and SS content evaluated at harvest were found between OP and IP fruits, but firmness and TA were higher in IP; this last result was coincident with the maturity stage indicated by the highest Hue value in the pulp. IP fruits also showed a higher content of B, Cu, N, P, and S. Although there were no significant differences between production systems in the AA content, IP fruits presented a gradual reduction with increasing days of storage whereas OP fruits maintained the content during the 21 days of storage.

S07.253

Impact of Different Cooking Methods on Total and Individual Glucosinolates in Pakchoi (*Brassica campestris* L. ssp. *chinensis* var. *communis*)

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Glucosinolates are an important group of health promotion phytochemicals in

Brassica vegetables. Five cooking methods (blanching, boiling, steaming, stir-frying and microwave) combined with varied treatment time were used to investigate the influence of cooking on glucosinolates (GSs) in pakchoi (*Brassica campestris* L. ssp. *chinensis* var. *communis*). The results showed that the loss of GSs was the lowest by blanching in cooked pakchoi, and then followed by steaming, microwave and stir-frying. The concentrations of glucoalyssin, gluconapin, glucobrassicinapin and gluconasturtiin were not significantly affected by blanching. Boiling caused the biggest loss of GSs, and significant losses for individual GSs except for 4-methoxyglucobrassicin were observed after boiling. After the treatment of 5 min boiling, the concentrations of glucoalyssin, gluconapin, glucobrassicinapin and glucobrassicin were decreased by over 50%. It indicated that different cooking methods had different influences on individual GSs. The most stable components after steaming and stir-frying were glucoalyssin and gluconapin, which belonged to aliphatic GS. Compared to aliphatic and aromatic GS, more indolyl GS was reduced by stir-frying. In contrast, microwave caused the least loss of indolyl GS, especially at short time treatment (within 1 min). The ratio of aliphatic to total GS was mostly kept stable during the cooking process (ranging from 83% to 85%), however, it was considerably reduced by boiling. The ratio of aromatic to total GS was kept by about 10%, and increased to 15% when boiling in water for 10 min. The results indicate that the methods and time of cooking affect the concentrations and profiles of GSs in pakchoi.

S07.254

Science into the Kitchen: Consumer Behavior and Healthy Vegetables

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The content of bioactive health promoting compounds are predominantly characterised in raw vegetables, e.g., glucosinolates in broccoli, and β -carotene in carrots. The intake amounts of these compounds have been associated to human health benefits. However, present literature indicates that the available amounts of these health promoting compounds are affected by various steps in the supply chain e.g., food processing and preparation. Consumer behaviour and food handling practices, the last step in the food processing chain, are considered to greatly influence the concentration of these health promoting compounds in Broccoli and Carrot. However, the effects of consumer behaviour on bioactive compounds in vegetables are hardly addressed in present available literature. Retaining the levels of health promoting compounds in prepared vegetables ultimately increases the nutritional and health value of the vegetables. In order to assess the influence of processing practices of these vegetables on the level of bioactive compounds and to come up with optimal cooking methods, it is important to know the common cooking practices and motivations among households. In-home observations and in-depth interviews could assist in this regard. Assessing and modelling the effects of these cooking practices, given sensory preferences, on the level of the health promoting compounds is essential, to advice and keep the consumers informed on healthy cooking practices of vegetables. Product and process design for vegetable products can be improved and novel kitchen equipment can be designed based on the results of the present research.

S07.255

Glucosinolates in *Brassica* Vegetables - the Influence of the Food Supply Chain on Intake, Bioavailability and Human Health

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For the human diet, representatives of the *Brassicaceae* are of particular importance as vegetables (e.g. cabbage, Brussels sprouts, broccoli, cauliflower), root vegetables (e.g. radish, turnip, swede), leaf vegetables (e.g. rocket salad), seasonings and relishes (e.g. mustard, wasabi) and sources of oil. Glucosinolates, a group of secondary metabolites, are claimed to be the components responsible for many of the

physiological effects proposed for *Brassica* vegetables in different types of studies, including *in vitro*, animal, human and epidemiological studies. Glucosinolates co-exist with, but are physically separated from, a plant thioglucosidase, myrosinase, within a 'glucosinolate-myrosinase system'. The myrosinase-mediated hydrolysis of glucosinolates generates a wide range of bioactive metabolites, including isothiocyanates, thiocyanates, indoles, nitriles and cyanoepithioalkanes. Brassica vegetables are exposed to various processes along the food supply chain which may modify the glucosinolate-myrosinase system as a result of e.g. inactivation of plant myrosinase, loss of enzymic cofactors, thermal breakdown and/or leaching of glucosinolates and their metabolites or volatilization of metabolites. In this overview we will elaborate various actors and relevant steps in the food supply chain of *Brassica* vegetables and their influence on intake and bioavailability of glucosinolates and bioactive breakdown products in relation to human health. By analyzing various steps of the supply chain of Brassica vegetables we identified four critical points that have the biggest impact on the level of glucosinolates in the final products: - Cultivar selection - Storage and packaging - Industrial processing - Consumer preparation A general strategy for production and supply chain management for optimizing glucosinolate intake and improving human health will be proposed.

S07.256

Glucosinolate Concentration Is Affected by Differential N Competition and S Utilisation in Sole and Intercrops of Broccoli and Lettuce

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Numerous studies proposed that the protective effect of cruciferous vegetables against cancer may be due to their relatively high content of sulfur-containing glucosinolates. Nitrogen (N) and sulfur (S) application significantly affect glucosinolate concentration in plants. Total S requirement differs between crop species; in general S demand of *Cruciferae* is high. S supply has an impact on the total glucosinolate concentration but also on the relative proportions on the individual glucosinolates. Investigations showed that in broccoli plants, total glucosinolate concentrations were high at insufficient N supply, independent of the S level. This study aimed to improve the nutritional value of broccoli (*Brassica oleracea* var. *italica*) by intercropping. A competitive broccoli-lettuce intercropping system were designed in order to assess how the single intercrop component species utilize and compete for N and S resources and how these dynamics are altered in response to changes in nutrient availability. Lettuce expected to reduce the available N for broccoli without influence S availability. The first experiment consisted of 6 treatments, combinations of two levels of N (90 and 220 kg×ha⁻¹) fertilization and three cultivation systems (broccoli-lettuce intercropping, sole broccoli and sole lettuce). In the second experiment also two levels of S (0 and 65 kg×ha⁻¹) were included and the total number of treatments was 12. In the soil depths 0-25 and 25-50cm the distribution of N and S was differed significant among the treatments. Lettuce yields were reduced significant (p<0.0001) when grown in intercropping with broccoli, whereas broccoli was less affected by cropping system. In addition, treatments influenced both S and N uptake, and glucosinolate concentration.

S07.257

Increasing the Intake of Fruit and Vegetable to 400 g per day by Modelling Is Not Sufficient to Reach an Optimal Nutritional Pattern

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Fruit and vegetables (FV) are an important food group of a healthy diet, and the consumption of a minimum of 400 g of FV per day is recommended. Our aim was

to quantify the nutritional benefit of increasing FV intake up to 400 g per day. Dietary data (7-day records) of adults from the French INCA2 survey who consumed less than 400 g/d of FV (N=929 among 1918 participants) were used. Starting from each observed diet, a modelled diet that contained 400 g/d of FV (including nuts and processed FV) was designed. Deviation from each individual food intake pattern was minimized and the energy content was set equal to the observed intake. To compensate for the increase in energy from FV, a reduction of high-fat high-sugar foods (namely animal fat, salted "aperitif" foods and/or sweets) was allowed. To raise the FV content of each diet up to 400 g/d while keeping total energy constant, a mean decrease of 67 kcal from high-fat high-sugar foods was needed. Energy density (solid foods) decreased from 185 to 163 kcal/100g and the mean adequacy ratio for 20 nutrients increased from 77.1 to 80.8%. Intakes were improved for most nutrients but this was not sufficient to fulfil the estimated average requirements (EAR). For instance, the percentage of modelled diets fulfilling the EAR for vitamin C (>85 mg/d) only increased from 23% to 52%, and for vitamin B9 (>254 mg/d for men and >231 mg/d for women) increased from 44% to 66%. In a recent study, a higher level (approx. 550 g/d) was needed to respect a full set of nutrient recommendations in individually-optimized diets (Maillot *et al.* Am J Clin Nutr, 2010). Increasing the intake of FV up to 400g/d is likely to improve the overall pattern of nutrient intakes but is not sufficient to fully optimize nutritional quality.

S07.258

The Examination of Saffron Extract on Free Radical Oxidation of Lipids and Activity Transport Adenosinediphosphatase in Retina

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Saffron extract contains multiple complex components of biologically active substances. But however, pharmacology and biochemistry properties of saffron extract had not been studied. Lipid oxidation of cell membranes is playing a pivotal role in pathogenesis of many inflammatory diseases in the organism. Stimulation of lipid peroxidation (LP) processes in the cells leads to change one of the most important physiological functions as the membrane conductivity. For to be provide base for application of saffron extract in treatment of retinal degeneration was studied influence on the metabolism of LP products and the activity of transport ATP in the photoreceptor cells. In control animals on the 10th and 15th days of the experiments are intensified of LP processes. In his case is increase of LP processes which leads to a decrease in the ATP activity. The control experiments are demonstrated that the level of LP products in the animals with retinal degeneration was higher by 9-25% at the average in comparison with intact controls. The results have shown that LP processes are enhanced at retinal degeneration, which is accompanied by suppression of Na⁺, K⁺-ATP activity. In the experimental group of animals had been retrobulbar injection of the 0.5% aqueous solution of saffron extract every day. At the retinal degeneration, the activity of transport ATP decreased from the 1st day of the experiment. This tendency is observed on the 10th and 15th days of the experiment as well. The administration of saffron extract leads to a decrease of LP products in retina, which in turn restores activity of ATP on the 20th day of the experiment and is close to the intact control.

S07.259

Quality Analysis and Determination of Oxalic Acid Content of Star Fruit

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Oxalic acid on human health hazards are increasingly a cause for concern and the most carambola fruits contain a high amount of oxalic acid. In our study, fruits quality and the oxalic acid content of sixteen carambola varieties were analysed respectively by routine analysis and ion-chromatography. At the same time, the changes of the oxalic acid content during the star fruits growth and the oxalic acid

content in different fruit's parts were studied. The results showed that: (i) The soluble solids content of their star fruits showed no significant difference, but the titratable acid content of different varieties of carambola showed significant difference. (ii) The difference of the oxalate content of most of carambolas was extremely significant and the soluble oxalate content in Local-acid-carambola was as 1051 times as it in Singapore Single-skin-5 carambola. (iii) The fruits of Singapore single-skin carambola fruit was good quality and low oxalate. (iv) The soluble oxalate content of young fruits was increasing up very quickly Within 20 days after flowering, from 2000mg/Kg to 4000mg/Kg in a sweet variety of carambola. Then, the oxalic acid content of fruit decreasing until fruit ripening, about two months, from 4000mg/Kg to no more than 300mg/Kg. (v) Different parts have different quantity oxalic acid in a same ripe star fruit. The oxalic acid content in endocarp was 5 times as in pulp (mesocarp), and it in epicarp was nearly 3 times as it in pulp.

S07.260

Antioxidant Effects of Saffron Extract in the Rat Retina under Dystrophy

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In the present work is studied the impact of saffron extract the levels of lipid peroxidation (LPO) products in the damaged rat photoreceptor cell. The experiments were conducted on white albino Wistar rats weighing 180-200 g. The moderate experimental dystrophy of the retina was induced by an injection of 4% monoiodoacetic acid into the caudal vein. 0.5% solution of saffron extract was administered at a dose of 0.1-0.3 ml, using peribulbar injection. The activation of lipid peroxidation processes in cell membranes causes a number of pathological conditions. Retinal dystrophy is accompanied with a considerable and significant activation of LPO reactions, manifested in an increase in the levels of hydroperoxide and malondialdehyde in the photoreceptor cell. Saffron extract decreased the levels of LPO products and thus facilitated the correction of structural and functional changes, acting as a natural antioxidant. It is generally known that certain pathological conditions, such as dystrophic damages, aging, ionizing radiation etc. are accompanied by changes in the condition of SH groups. Our results indicated that dystrophy intensifies LPO processes which, through the oxidative modification of sulfhydryl (SH) groups by free radical oxidation products, lead to a decrease in the levels of all SH groups. An administration of saffron extract facilitated the stabilization of LPO processes and prevented the decrease in the levels of SH groups. Therefore, our results indicated that saffron extract, which has a diverse and unique chemical composition, has antioxidant properties, manifested in the efficient suppression of LPO processes.

S07.261

Functional Characterisation of Old Cultivars of Long Storage Tomatoes

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Lycopersium esculentum Mill, widely used in the "Mediterranean diet" is well known for its health properties. Indeed, the tomato has assumed the status of a functional food, considering the overwhelming epidemiological evidence that it reduces the risk of different diseases. Its disease-preventing potential is the consequence of several constituents with antioxidant activity which may interact synergistically. Lycopene, has been shown to have strong antioxidant properties; its dietary intake is correlated with different beneficial effects. Recently, there has been increasing interest in the recovery of old tomato cultivars grown on non-irrigated marginal land. In this context, the aim of the present work was to characterise nine cultivars of long storage "winter" tomatoes cultivated in the past in Southern Puglia (Italy). The tomatoes selected ('Minervino', 'Tricase', 'Botrugno', 'Brindisi Pirunella', 'Brindisi Rosso', 'Morciano', 'Palmariggi', 'Serranova Giallo' and 'Serranova Rosso') were characterised quantifying the carotenoids, flavonoids and phenolic components by HPLC/DAD. The total antioxidant activity (AA) was determined on the lipophilic and hydrophilic fractions (DPPH assay), and on the hydrophilic fraction

(ABTS test). The results showed that the carotene varied between 9.6 and 36.6 mg/kg fresh weigh (FW), lycopene changed between 8.9 and 106.5 mg/kg FW while lutein varied between 1.7 and 5.1 mg/kg. When compared with commercial cherry tomatoes, the cultivars analysed showed high amounts of lutein (up to three times higher). Total phenols ranged between 68 and 290 mg/kg FW, rutin content between 56 and 109 mg/kg FW. DPPH test showed that hydrophilic fraction AA was significantly higher than the lipophilic fraction AA, corresponding, on average, to about 40%. The ABTS assay on the hydrophilic fraction, found high AA values (about 30-90%). These ancient tomato varieties are rich in numerous compounds with high biological activity; for this reason, they should be protected and valued as a natural source of phytochemicals.

S07.262

Antioxidant Phytochemicals in Savoy Cabbage (*Brassica oleracea* L. var. *sabauda* L.)

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Brassicaceae is a wide botanical family with a great number of edible members. These vegetables are highly regarded for their nutritional value providing high amounts of vitamin C, soluble fiber, minerals and antioxidants, nutrients with potent anti-cancer properties. Some of the most common brassicas include broccoli, Brussels sprouts, cabbage, cauliflower, swedes, and turnips, while broccoli raab, collards, cress, kale, kohlrabi, mustard, and bok choy are less familiar. Cabbages are one of the oldest of the brassica vegetables in Europe and they are classified as either green or red, although colour ranges from nearly white to reddish-purple. Savoy cabbage is an excellent source of antioxidant compounds, therefore the aim of this work was to evaluate the content of these compounds, such as the vitamin C, b-carotene, lutein and total phenol content, in these brassica vegetables. Savoy cabbages were grown at the experimental fields located in Finca la Orden-Valdesquera in Extremadura (Spain) during the first week of February 2009. After their harvest they were rapidly transported to the INTAEX laboratory for their analysis. The contents of the main phytochemical compounds measured in Savoy cabbage were 49.06 mg/100 g fresh weight of vitamin C, 0.367 mg/100 g fresh weigh of b-carotene and 0.182 mg/100g fresh weight of lutein. Finally, the total phenolic compounds measured as equivalent of chlorogenic acid was 102.71mg/100 g fresh weigh.

S07.263

Characterization of Some Qualitative Traits in Different Perilla Cultivars

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Perilla frutescens (L.) Britt. (Fam. *Lamiaceae*) is widely used in Asian countries both as culinary herb, and medicinal plant. Perilla leaves are reported to be rich in phenolic compounds, which are beneficial for human health, whereas seeds contain an oil rich in alpha-linolenic acid (omega-3 fatty acid), useful in the human diet, too. Since perilla is almost unknown in Europe, we started a trial aiming at evaluating the suitability of this species to be grown in our environments. As first step, we estimated the antioxidant properties and major component content of different cultivars, in order to explore the existing variability. Five red and green leaved commercial genotypes of perilla ('Qing su' and 'Zi su' of Agrohaitai, 'Ao shiso' and 'Ako shiso' of Tokita, 'Korean perilla' of Kitazawa Seed) were grown at the Minoprio Foundation experimental station (Vertemate, Como, Italy). Seeds were sown in

greenhouse in April and plants were transplanted in open field about one month later, according to a randomized block design with four replicates. The distances between plants were maintained at 60 x 25 cm and each plot was about 9 m² wide. We detected the morphological traits during the growing cycle and the content of chlorophyll a and b, total phenols, anthocyanins and carotenoids at the marketing maturity stage (about 60 days after transplant) on twelve random plants collected from each plot. Moreover, contents of perillaldehyde and perillaketone, which are responsible for the typical flavour and are involved in the chemesthetic mechanisms of taste perception, were detected. Generally, all the cultivars performed very well and showed high antioxidant properties; nevertheless, significant variability among them arose. We concluded that perilla has good perspectives to become an innovative and healthy leaf vegetable also in Italy, to be used for example in the minimally processed salad mix production.

S07.264

Quantification and Characterization of Extracted Lutein of Flowers of *Tagetes patula* L. and *Calendula officinalis* L.

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The contents of lutein and characterization of the chromatographic profile of carotenoids from the yellow, orange and brown *Tagetes patula* L. (african marigold) as well as the yellow and orange *Calendula officinalis* L. (marigold) flowers were determined by UV-visible spectra and High Performance Liquid Chromatography (HPLC). The brown *T. patula* L. showed the highest content of lutein (1230.6 mg×100g⁻¹), which significantly differed from the others. However, the concentration of lutein in *C. officinalis* L. (29.80 mg×100g⁻¹) was similar to the concentration found in yellow *T. patula* L. (59.7 mg×100g⁻¹). The carotenoids profile from the orange *T. patula* was similar to that obtained from brown *T. patula* L. flowers. This profile was different from those obtained from the yellow *T. patula* L. flowers and yellow and orange *C. officinalis* L. Lutein was the major carotenoid present in the african marigold, although the same was not observed in marigold. This results show the potential use of *T. patula* L. as a source of lutein.

S07.265

Quantification of Anthocyanins in Fruits and Vegetables

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Anthocyanins from different fruits and vegetables including acerola (*Malpighia glabra* L.), açai (*Euterpe oleracea* Martins), plum purple (*Prunus domestica*), blackberry (*Rubus fruticosus*), bacabi (*Oenocarpus minor* Mart.), eggplant (*Solanum melongena*), camu-camu (*Myrciaria dubia*), onion (*Allium cepa*), figo (*Ficus* spp.) jaboticaba (*Myrciaria cauliflora*), red jambo (*Syzygium malaccensis* L.), black plum (*Syzygium cumini* L.), apple (*Malu pumila*), red passion fruit (*Passiflora edulis*), strawberry (*Fragaria* spp.), cabbage (*Brassica oleracea*), pomegranate (*Punica granatum*), grape (*Vitis vinifera*), were extracted with ethanol 70% (v/v) and spectrophotometrically quantified by at 535 nm. The solution was adjusted to pH 2,0 and 3,0 with chloridric acid (HCl) 0,03%, and to pH 3,0 with citric acid 3%. The higher amount of pigments in most of the fruit and vegetables were obtained by extraction with ethanol 70% acidified with HCl at pH 2,0, which contributed to minimize degradation. The exceptions were black plum and eggplant, where ethanol 70% acidified with citric acid was the most efficient. These results indicate that jaboticaba, açai, black plum, grape, prune, purple cabbage, bacabi, blackberry, red jambo, eggplant, acerola and camu-camu can be used as potential sources of natural colorants, mainly jaboticaba, açai and black plum, which showed a total content of anthocyanins higher than 1200 mg/100g.

S07.266

Ultrastructure of Sweet Orange Ripening Fruit and the Role of Hydrolases in Dietary Fibre Degradation

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Dietary fibre and hydrolases of sweet orange (*Citrus sinensis* L. Osbeck) fruit were studied. The results showed that polygalacturonase (PG) was largely responsible for pectin depolymerization and solubilization, but PG-mediated pectin depolymerization requires pectin to be de-methyl-esterified by pectinesterase (PE). All these pectin-modifying proteins affect the integrity of the middle lamella, which controls cell-to-cell adhesion and thus influences fruit texture. In contrast, the primary cell wall changes caused by beta-galactosidase (β-Gal) and cellulase (Cx), which may restrict or control the activities of other ripening-related enzymes necessary for the fruit softening process. Taken together, we could consider that the changes of dietary fibre concentration and composition were caused by the solubilisation and depolymerisation of pectins in middle lamella and the disintegration of the primary cell wall.

S07.267

Dynamic Chemical Profiling in Semi-Fermented Tea Manufacturing Process

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The manufacturing process of semi-fermented tea is an art and experienced work. Dynamic changes in chemical volatiles are the useful index during each key step in tea manufacturing. Semi-fermented tea samples were made from *Camellia sinensis* var. *sinensis* cv. Chin-sing dah-pang at 5 unique stages, which were fresh leaves, grassy flavor emitting during fermentation, floral flavor developing during fermentation, before panning, and tea product brewing in hot water. The volatile compounds collected by solid-phase microextraction (SPME) and direct dry heated extraction were investigated by GC-MS analysis. The proportions of the compounds with fresh grassy flavor, trans-2-hexenal and cis-3-hexenol, were higher in samples of fresh leaves and of grassy flavor in fermentation, while they declined when floral flavor arisen during fermentative process. The compounds represented floral flavor were trans-β-ocimene, geraniol, β-myrcene; sweet flavor were linalool and its oxides; and fruity flavor most come from benzylaldehyde. Before panning, which is the fixation of tea product, the volatile compounds showing floral and fruity flavors were the major constituents. Volatiles of semi-fermented tea product with distillation extraction showed more than 90% balanced floral smell compounds but less fresh and woody odor compounds such as β-ionone and nerolidol. The results of dynamic profiling with SPME GC-MS analysis showed the alternative changes in volatile compounds during manufacturing process of semi-fermented tea.

S07.268

Antioxidant Properties of Mushrooms *Clavaria fennica* and *Clavaria pistilaris*

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For many centuries mushrooms have been used for their medicinal properties

and nutritional value. Considering the demand research of natural antioxidants and natural antioxidants sources and growing interest for edible mushrooms, as a functional food, antioxidant properties of two selected edible *Clavaria* mushrooms were investigated. *Clavaria fennica* and *Clavaria pistillaris* were collected from Istra region in Croatia, in late summer 2008. Antioxidant properties of these two mushrooms were investigated using different methods of evaluation: scavenging capacity of DPPH, OH and O₂⁻, capacity to remove lipid peroxidation and reducing power. Both mushroom extracts showed high scavenging capacity of OH radical. Relative inhibition of this radical was 87±5% for *C. fennica* and 82±3% for *C. pistillaris*. Opposite of this, lower scavenging capacity of O₂⁻ was detected for both investigated mushroom extracts (45±1% for *C. fennica* and 36±5% for *C. pistillaris*). Both extracts prevent lipid peroxidation. 50% of inhibition value of DPPH radical has been achieved at 0.032 mg/ml of extract concentration for *C. fennica* and at lower concentration for *C. pistillaris*. Higher content of phenolic compounds was determined for *C. pistillaris* (7.248 mg GAE/g of extract). In both mushroom extracts antioxidant compound pistillarin has been detected and quantified. Protocatechuic acid was found only in *C. fennica* extract.

S07.269

Evolution of Nutrients during Some Leafy Vegetables Growth

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In Côte d'Ivoire several leafy vegetables are grown and consumed. However, their maturity stages for consumption are not really defined. So, six leafy vegetables (lagos spinach, jute mallow, roselle, spinach, black nightshade and amaranth) were grown during 2 months at the Agronomic Research Station of Anguededou. They were analysed each weeks for the determination of pH, oxalic acid, proteins, sugars, fibers, vitamin C, β-carotene, phosphorus and minerals. The results revealed that roselle was the most acid leafy vegetable and had the highest oxalic acid rate. Protein level decreased during leafy vegetables growth. Total sugars level was constant between 2nd and 5th weeks. Lagos spinach had the most elevated fibers rate at 3rd week (37.17 % for soluble fiber and 66.1 % for insoluble fiber). Amaranth and black nightshade offered the highest vitamin C content at 7th week (64.44 and 66.67 mg / 100 g fresh weight (FW) respectively). Moreover, the most elevated β-carotene rate was contained in roselle (64.12 mg / 100 g FW, at 5th week). Phosphorus content of amaranth and black nightshade was high at 6th week with respectively 0.45 mg / 100 g dry matter (DM) and 0.33 mg / 100 g DM. Magnesium level was constant during leafy vegetables growth. Spinach and jute mallow had the highest iron rate at 5th week (70 and 88.8 mg / 100 g DM). The most elevated calcium level was found in spinach (3.68 g / 100 g DM at 6th week) and in lagos spinach (4.8 g / 100 g DM at 8th week). On the other hand, the less potassium rate was in roselle (1.84 g / 100 g DM at 8th week). The propitious period for leafy vegetables consumption is between the 3rd and the 5th weeks of growth because nutrients levels are maxima.

S07.270

Morphological Characterization and Determination of Pungency in *Capsicum* spp.

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Peppers belong to the genus *Capsicum*, and include about 30 species, whose cultivation is widespread due to their rich content in vitamins and capsaicinoids, responsible for their pungency. Quantification of pepper pungency is important for the consumer, as a base ingredient in food preparation, for pharmaceuticals formulation, and for the global industry market. The purpose of this paper is the identification of species in a population of 71 plants from various countries, grown in plas-

tic pots at Instituto Superior de Agronomia, Portugal, and the quantification of capsaicinoid content with subsequent determination of fruit pungency in Scoville heat units (SHU). For the identification of species, accessions of *Capsicum* were morphologically characterized, using descriptors according to the guidelines of the Community Plant Variety Office and others from the International Plant Genetic Resources Institute. Morphophysiological characterization lead to the identification of samples in a population that included all five cultivated species: 32 *C. annum*, 5 *C. baccatum*, 27 *C. chinense*, 6 *C. frutescens*, and 1 *C. pubescens*. The record of the descriptors of each plant was performed from seed to fruit maturity, aiming not only the identification of the species but also the determination of a narrower group of more useful characteristics that would allow that identification. Results of hierarchical cluster analysis showed that the most useful characteristics needed for the correct identification are: seed and corolla color, presence of spots on petals, and the presence or absence of ring constriction. Capsaicinoids were quantified by HPLC. Values between 88 and 14 814mg×kg⁻¹ were registered for capsaicin, and between 4 and 5860mg×kg⁻¹ for dihydrocapsaicin resulting in a range of 1417 SHU for *C. annum* 'Padrón' to 324 928 SHU for *C. chinense* 'Scotch Bonnet'. No direct relationship between pungency and species was found, although *C. chinense* reached the highest levels.

S07.271

Effect of Processing Techniques on the Phenolic Compounds and Antioxidant Activity of Pomegranate Leaf Tea

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The objective of this study was to investigate the effect of processing techniques on the phenolic constituents and antioxidant activity of pomegranate leaf tea. The fresh leaves after sprouting one month were oven-drying as control tea, the green tea and red tea were made with traditional techniques. Results show that the contents of total phenolics and catechin in green tea kept unchanged compared to the dried leaves, but the contents in red tea decreased significantly with the percentage of 30.8% and 60.3%, respectively. Correspondingly, the antioxidant activity of red tea decreased obviously. The contents of thearubigin and theaflavin in green tea were not significantly increased, but respectively increased 165% and 181.3% in red tea. In addition, the content of ellagic acid was not markedly decreased both in green tea (6.3%) and in red tea (9.3%). Therefore, green tea made from pomegranate leaves exhibited significantly higher content of total phenolics and antioxidant activity.

S07.272

Studies on the Extraction, Identification, Stability and Antioxidant Capacity of Anthocyanins in Purple Radish

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Anthocyanins are responsible for the orange to blue coloration of plant. They are beneficial to human health and widely used as food colorants. Extraction of anthocyanins from purple radish was studied using ultrasound as the assisted method. Orthogonal test design was used to ascertain the optimum technologies of ultrasonic assisted extraction after 2h shaking. The optimum conditions for ultrasonic extracting were as follows: The extraction time is 20min; the concentration of acetone solution is 70%; the ratio of material to reagent is 1: 60. PC can be used as an assistant method in pigments component analysis by Xin Hua No.3 filter paper. HPLC methods were well determined for pigments in purple radish. of those the column: inertsil® ODS C18 (5µm, 4.6 x 250mm); Elution solvent: (A) 100% HPLC-grade acetonitrile and (B) 1% phosphoric acid, 10% acetic acid (glacial), 5% acetonitrile (v/v/v). Elution conditions: grade elution; Flow rate: 1ml/min; Injection volume: 20ul; UV/Vis spectrophotometry, detec-

tion at 520nm. The anthocyanins of purple radish are identified preliminary by comparison with data in the literatures. The results show that the anthocyanin of purple radish may compose of pelargonidin-3-5-diglucose. *In vitro* antioxidant activities of anthocyanins from purple radish, purple sweet potatoes and purple cabbages extracts were studied and evaluated. Comparing antioxidant abilities among them by DPPH method, it was found that their IC50 value on scavenging DPPH free radical were 0.0121mg/ml, 0.0165mg/ml, 0.0187mg/ml respectively. Assessing inhibition ability on oxidation, induced by Fe²⁺, of lecithin liposome system of anthocyanins among them, the antioxidant activities of the different pigment extracts were found to vary as follows: purple sweet potatoes > purple radishes > purple cabbage.

S07.273

D-Pinitol Content of Carob Beans (*Ceratonia siliqua* L.)

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Carob (*Ceratonia siliqua* L.) is a tree that has been widely grown in the Mediterranean region for a long time. It belongs to the *Caesalpinaceae* subfamily of the family *Leguminosae*. Turkey is located within the region where the plant originated and has "cultivated types" and many "wild types". Several products are produced from the seed and pod of carob, and the economic importance of the crop results from the use, by industry, of locust bean gum that is obtained from the seed. The pod of the carob fruit has long been used as a feed for livestock and in human nutrition, including sweets, biscuits and processed to pekmez; a traditional concentrate. The latest studies also show that D-pinitol is a major sugar derivative component in the *Leguminosae* family. In this study, this bioactive component which has an insulin effect is determined in cultivated and wild types which were grown in the Mediterranean region of Turkey.

S07.274

The Characteristics of Polyphenol Oxidase in Small Cherry Tomato (*Solanum lycopersicum*) Cultivated in Kurdistan of Iran

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Polyphenol oxidase (EC 1.14.18.1) (PPO) is a copper-containing enzyme which can be found throughout the phylogenetic tree. PPO is the rate-limiting enzyme in the melanin biosynthesis pathway. It hydroxylates and oxidizes phenols to o-quinone. PPO activity was determined, using catechol (dihydroxyphenol) and pyrogallol (trihydroxyphenol) as substrate, in extracts prepared from small cherry tomato (*Solanum lycopersicum*) cultivated in kordistan (Iran). pH profile for crude extracts showed that one optimum pH exists for catechol as well as pyrogallol. The optimum pH for PPO activity has been found at pH 8. Kinetics parameters at pH 8 indicated that the apparent Km and Vmax per mg protein were, respectively, 27 mM and 0.11 Unit/ml, 1.5 mM and 45 Unit/ml with hyperbolic curves for catechol and pyrogallol. Catalytic efficiency, calculated per mg extract protein, was respectively 0.004 per 30 min⁻¹ for extracts prepared from small cherry tomato. A strong substrate inhibition was observed with catechol and pyrogallol. In all activity assays, the oxidation product of catechol was detectable after a lag period. In the presence of different concentrations of catechol, the oxidation rate of catechol increased while the length of the lag period was decreased. This was probably interpreted as the release of the latent form of the enzyme to its active form in addition to a facilitated substrate access. During substrate inhibition with increase of catechol concentration, lag time increased. On the other hand, in the presence of pyrogallol as second substrate, oxidation of substrate showed no lag time. In general lag time of enzyme depended on the enzyme and substrate concentration, the pH and the presence of catalytic amounts of substrate. Phenolic compounds are thought to be sequestered in cell vacuoles and simple phenols as well as most of the phenolic compounds are intermediates and derivatives of the shikimate and phenyl propanoid pathways.

S07.275

Apple: Extraction Optimization of Antioxidant Compounds and Determination of Total Phenolic Amount and Antioxidant Activity on Products and Co-Product

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Apple (*Malus domestica*) is one of the most commercialized fruit in Brazil, having great importance to the Brazilian fresh fruit market. The main destination to the apple Brazilian production is the fresh market; however new alternatives are being sought since the fresh consumption has not increased in the last few decades. The alternatives to develop new products pass through the food, pharmaceutical and cosmetic industries. Beverages such as apple juice concentrate, extraction of pectin, apple flour to make cakes, breads and shakes and cosmetics are good examples of high added value products made of apple fruits. Apples have a series of bioactive compounds, also called phytochemicals, which can prevent chronic non-communicable diseases. Genetic factors, as well as environmental factors may affect the content of these bioactive compounds. To increase the knowledge of apples produced in Brazil, Embrapa Temperate Agriculture, Pelotas, has been conducting research activities on chemical composition and antioxidant activity of the main cultivars produced in Brazil and some co-products. Some products and co-products were analyzed such as the cultivar Fuji, apple flour, concentrate apple juice and fruits from the pollination apple (*Malus everest*) plant. Also, a methodology to extract the antioxidant compounds from apple was developed. Regarding to the results, fruits from the pollination apple plant show the highest antioxidant activity among all the studied products and co-products. This is important information to the farmers and to the industries since this product is not usually commercialized. Cosmetic industry can use this material to extract antioxidant compounds to be used as natural extract on cosmetic formulations. Regarding to the methodology to extract the antioxidant compounds, several solvents and mixtures of solvents were tested and a mix of acetone and ethanol was the most efficient to extract antioxidant compounds from apples.

S07.276

Anthocyanin Profile of Two Italian *Cichorium intybus* L. Cultivars

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Cichorium intybus L. consists of many varieties, two typical Italian crops are the red (Radicchio Rosso di Treviso) and the red-spotted (Radicchio di Castelfranco) chicories belonging to the foliosum variety, both representative of Italian cultural realities related to a specific territory. These leafy vegetables are cultivated in north-east Italy. Radicchio Rosso di Treviso is cultivated according to traditional growing technique involving leaves tying during growth and a bleaching process at harvesting. Both cultivars are recognized with the PGI label (Protected Geographical Indication) from European Union. The aim of this study was to examine the qualitative and quantitative compositional profile of anthocyanins, the main phytochemical characterizing and distinguishing both the red and red spotted Italian variety of *Cichorium intybus* L. Radicchio Rosso di Treviso was sampled in 4 different locations and Radicchio di Castelfranco in 3. Anthocyanins were separated by HPLC, and NMR spectroscopy was used to identify their profile, 1D- and 2D-NMR experiments allowed the recognition of some compounds for which standards for HPLC are not available. The red cultivar (Radicchio Rosso di Treviso) showed a marked variability in anthocyanins concentration among the

four localities studied. Pelagornidin-3-glucoside, cyanidin-3-glucoside, delphinidin 3-O-(6''malonyl)-glucoside and cyanidin 3-O-(6''malonyl)-glucoside were the main anthocyanins found, the last showed the highest concentration. The red-spotted cultivar (Radicchio di Castelfranco) showed a similar anthocyanin profile with markedly lower concentration compared to the red cultivar. The research aimed at a systematic study of the anthocyanin profile of both Radicchio Rosso di Treviso and Radicchio di Castelfranco as function of their production areas. Our findings gave a fingerprint of the red and red-spotted Italian PGI cultivar of Radicchio. Further studies are needed to elucidate the contribution of both environmental factors and traditional treatment applied during growth to the compositional variability observed.

S07.277

The Effect of TTES no.13 Paochung Tea Caffeine and Catechins Content by Using Different Roasting Methods

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Roasting methods profoundly influence the chemical composition of Paochung tea. In this study, Paochung teas were produced from TTES No.13. The processing parameters under investigation included temperature (80 °C, 100 °C, 120 °C), duration (1, 3, 6, 9, 12 hr) and the number of times. Summer tea of 2008 was used and first roasting was done in the autumn of 2008. Second and third roasting were done in 2009. After roasting, caffeine and catechins were analyzed by HPLC. Caffeine content increased after first roasting. While decreased after second and third roasting. Catechins content of tea decreased with increasing of roasting duration and times.

S07.278

Correlation of Lutein and β -Carotene Content with Total Chlorophyll Concentrations in Green Leafy Salads

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Due to their antioxidative properties and postulated beneficial outcomes to health which are associated with a diet rich in carotenoids, green leafy vegetables can play an important role in a balanced and healthy diet. The major pigments accumulated in green leaves - beside chlorophylls - are the yellow coloured xanthophyll lutein and the orange β -carotene. Lutein is reputed to have a protective effect against several eye diseases, whereas β -carotene is especially known for the provitamin A properties. There is some evidence, that high chlorophyll concentrations in green leafs are related to elevated lutein and β -carotene contents. Therefore, we investigated the relationship between carotenoids and chlorophylls in salads. 45 leaf salads divided in common eaten *Asteraceae* (red and green lettuce cultivars and baby leaf) and old *Asteraceae* cultivars (chicory, sugar loaf) were selected. For each cultivar one quarter per head (n=12) were deep frozen with liquid nitrogen at day of harvest and crushed to a frozen powder. The samples were extracted with methanol: acetone (1:1 v/v) and lutein, β -carotene, chlorophyll a and b were quantified by HPLC-DAD. Separation was achieved in 30min on a C30-column with a methanol/MTBE gradient. We identified a strong correlation between the total carotenoids and chlorophylls of $R^2 > 0.9$. Concerning the lutein/chlorophyll ratio we observed two groups. In the group of old *Asteraceae* the carotenoid/chlorophyll ratio was approximately 1:10 whereas in the common eaten cultivars we determined a ratio of 1:18. In contrast, we found for the β -carotene/chlorophyll relation a fix ratio of 1:26 for all cultivars. As a conclusion we figured out that lutein is responsible for the two groupings between the carotenoid/chlorophyll ratio in the different salad cultivars. As a further objective, we intend to implement leaf colourisation measurements which may develop into a fast screening tool for carotenoid contents.

S07.279

Long-Time Heating Improves the Functionality of Chinese Quince and Quince Fruit Products

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Chinese quince (*Pseudocydonia sinensis*) and quince (*Cydonia oblonga*) are rich in polyphenols and dietary fiber and have been used traditionally as a folk medicine or a medicinal foodstuff. These fruits are often subjected to long-time heating when they are processed or treated for extraction of active ingredients. However, the changes in components of the fruits during long-time heating and the phytochemical composition of the extracts are unclear. We investigated: 1) the functional characteristics of boiling-water extracts of Chinese quince and quince fruit, 2) the effect of boiling time on the polyphenol and polyuronide content of fruit jelly made from the boiling-water extracts, and 3) changes in polyphenols during heat treatment. The experimental data showed, the boiling-water extracts of Chinese quince and quince fruits were rich in polyphenols and polyuronides and showed *in vitro* bile acid binding, antioxidant and antiulcerative properties. Concerning the characteristic of the fruit jellies made from the extracts, the intensity of reddish color, polyphenol and polyuronide content, viscosity and DPPH radical scavenging activity all increased with the boiling time. The polyphenol content of the jelly made from Chinese quince fruit was approximately 530-820 mg/100g and it was 3-4 times higher than that of quince jelly (120-240 mg/100g). Meanwhile both polyuronide content of the jellies were almost similar (140-300mg/100g). Polyphenols seemed to contribute to the viscosity of the jelly. Low molecular polyphenols in the boiling-water extracts were increased by heat treatment. In conclusion, boiling is an effective method to extract and improve the functionality of Chinese quince and quince fruits, and the functional characteristic of the extracts or the jellies seemed to be controlled with boiling time.

S07.280

Changes in Saponins, Alkaloids, Nucleosides and α -Glucosidase Inhibitory Activity in Jujube during Acetification Process

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In this study, we demonstrated for the first time the influence of hydrolysis of pectin, alcohol and acetic acid fermentation on the bioactive substances and α -glucosidase inhibitory activity (GIA) of Chinese jujube. The analyzed components included total soluble sugar, total phenolics, total saponins, total alkaloids, nucleosides (cAMP and cGMP), and triterpenoids (ursolic acid, oleanolic acid, betulin and jujuboside B). Investigations showed that the hydrolysis of pectin had no obvious effects on the contents of total soluble sugar, total phenolics and total alkaloids, while it significantly released total saponins, nucleosides and triterpenoids ($p < 0.05$). The alcohol fermentation caused the decreases in all of these bioactive components, and the followed acetic acid fermentation continued to decrease the soluble sugar, total phenolics, total saponins and nucleosides until the entire fermentation was finished. It was necessary to emphasize that the contents of the total alkaloids and triterpenoids were decreased slightly at the beginning of acetic acid fermentation, while they were significant increased at the end of the fermentation. The α -glucosidase inhibitory activity (GIA) of jujube was also affected significantly ($p < 0.05$) by these processes. The results of analysis showed that GIA was significantly increased ($p < 0.05$) after hydrolysis of pectin, and was decreased after alcohol fermentation. GIA had no significant difference ($p > 0.05$) at the beginning of acetic acid fermentation, where it increased significantly at the 7th day of the fermentation ($p < 0.05$). Significant correlation ($r^2 = 0.997$, $p < 0.05$) was found between GIA and the alkaloids and triterpenoids. Although the neutralized vinegars were lower than the non-neutralized vinegars in GIA, it still had strong

GIA. These results suggest that these bioactive compounds play an important role in GIA of jujube vinegar, and Chinese jujube could be exploited for development of an anti-diabetic food by acetification process.

S07.281

Polyphenol Content and Antioxidant Activity of Fruit Tea Samples Made of Berries

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Recently, polyphenols have gained much more attention, owing to their antioxidant capacity and their possible beneficial implications in human health. Berries are rich in polyphenols and there are many studies about their quantity and quality. Fruit teas are becoming more and more popular products that are often made of berries too. We don't have enough data on the amount of the components in tea infusion made of berries. The aim of our work was to examine the polyphenol content and the antioxidant activity of fruit tea samples made from berries. We measured tea samples made from rosehip (*Rosa canina*), blackberry (*Ribes niger*), cranberry (*Vaccinium macrocarpon*). We measured both of filtered products and products made of fruit sarcocarp. Tea infusions were prepared with pouring hot water (100 °C) and soaking, in different temperatures. Tea samples were bought in herb shops and food stores. Polyphenol content was measured with Folin Ciocalteu method. Antioxidant activity was measured with DPPH reagent. Antocian content was measured by spectrophotometer directly. Data were evaluate by t test at $p < 0.05$. There were significant differences between the tea samples made of filtered products and the samples made of fruit sarcocarp. The polyphenol content and antioxidant activity were higher in samples made of fruit sarcocarp. There were significant differences between the samples prepared by pouring hot water and the samples prepared by soaking. The polyphenol content was higher in samples prepared by soaking.

S07.282

Determination of Various Chemical Properties, Total Phenolic Contents, Antioxidant Capacity and Organic Acids in *Laurocerasus officinalis* Fruits

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Laurocerasus officinalis (cherry laurel), also known as Taflan or Karayemiş, is the fruits of the officinalis species in the *Rosaceae* family and *Prunoideae* subfamily. It is mostly consumed as fresh fruit but may also be dried, pickled, and processed to produce jam, marmalade, and fruit juice. The nutritional value of cherry laurel fruit arises from its phenolic content and other chemical properties. In addition, both fruits and seeds of cherry laurel have been used in the treatment of stomach ulcer, digestive system illness, bronchitis (seeds), eczemas, haemorrhoids and as a diuretic (fruits) and analgesic agent in traditional medicine in Turkey. Pulp of the fruit were tested for chemical composition (protein, sugar, fat, moisture, ash), total antioxidant capacity, total polyphenol content; in addition organic acid contents (malic acid, acetic acid, fumaric acid, oxalic acid, citric acid, L-Ascorbic acid, succinic acid) of the fruit were determined. Total polyphenol content was estimated using Folin–Ciocalteu assay. The antioxidant activity of cherry laurel was assessed by scavenging 2,2-diphenyl-1-picrylhydrazyl (DPPH). An ion chromatography with UV detection was used for determination of organic acids in fruits. On a fresh weight basis, cherry laurel fruit exhibited a significantly ($P < 0.01$) high phenolic and antioxidant activity. Since it is a rich source of chemical compounds, total phenolic and antioxidant contents as well as organic acid contents, *L. officinalis* has important health benefits and might be considered as a functional food.

S07.283

From Producing Fields of Huelva to the Market: Qualitative Assessment of Strawberry's Antioxidant and Nutritional Properties

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In the last few years, most of strawberry growers have shown an increasing concern about the future's sector. Among the major demands they have, a reasonable fruit price for strawberries before shipping in producing fields, it can be stand out. Prices normally undergo an important rise throughout the distribution and commercial chain, whereas in many cases, profits scarcely cover producing costs. This usually takes place when markets get to be saturated of fruit coming from others countries. Furthermore, the predominance of adequate quality and traceability controls in some cases is insufficient yet. For above reasons, it is more and more necessary to enhance both nutritional and bioactive value of strawberries, consumption of which, supplies healthy benefits. Most of them seem to be linked to the antioxidant properties and free radical scavenging capacity of several fitochemical compounds contained in fruits, just like have pointed out many studies. The objective of this work has been to evaluate changes in the nutritional and antioxidant character of strawberries ('Camarsosa', 'Candongá' and 'Fuentepina' cultivars) produced in the region of Huelva after being subjected to a post-harvest treatment simulating transport from producing fields to European markets. Periodical analyses of brix-grade, pH, titratable acidity, carbohydrates, total phenolic compounds, anthocyanins, antioxidant capacity of extracts (DPPH) and antioxidant enzymatic activities were performed. The effect of temporary storage at -20 °C on antioxidant properties and possible correlations between parameters has been also discussed.

S07.284

Effect of Cooking on the Nutritional Characterization of Nopal Milpa Alta and Atlixco Varieties (*Opuntia ficus indica* L. Miller)

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Beside the widely spread use of the cactus pear fruit, the part of the cactus consumed as a vegetable is the young stem known as cladode or "nopal". Cladodes have been a traditional fresh green vegetable in the Mexican diet, which is eaten after a culinary process. Chemical composition of Milpa Alta and Atlixco varieties were investigated. Analyses were conducted in raw and cooked plants by common household practices (boiled during 20 min in distilled water). Cladodes were analyzed for moisture, ash, minerals and protein as per the standard AOAC methods. Minerals concentrations were determined after dry ash at 550 °C in a microwave oven. The mineral content in the diluted acidified samples was determined by Atomic Absorption Spectrophotometer. Nitrogen content was estimated by Kjeldhal method and was converted to protein using factor 6.25. Soluble sugars concentration and the proportion of saccharose, glucose and fructose in soluble sugar were measured by HPLC. The amount of soluble dietary fibre (SDF), insoluble dietary fibre (IDF) and total dietary fibre (TDF), was determined by a gravimetric enzymatic method. Analysis of variance (ANOVA) was used to compare any significant differences between samples ($p < 0.05$). In this study, moisture, minerals and carbohydrates were relevant in the nutritional composition of cladodes studied. Potassium was the most abundant mineral in both varieties of cladodes studied, followed by Ca and Mg. Dietary fibre was the most important carbohydrate fraction followed by soluble sugars. Total fibre represents almost 50% of dry matter in this plant, and

insoluble fraction was the most important fraction of total fibre. Low protein content was observed. No significant differences were observed between the cladodes varieties. Cooking of vegetables, produce an important decrease in soluble sugars, protein and minerals by leaching into the cooking water.

S07.285

Evaluated Some Biochemical Components in Fruits Juice, Pulp and Peel of Lime and Lemon Fruits

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Lime and lemon are the more important of citrus product crops. The large parts of lime and lemon product are used to produce juice or dried fruits. All parts of Citrus (pulp, peel, seed and leaf) are known to be rich in polyphenols, antioxidant compounds and Carotenoid, pectin and dietary fibers. In this investigation some biochemical components in some parts of two local genotypes of lime (Persian lime, Bikhar lime) and lemon (Mayer, Lisbon) fruits were evaluated. The contents of total polyphenols, pectin content, carotenoid and dietary fiber in peel and pulp of fruits were determined. The some characteristics of juice such as ascorbic acid, antioxidant activity, pH, EC, TSS, titration acidity was also determinate. The analysis of variance showed no significant difference in the contents of total dietary fiber in the genotypes but the contents of total dietary fiber in peel were significantly higher than in pulp ($p < 0.05\%$ in all cases). The highest total phenolic content was absorbed in fruit's peel with range of 64.72, 60.16 mg acid Gallic/100 g DW and then in pulp of fruits. The analysis of carotenoid and pectin show the existence of significant difference in the parts and genotypes. In all four fruits, the pectin and carotenoid contents in peel were significantly higher than pulp. Lemons juice fruits showed higher antioxidant activity, TSS and pH than limes, but they show lower ascorbic acid, EC, titration acidity than limes juice fruits. In conclusion all parts of lemon genotypes have highest polyphenol content. Peel and pulp of lime fruits show highest pectin. The peel of all genotypes is rich in dietary fiber and total carotenoid.

S07.286

Nutritional Parameters and Sensory Quality in Cooked Vegetables in MAP

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Ready-to-eat (RTE) products are an essential component of modern lifestyle. Modified atmosphere packaging (MAP) has become a popular form of extending the shelf life of fresh food products because they are easier and faster to prepare. Also fresh or cooked vegetables are popular as side dishes in Atlantic and Mediterranean diets, being considered healthy due to the fact that they are important sources of micronutrients and of a large variety of bioactive compounds. There is now strong evidence that these compounds are effective in preventing cancer and coronary diseases. They are also important in keeping organoleptic characteristics during shelf life. Therefore monitoring these compounds during storage is of maximum importance in order for producers to choose the best gas mixtures ($O_2/CO_2/N_2$) to be used as packaging atmospheres. As reported by several authors, the presence of high CO_2 concentration conjugated with absence (or residual amounts) of O_2 , will affect micronutrients interaction with the atmosphere inside the package and within the food matrix itself. As a consequence pH, water content and organoleptic properties will be affected. We have been evaluating the influence of different gas compositions, mainly air and combinations of 0, 2.5 and 5 % O_2 with 40, 60 and 80 % CO_2 (and N_2 to complete) on the quality of cooked vegetables (cauliflower, cabbage, broccoli, green beans and carrots) during storage at 5 °C. Colour (Lab system), pH (potentiometry), water content, antioxidant activity of bioactive compounds (spectrometry) and microbial evaluation (plate count at 30 °C) have been used to follow quality changes over 20 day storage. All samples are analysed by a group of five trained sensory judges for the presence of defects in appearance, flavour and texture. Results for cabbage and carrots show that MAP with low O_2 and high CO_2 percentages enable minor quality changes in all parameters during storage.

S07.287

Bioactive Compounds and Total Antioxidant Activity during the Development of Sapodilla Fruit

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The total antioxidant activity (TAA) of fruits can be influenced by several factors, so that fruits from the same species can vary in activity values due to cultivation system and developmental stage. This work aimed to analyze the influence of the developmental stage on bioactive compounds and TAA of sapodilla (*Manilkara zapota* L.) fruits. Fruits of the two cultivars 'Sapoti Ipacuru (BRS 227)' and 'Sapota tropical (BRS 228)' were harvested at different stages: 90, 120, 150, 180 (physiologically mature) days and ripe, and analyzed for total soluble polyphenols (TSP), vitamin C, yellow flavonols and total antioxidant activity according to the ABTS+ method. The TSP content decreased during developmental period and varied between cultivars, as 'Sapoti' started at 1663.83 and reduced to 67.01 mg galic acid/100 g, meanwhile 'Sapota' maintained higher levels, from 2090.90 to 163.15 mg galic acid/100 g. The vitamin C content decreased from 23.62 to 11.41 mg/100 g and 25.23 to 12.16 mg/100 g for 'Sapota' and 'Sapoti' fruit, respectively. The yellow flavonol content decreased from 11.44 to 3.16 mg/100 g and 6.91 to 1.70 mg/100 g for 'Sapota' and 'Sapoti' fruit, respectively. However, there were no statistical differences found for the vitamin C and yellow flavonol results between cultivars. The TAA decreased from 2382.90 to 33.54 μ M Trolox/g and 2481.99 to 132.92 μ M Trolox/g for 'Sapota' and 'Sapoti' fruit, respectively. These results show that during the development of the sapodilla cultivars studied, there was a decrease of the analyzed bioactive compound contents and of TAA, thus indicating that developmental stages influences the antioxidant quality of sapodilla.

S07.288

Phenolic Compounds in Olive Tree Leaves: Analysis of Extracts, Infusions and Natural Supplements

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Phenolic compounds are plant secondary metabolites, which play an important role in disease resistance, protection against pests and species dissemination. The interest on these compounds is related with their antioxidant activity and promotion of health benefits. The interest on phenolic compounds has raised attention for its study in olive fruits and other parts of the olive tree [1]. Traditionally, olive tree leaves have been used as a folk remedy against fevers and other diseases, such as malaria [2,3]. Previous investigations carried out on olive leaf extracts have demonstrated hypotensive, hypoglycaemic, hypouricaemic, antimicrobial and antioxidant activities [2]. The antiviral activity of olive leaves extracts against HIV-1 infection and replication has also been referred [4]. The purpose of this work was to study phenolic compounds present in olive tree leaves. Commercial dried leaves of different origins were purchased from an herbalist shop, for comparison purposes, and capsules containing criotriturated leaves were purchased at a Pharmacy. Water:methanol extracts as well as infusions were prepared. Extracts/infusions were analysed by reverse phase liquid chromatography using two chromatographic systems: HPLC-DAD-ED and HPLC with DAD detection in tandem with a triple quadrupole mass spectrometer (Micromass® Quatro Micro™, Waters®) with an electrospray source that was used in negative mode. This methodology allowed the identification of some common phenolic compounds, namely, hydroxytyrosol, luteolin-7-glucoside, verbascoside and oleuropein. Mass spectrometry methods were implemented in order to quantify oleuropein and other major phenolic compounds in the samples.

S07.289

Characterization of Secoiridoids in Olive Seeds Using MALDI-TOF Mass Spectrometry

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The olive tree belongs to the genus *Olea* of the *Oleaceae* family. Members of the *Oleaceae* family are characterized by the presence of secoiridoids. These compounds have in their structure elenolic acid or one of its derivatives. While phenolic acids, phenolic alcohols and flavonoids occur in many fruits and vegetables belonging to various botanical families, secoiridoids are present exclusively in plants belonging to the *Oleaceae* family which includes *Olea europaea* L. Oleuropein, ligstroside and nüzhenide are the most abundant secoiridoids in olives [1]. Some phenolic compounds have been identified in olive seeds like salidroside, nüzhenide, hydroxytyrosol, nüzhenide 11-methyl oleoside, oleuropein, tyrosol, and demethyloleuropein [1]. In previous works we reported the analysis and chemical characterization of seed extracts from *Olea europaea* L. using reversed phase HPLC, with electrochemical and diode array detection, hyphenated with mass spectrometry (electrospray ionization). Nüzhenide and nüzhenide 11-methyl oleoside among other 11-methyl oleosides are the most important compounds detected in olive seeds [1,2]. The indication of the presence in seeds of secoiridoids compounds with higher molecular mass than nüzhenide 11-methyl oleoside - nüzhenide di and tri (11-methyl oleosides) – lead us to MALDI-TOF mass spectrometry assays in order to characterize secoiridoids in olive seeds.

S07.290

Chemical Composition and Antimicrobial Activity of Feverfew (*Tanacetum parthenium* L.) Essential Oil

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In this study, the aerial parts of feverfew (*Tanacetum parthenium* L.) were collected from Hamedan and Tehran regions at the vegetative, flowering and seeding stages. Essential oils from the whole aerial parts as well as stem/leaf, inflorescence and ripe seeds were isolated through hydro-distillation. The amount of essential oil obtained from the above parts of the Hamedan plant samples were 0.49%, 0.31%, 3.81% and 1.80% (w/w), and from those collected from Tehran were 0.96%, 0.87%, 3.59% and 4.96% (w/w) respectively. The oils of different parts of plants were also analyzed by GC and GC/MS. Camphor was the major constituent in total oils (21.7% - 82.4%) followed by chrysanthenyl acetate (14.6% - 55.4%) and camphene (7.2% - 11.7%). However, Bornyl acetate, -pinene and P-cymene were found in the Hamedan plant samples only. The antimicrobial activity of the oils was determined using the disk diffusion method against Gram positive bacteria (*Bacillus subtilis*, *Bacillus cereus*, *Micrococcus luteus* and *Staphylococcus aureus*), Gram negative bacteria (*Yersinia enterocolitica*, *Klebsiella oxytoca*, *Serratia marcescens*, *Escherichia coli* and *Pseudomonas aeruginosa*) and yeast (*Candida albicans*). Results showed a significant difference between Gram positive and Gram negative bacteria in their susceptibility to the oil, although Gram positive bacteria were more susceptible to the antimicrobial activity of feverfew oil. In addition, the oil extracted from Hamedan samples showed more antimicrobial activity compared to those from Tehran.

S07.291

The Effect of Nitrogen and Plant Density on the Essential Oil Content and Composition of Peppermint (*Mentha piperita* L.)

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In order to study the effect of different amounts of nitrogen and plant density on the essential oil content and composition of peppermint, an experiment was conducted in 2008 at the Experimental Field of the Agricultural Faculty of Bu-Ali Sina University. The experiment was a split plot based on a randomized complete block design with three replications. The main plots included the amounts of 100, 150 and 200 kg nitrogen/ha. The sub-plots were also considered for the plant densities as 8, 12 and 16 plants/m². Cuttings of peppermint were provided by the Research Department of Medicinal Plants, Jihad Daneshgahi Center, Tehran province. After isolating essential oil from dried leaves through the hydrodistillation method, composition of essential oil were identified by gas chromatography (GC) and GC/Mass spectrometry analysis. As many as 37 compositions were identified in essential oil. Pipertinone oxide, α -Terpinene, Menthol, trans-Carveol, isomenthone and β -Caryophyllene showed the highest amounts compared to the other essential oil compositions. According to the results, nitrogen treatment and plant density had a significant effect on essential oil percentage and its composition. Interaction of nitrogen and plant density had also a significant effect on essential oil percentage only. Final results showed that the highest amount of essential oil and its composition was obtained when 150 kg nitrogen/ha applied on 8 plants/m².

S07.292

Characterisation of Peach Cultivars by HPLC Analysis of Polyphenol Compounds

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Peach cultivars were compared for polyphenolic content in fruits by HPLC-DAD analysis. Skin and flesh of fruits of either white or yellow flesh cultivars, at the same ripening stage, were separately analysed. The chromatographic protocol applied allowed to separate all the main polyphenolic compounds. Neochlorogenic acid, chlorogenic acid, procyanidines, catechin, epicatechin, quercitins and anthocyanins were identified by comparison with commercial standard and UV spectra. The total content and relative distribution were dependent upon cultivar. The highest content in flavan-3-ol, and in general in polyphenols, (0.211 and 0.331 mg/g fw, respectively) in flesh was found in the cv. Silvette, while the cv. Snow Queen was found to be the cultivar with the highest levels in the skin. Cv. Farlaine showed the highest content of hydroxycinnamic compounds both in flesh and skin (0.191 and 0.430 mg/g fw, respectively) and in Redtop and Gilda Rossa fruits was found the highest concentration of anthocyanins in flesh (0.066 mg/g fw) and skin (0.485 mg/g fw), respectively. Concerning flavonols, the highest concentration in flesh was found in Snow Queen (0.016 mg/g fw), while Farlaine showed skin with the highest content (0.156 mg/g fw). No overall difference was found in the polyphenol content between yellow and white flesh peaches. In general, the skin was confirmed to have higher total polyphenol content than flesh in all cultivars, however, the abundance of neochlorogenic acid was not significantly different between epicarp and mesocarp.

S07.293

Harvest Maturity Influences the Antioxidant Activity in Jalapeno Chilli

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Chillies are good sources of phytochemical compounds. The concentration of these compounds varies depending on the genotype, harvest maturity, location within the fruit, and the conditions during growth and postharvest handling. 'Jalapeno' chillies were tagged at flowering and harvested at different maturities to study the antioxidant capacity. Two assays, the ferric-reducing antioxidant power (FRAP) assay and scavenging of diphenyl-picrylhydrazyl (DPPH) radicals were used to assess the antioxidant activity while the Folin-Ciocalteu assay was used to measure total polyphenol content (TPC). Two extraction solvents were tested, water and 50% ethanol. The FRAP values significantly increased ($P < 0.01$) in water extracts as the fruit matured. In contrast, harvest maturity had no influence on TPC or free radical scavenging activity in either solvent. Both FRAP and TPC values were significantly lower ($P < 0.01$) in ethanol extracts than in water extracts. The results showed that the antioxidant activity as measured by the FRAP assay correlated positively with the TPC in both extracts indicating that the polyphenols are the major contributors to the antioxidant activity. Overall, maturity at harvest of 'Jalapeno' chilli is an important factor for health-benefit properties with fully mature fruit (i.e. 6 weeks after flowering) having the highest antioxidant activity measured by FRAP assay.

S07.294

Vitamin C and Anthocyanine Content in Fresh and Processed Berries

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The berries contain big quantity of pigments, which mainly are flavonoids belong to the anthocyanine group with high antioxidant capacity. The high vitamin C content has significant antioxidant activity too. Our target was to test the antioxidant capacity of fresh berries species and the popular products made from berries consumed in Hungary. We got the raw samples from CAO fruit variety-test station. The samples contained intact, healthy fruits on same ripening level. The tested fruits were elderberry, black currant, blackberry, blueberry, josta, gooseberry, raspberry, cranberry, redcurrant, white currant. After the measuring the antioxidant components of fresh fruits different products were made in the departments' practicing kitchen. We used classical home-made or small-scale methods for quality products keeping the nutrition value of fresh fruit. Our working team used traditional spectrophotometric methods to determine the antioxidant activity, vitamin C and pigment content of samples: C-vitamin: water solution, ferri-chloride, dipiridil reagent. Anthocyanine: We solved from the samples the pigment colour with sulfuric-acid-ethanol mix. After direct measurement of absorbance we counted the whole quantity of flavonoids with the equivalence of the main anthocyanine component (cyanidin-3-glucoside). Antioxidant activity: classical DPPH method. The results gave us a numerical comparison of the different berries related with the nutrition value. Among the examined fruits contained the biggest antioxidant activity: elderberry, black currant and blackberry. The processed products were keeping the quality of fruit in different ratio. The data we got from the fruit products were very diverse since the fruit content and the method and time of heat treatment. It is important to consider the raw material maturity and quality as well. Highest value we measured in black currant jam processed with low sugar and short heating. To conclude, with the results we can recommend these fruits to the people who are interested in continue a healthy diet.

S07.295

Quality, Bioactive Compounds and Antioxidant Activity in Fruits of a Seedless Peach Palm Selection from Acre, Brazil

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The peach palm (*Bactris gasipaes*) is native to the Amazon region, but is widely distributed in tropical forests throughout South and Central America. The fruit is yellow or orange, contains large amounts of carotenoids and is a popular local food most often consumed in cooked form. The vast majority of peach palm trees, whether cultivated or natural, produce seedless fruits, but parthenocarpy is a relatively common phenomenon. The objective of the present study was to evaluate the quality, bioactive compounds and total antioxidant activity of a selection of seedless peach palm drupes from Acre, Brazil. The selected drupes were flown to the Laboratory of Physiology and Post-Harvest Technology (Embrapa Agroindústria Tropical, Fortaleza, Ceará) for determination of total mass (TM), pulp mass (PM), peel mass (PM), pulp yield (PY), length (L), diameter (D), color, moisture, total lipids (TL), protein, pH, total acidity (TA), soluble solids (SS), SS/TA ratio, starch, reducing sugars (RS), vitamin C (VC), total carotenoids (TC), total anthocyanins (TAC), yellow flavonoids (YF), β -carotene, total extractable polyphenols (TEP), total antioxidant activity (TAA) by the β -carotene/linoleic acid method, and minerals. The average weight of the fruits was 11.3 g and the pulp yield was high (75%). The most important findings include: TL=47%; protein=3.97%; starch=14.11%; SS=23.93°Brix; VC=16.5mg/100g; TC=1.37mg/100g; YF=24.78mg/100g; TA=1.41mg/100g; beta-carotene=0.35mg/100g and TEP=54.48mg/100g, TAA, expressed as percentage inhibition of oxidation (OI), was 79.81% and 64.64% for the concentrations 5.0g/L and 2.5g/L, respectively. Overall, the fruit of the peach palm presents a considerable market potential based on its quality profile and bioactive compounds, especially with regard to antioxidant activity.

S07.296

Melatonin and an Isomer Are Present in Different Monovarietal Wines

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Melatonin (N-acetyl-3-(2-aminoethyl)-5-methoxyindole) is an indoleamine synthesized from L-tryptophan metabolism via serotonin. It is considered a neurohormone, and a chronobiotic and antioxidant compound. Due to its presence in vegetable tissue, MEL has been evaluated as a food component thanks to the cited biological activity. In order to determine its contribution as a bioactive compound, it is necessary to set up and design suitable methods for its qualitative and quantitative analysis. This paper aimed to detect accurately melatonin in wine for the first time by LC-ESI-MS/MS and multiple reactions monitoring mode (MRM). Melatonin was detected in wines by comparison of its retention time and MS, MS2 and MS3 spectra with its commercial authentic marker. In addition to melatonin, LC-ESI-MS/MS, analyses revealed the occurrence of a compound with an identical fragment pattern (positive mode ESI). The major mass fragmentation ions of the other $[M+H]^+$ (233) at m/z : 216, 174.1 and 159.1 was tentatively identified as a melatonin isomer (not previously described in wines). It appeared in certain monovarietal wines (Jaen Tinto, Merlot and Palomino Negro) whilst melatonin was the only compound in others (Petit Verdot and Syrah) and a third group of wines showed both of them (Cabernet Sauvignon, Prieto Picudo and Tempranillo).

S07.297

Melatonin Is Synthesized during Vinification Process

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Grapes and wines are a great source of biologically active compounds but little it is known about others such as indoleamines. Melatonin (N-acetyl-3-(2-aminoethyl)-5-methoxyindole), an indoleamine produced by pineal gland, is present in different plant materials. This work aimed to detect the presence of melatonin in grape (skin, seeds and pulp), and during wine production. Five red and a white grape varieties were studied. No melatonin was detected in any part of the grape (peel, pulp and seeds) using different extraction solvents (methanol: water (1:1), chloroform and ethyl acetate) and by multiple reaction monitoring mode (MRM) by LC-ESI-MS/MS. However, melatonin occurred during the vinification process as was confirmed by LC-ESI-MS/MS analyses. The winemaking steps of this study were: destem-crush vatt, press and racke for red wines and destem-crush, dejuice and racke for the white wine. Mel appears in press for red wines and in the juice used for the white wine just when yeast was added. Further studies are needed to explain the role of yeasts in the melatonin synthesis and to know the best parameters for the production of this compound.

S07.298

Extraction of Nutraceutical Active Compounds from Broccoli By-Products

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Glucosinolates and sulforaphane were extracted from blanching broccoli by-products (*Brassica oleracea* var. *italica*) using different ratio between ethanol and water (95% ethanol, 70% ethanol, 50% ethanol, 30% ethanol and 100% water and by double extraction system). The effect of time and temperature of extraction was also studied on the concentration of glucosinolates and sulforaphane. All glucosinolates (Glucoraphanin, sinigrin, glucoalyssin, progoitrin and 4-OH- glucobrassicin and sulforaphane contents were determined by HPLC and HPLC- Mass spectrum techniques. The obtained data showed that degradation of glucoraphanin to sulforaphane is correlated with the temperature and time of extraction. Less than one hour of extraction is sufficient to extract all amounts of glucosinolate compounds. Sulforaphane was mainly extracted by 70% ethanol in the short time (0.5hr) or by 95% ethanol in the long time. On the other hand, over 40 °C, all sulforaphane compound is degraded.