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THE STUDY OF THE INFLUENCE OF PLANT ADDITIVES ON INCREASING THE FOOD AND BIOLOGICAL VALUE OF SOFT WAFFLES

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Currently there is an acute shortage of fibres and proteins in the human diet, resulting in various diseases. The modern market needs a product capable of diversifying the range in the sector of functional, dietary flour confectionery. To this end, the article shows one of the ways to improve the macronutrient composition of waffles, especially with regard to the protein-carbohydrate component of the product. Laboratory analysis showed that the introduction of pea protein, chicory root syrup and apple fiber into the composition of flour and confectionery increased protein content by 3.3% in wafers made of rice flour only and by 5.6% in waffles made of a mixture of whole grains and rice flour. The amount of sucrose decreased in «Rice» waffles by 2.6% and by 2.3% in «Wheat-rice» waffles, and the amount of fiber on average is 3-4 times more, compared to the control sample. In comparison with the control sample, increased the average number of essential amino acids such as: lysine – in 1.5 times; phenylalanine – in 1.25 times; leucine and isoleucine– in 0.8 times; methionine – in 1.5 times, threonine – in 3 times. Thus, the study resulted in the development of dietary plant based soft waffles with improved macronutrient composition, able to expand the range of functional products and can be recommended for dietary nutrition.

Keywords: soft waffles, pea protein isolate, chicory syrup, apple fiber, nutritional value, macronutrient composition.

ИССЛЕДОВАНИЕ ВЛИЯНИЯ РАСТИТЕЛЬНЫХ ДОБАВОК НА ПОВЫШЕНИЕ ПИЩЕВОЙ И БИОЛОГИЧЕСКОЙ ЦЕННОСТИ МЯГКИХ ВАФЕЛЬ

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В настоящее время в рационе питания человека наблюдается острая нехватка пищевых волокон и белков, что приводит к различным заболеваниям. Современному рынку требуется продукт, способный разнообразить ассортимент в секторе функциональных, диетических мучных кондитерских изделий.С этой целью в статье отображен один из путей улучшения макронутриентного состава вафель, особенно в отношении белково-углеводной составляющей продукта. Лабораторный анализ показал, что введение в состав мучного-кондитерского изделия горохового белка, сиропа корня цикория и яблочной клетчатки повышает содержание белка по сравнению с контрольным образцом на 3,3% в вафлях только из рисовой муки и на 5,6% в вафлях из смеси цельнозерновой и рисовой муки. Количество сахарозы уменьшилось в вафлях «Рисовые» на 2,6% и на 2,3% в вафлях «Пшенично-рисовых», а количество клетчатки в среднем в 3-4 раза больше, по сравнению с контрольным образцом. По сравнению с контрольным образцом, увеличилось среднее количество незаменимых аминокислот, таких как: лизин – в 1,5 раза; фенилаланин – в 1,25 раза; лейцин и изолейцин – в 0,8 раза; метионин – в 1,5 раза, треонин – в 3 раза. Таким образом, в результате исследования были разработны диетические мягкие вафли на основе растительного сырья с улучшенным макронутриентрым составом, способны расширить ассортимент функциональных изделий и могут быть рекомендованы для диетического питания.

Ключевые слова: мягкие вафли, изолят горохового белка, сироп цикория, яблочная клетчатка, пищевая ценность, макронутриентный состав.

ӨСІМДІК ҚОСПАЛАРЫНЫҢ ЖҰМСАҚ ВАФЛИДЫҢ ТАҒАМДЫҚ ЖӘНЕ БИОЛОГИЯЛЫҚ ҚҰНДЫЛЫҒЫН АРТТЫРУҒА ӘСЕРІН ЗЕРТТЕУ

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Қазіргі уақытта адам рационында диеталық талшықтар мен ақуыздардың жетіспеушілігі байқалады, бұл әртүрлі ауруларға әкеледі. Қазіргі заманғы нарық функционалды, диеталық ұннан жасалған кондитерлік өнімдер секторында ассортиментті әртараптандыруға қабілетті өнімді қажет етеді. Осы мақсатта мақалада вафлидің макронутриенттік құрамын, әсіресе өнімнің ақуыз-көмірсулар компонентіне қатысты жақсарту жолдарының бірі көрсетілген. Зертханалық талдау ұнкондитерлік өнімнің құрамына бұршақ ақуызын, цикорий тамырының сиропын және алма талшығын енгізу бақылау үлгісімен салыстырғанда ақуыздың құрамын тек күріш ұнынан жасалған вафлиде 3,3% - ға және тұтас бидай мен күріш ұны қоспасынан жасалған вафлиде 5,6% - ға арттыратынын көрсетті. "Күріш" вафлінде сахароза саны 2,6%-ға және "Бидай-күріш" вафлилерінде 2,3% - ға азайды, ал бақылау үлгісімен салыстырғанда жасұнық мөлшері орта есеппен 3-4 есе көп. Бақылау үлгісімен салыстырғанда маңызды аминқышқылдарының орташа саны өсті, мысалы: лизин – 1,5 есе; фенилаланин – 1,25 есе; лейцин және изолейцин – 0,8 есе; метионин – 1,5 есе, треонин – 3 есе. Осылайша, зерттеу нәтижесінде жақсартылған макронутриентті құрамы бар өсімдік негізіндегі диеталық вафли жасалды, функционалды өнімдердің ассортиментін кеңейтуге қабілетті және диеталық тамақтану үшін ұсынылуы мүмкін.

Негізгі сөздер: жұмсақ вафли, бұршақ протеинінің изоляты, цикорий шәрбаты, алма талшығы, тағамдық құндылығы, макронутриент құрамы.

Introduction

The relevance of the chosen topic is due to the fact, that the market of flour confectionery is rapidly developing, manufacturers are beginning to engage modern technologies and innovative ingredients, and recently the consumer prefers healthier foods. On this basis, the real scientific work is carried out with the aim of expanding the range of functional flour confectionery products characteristic of present.

Currently, the most negative impact on an organism is caused by incorrect eating behavior of people and low physical activity. Excessive intake of high-calorie foods containing a large amount of easily digestible carbohydrates, negatively impacts the human body and causes violations of carbohydrates and lipids exchanges, the development of obesity, diabetes, cardiovascular and other diseases [1].

According to the FAO and WHO guidelines for healthy diets, fat consumption should not exceed 30 percent of the total diet, protein should not be less than 20 per cent, and free sugar should be between 25 and 50 grams per day. Also, about 30 grams of fiber should be included in the daily diet, increasing the consumption of vegetables, whole grains and pulses [2]. The FAO recommendations for protein quality assessment in the human nutrition state that the amount of protein in adult diets (>18 years) should be at least 0.66 g per 1 kg of body weight. However, according to recent data, average protein consumption per capita has been declining in recent years [3, 4].

Thus, in order to improve people's health, the main task of the flour confectionery industry is to create a functional, dietary product with improved macronutrient composition. Specifically, reduces fats and simple sugars, while increasing protein, essential amino acids and dietary fiber. In this regard, the pertinence and importance of this study is confirmed.

Due to the factor of relative novelty, as enriched flour confectionery was taken a nice kind of soft waffle, also called «Belgian». According to GOST 14031-2014, soft waffles are baked flour confectionery based on flour, sugar and fat, with a flour content of at least 50%, a moisture mass fraction of not more than 20%, a mass fraction of total sugar not more than 40%, a mass fraction of fat not more than 25% [6].

This article describes the reason for the introduction in recipe such components as: the isolate pea protein, apple fiber and chicory root syrup, each of the ingredients has its own benefit.

The aim of the work is to study the influence of pea isolate and apple fiber on increasing the nutritional and biological value of soft waffles.

In order to achieve the objective of the study, the following objectives are set: to study the impact of plant based additives on the change of the nutritional value of soft waffles; carrying out a comparative analysis of the amino acid and carbohydrate composition to study the influence of plant ingredients on the biological value of products.

Methodology

To produce waffles, the following raw materials are used:

apple fiber according to GOST 27572-2017 TC 10.89.19-040-83387545-2017 «Fiber»

rice flour according to TC 10.61.23-032-83387545-2017 «Flour packed. Technical conditions»- isolate pea protein TC 10.89.19-002-0200216635-2020;

skim milk powder according to GOST 33629-2015

chicory syrup according to GOST 28499-2014

eggs according to GOST R 57901-2

FitParad №10 according to TC 10.86.10-017-83387545-2017 «Complex food additive: a mixture of sweeteners»

salt according to GOST R 51574-2018

baking powder according to GOST 6829-2015

vanillin according to GOST 16599-71

The working hypothesis of the study assumed that the introduction of components such as the isolate pea protein and apple fiber into soft wafers would increase their nutritional and biological value.

The study consisted of following main processes: selection of raw materials, compilation and optimization of recipes, the selection of technological parameters, adjustment of the formulation and technological parameters, the study of the physical-chemical properties of the finished product.

Sampling was carried out by aa quartering method in accordance with GOST 5904-2019 “Confectionery products. Acceptance Rules and Sampling Methods”.

Organoleptic indicators were determined by the sensory method at the tasting room of Almaty Technological University. We studied the nutritional and biological value of waffles at the certified testing laboratory “Food Safety” of the Almaty Technological University.

The mass fraction of protein was determined by the Kjeldahl method according to GOST 10846-91 and carbohydrates by the permangometric method according to GOST 5903-89. Studies of fats and fiber were determined in accordance with GOST 29033-91 "Wend's Method". Determination of proteinogenic amino acids was carried out by capillary electrophoresis according to GOST R 55569-2013 (on the device Kapel-105M). The carbohydrate composition was determined according to GOST 31745-2012 by the method of high-performance liquid chromatography (on the device Agilent-1200).

Literature review

The authors [7] have developed a recipe and a method for baking a variety of flour confectionery products based on vegetable proteins of pea, bean and soy flour, in an amount of 2-4% by weight. As a stabilizer, to normalize the work of the gastrointestinal tract, to reduce the level of cholesterol in the blood, pectin dietary fibers, citrus fibers were used at a ratio of 1-2 wt. % Excess sugar content is solved by using sweeteners instead of sucrose: stevioside, sucralose, oligofructose and jerusalem artichoke syrup. [7].

During the literary review, the importance of leguminous crops, in particular peas, was proved [8]. Chemical composition of peas: protein (20-25%), fat (1.5–2.0%), carbohydrates (24-49%), dietary fiber (60-65%). The most important mineral element present in peas is potassium (1.04%), phosphorus (0.39%), magnesium (0.10%) and calcium (0.08%). In addition, they are also a good source of water-soluble vitamins, especially rich in vitamins of group B. There are also essential amino acids with a high content of lysine and threonine.

The choice of these ingredients made it possible to obtain a dietary product containing all the substances necessary for the body, and at the same time having good organoleptic properties and increased nutritional value.

Researchers [9] have developed a method for making waffles, in which buckwheat flour was used as an unconventional type of flour, mixed with wheat. And also, yolks – as a binder, margarine – a fat filler, stevioside – as a sugar substitute and two types of dietary fiber for enrichment: citrus and beetroot.

In study [10], the authors set a goal to diversify the line of "street food", and developed useful Hong Kong waffles on wheat flour, with the following amount of additives: 100% stevioside, 100% sea buckthorn oil and 15% Hi-Maize

resistant starch. This topic deserves special interest, since it is important not only to determine the enrichment strategy, but also what format the product itself should be. Street food has always been characterized by a fast and unbalanced meal, and due to the modern pace of life, it has firmly integrated into the everyday life of each of the people.

In a scientific article [11], the authors practiced the complete replacement of sugar-containing raw materials in wafers with fat filling with the sweetener maltitol. Scientists also solved the problem of protein deficiency in flour products by introducing vegetable raw materials - sunflower pomace. Strawberry powder was used to enrich the products with fiber and vitamins. The nutritional value was calculated and physico-chemical analyses were carried out to identify the amount of essential amino acids and vitamins, the data showed positive results and confirmed the effectiveness of the formulation. This product is recommended by the authors for inclusion in the diet of vegans and the elderly.

In the work of the authors [12], the necessary concentration (25-100%) of lupine flour in a flour confectionery was identified. Lupin is a plant of the legume family, has similar characteristics to peas, so the results of scientific work can be used in this study. The study showed that the introduction of legume flour significantly improved the mineral component of the finished product.

The aim of the study [13] was to develop gluten-free products (muffins, cookies and waffles) based on pumpkin flour (5-15%). Pumpkin flour is extremely nutritious and beneficial for human health. Based on the taste and physical properties, waffles containing 5% pumpkin flour were considered the most acceptable. Microstructural analysis of finished products showed that the addition of dietary fiber reduces porosity. But at the same time, the enriched muffins, cookies and waffles contained high levels of beta-carotene, total phenols and flavonoids, as well as improved nutritional qualities.

This work provides valuable information for scientists, and can serve as a starting point for the further development of flour products based on various vegetable powders and with the replacement of various types of flour with a gluten-free type. Which in turn will help diversify the segment of functional foods for school-age children, adults and patients with celiac disease.

Based on the experience of researchers [14], it can be argued that replacing sugar with chicory syrup does not worsen the organoleptic properties of flour products. On the contrary, it has been proven that the syrup gives a caramel taste, an attractive smell and a browner crust color. Chicory syrup was added in an amount of 7%, and increasing the dosage accordingly increased the hardness of the crumb and the rate of staling.

In one of the patents [15], these important structure-forming, functional properties were also proved. The foaming role of pea protein in the dough was revealed and the prospect of the production of protein confectionery, with the replacement of eggs with pea protein, was determined.

In the work of the authors [16], the functional properties of pea protein in flour products were studied. The addition of protein isolates of beans and peas in an amount of 10% increased the viscoelasticity of the dough and led to the production of cupcakes with qualitative characteristics (crust color, specific volume, elasticity, appearance and porosity). It has been confirmed that legume proteins have increased properties of gelation, emulsification, absorption of water and fat, which in turn has a positive effect on improving the quality of cupcakes.

The authors [17] patented a waffle recipe based on hemp and wheat flour, apple fibers, inulin, grape seed oil and whey powder. As a result, a product with anti-carcinogenic, antimicrobial, prebiotic and other effects was obtained. With this development, the daily portion of fiber was achieved with just one serving of waffles.

There is also a patented composition of soft wafers [18], based on a mixture of flavor filler – apple and orange fibers, a fat component – palm and linseed oils, stevioside – as a sweetener, as well as melange and wheat flour. This sample has proven itself with its excellent nutritional and biological properties.

Experiments were conducted [19] to replace the traditional type of flour in Belgian waffles with millet flour. Waffles were evaluated according to their qualitative characteristics and nutritional composition. Waffles containing 30% and 40% millet flour showed the highest acceptability in terms of taste qualities. The replacement of wheat flour with millet flour did not have any negative effect on the integrity of the crumb and the structure of the wafers. The use of millet in the formulation led to an increase in the total amount of dietary fiber, a decrease in the content of carbohydrates and caloric content of wafers, an increase in the content of minerals in all experimental wafers. The use

of millet can effectively improve the nutritional properties of wafers.

An invention is known [20] relating to the field of food industry, in particular to the method of preparing soft wafers. As raw materials for the preparation of waffles are used: flour with a high content of gluten, melange, sweetener – xylitol, safflower oil, konnyaku flour (plant) and sorghum extract. The resulting Belgian waffles solve the technical problem of creating a product with less sugar and more value for health.

The aim of the study [21] was to develop a recipe for gluten-free waffles with special grade rice flour and wheat flour. Sugar was replaced in the recipe with palm sugar and maltitol. The results showed that replacing sugar by 50% (by weight of the total amount of sugar) with palm sugar and 50% maltitol was the most acceptable recipe, which received the highest acceptability ratings in terms of texture. Thus, such waffles can be used as an alternative gluten-free product for celiac patients.

Based on the conducted literature review, it can be seen that the development of dietary flour confectionery products of functional orientation with the addition of raw materials of plant origin is relevant, deserves attention and further development.

Results and their discussion

The study compared the macronutrient composition of 3 types of soft waffles: control sample, sample №1, and sample №2.

The control sample contained sugar as well as rice flour, corn starch, eggs, kefir, baking powder, vanilla and salt.

Enriched specimens are based on the following identical ingredients: dry skim milk powder, pea protein isolate, rice and wheat flour, apple fiber, sweetener «FitParad 10», chicory root syrup, eggs, kefir, baking powder, vanilla and salt. The difference between the samples is that sample №1 contains only rice flour and sample №2 contains a mixture of rice and wheat whole grain flour.

The study resulted in a physico-chemical analysis, in accordance with standard methods, the results of which are presented in table 1.

Table 1 – Nutritional and energy value of waffles

Indicatorname	Control sample	Sample №1	Sample №2
Mass fraction of protein, %	7,03±0,25	10,32±0,52	12,64±0,45
Mass fraction of fat, %	3,04±0,02	2,15±0,03	2,86±0,04
Mass fraction of digestible carbohydrates (%):	40,54±0,41	36,13±0,73	42,20±0,82
- mass fraction of sucrose, %	3,21±0,005	0,60±0,005	0,91±0,005
- mass fraction of maltose, %	0,81±0,005	1,31±0,005	0,85±0,005
- mass fraction of glucose, %	1,26±0,01	1,34±0,02	1,08±0,01
- mass fraction of fructose, %	0,52±0,002	2,14±0,01	1,23±0,01
Mass fraction of dietary fiber, (%):	0,13±0,001	3,64±0,05	2,98±0,04
Mass fraction of moisture, %	24	32	36
Energy value, kcal/kj per 100 g	218	205	244

Thus, the protein content in waffles №1 increased by 3.3%, in sample №2 by 2.6% in comparison with the control sample.

The control sample contains mostly no dietary fiber, like many other flour confectionery products with traditional recipes. In enriched products, on the other hand, its extremely high content, on average, 3-4 times higher.

Table 1 also suggests that enriched waffles contain almost no sucrose but mainly fructose. This is explained by the use of sweeteners such as chicory syrup and composite mix "Fitparad №10" will reduce the amount of simple sugars included in the recipe and the calorie content of the product.

Fructose is a monosaccharide of natural origin with a low glycemic index. At the same time, fructose is 1.5-1.7 times sweeter than sucrose [1].

In addition to fructose, the composition of the waffles contains fiber, which improves the condition of the intestine microflora and maintains a stable level of glucose in the blood, which prevents many diseases.

Figure 1 illustrates the visual ratio of macronutrients in control and enriched samples.

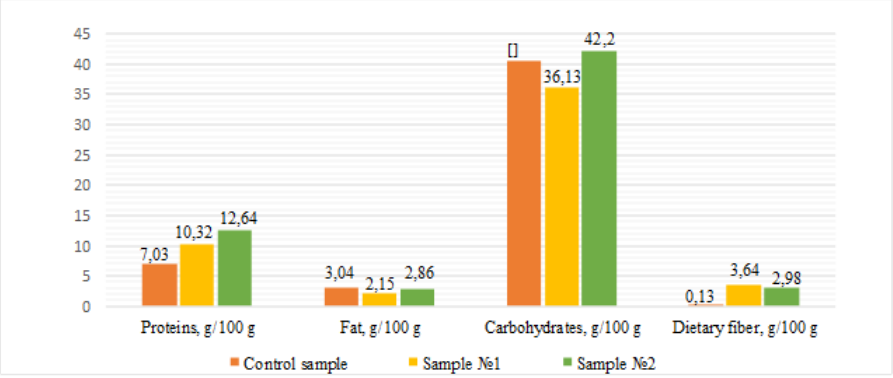

Figure 1 – Comparison chart of macronutrient and fiber content

The quality of the protein composition is also indicated by the amino acid composition shown in Figure 2.

The analyses show that experimental samples №1 and №2 lead all physico-chemical indicators, especially with amino acids phenylalanine, threonine, leucine and isoleucine reaching the highest levels.

In comparison with the control sample, increase the average number of such amino acids as: lysine – in 1.5 times; phenylalanine – in 1.25 times; leucine and isoleucine– in 0.8 times; methionine – in 1.5 times, threonine – in 3 times.

Phenylalanine is responsible for the transmission of nerve impulses, threonine for the growth and formation of tissues, leucine for normal blood sugar levels and stimulates growth hormone, isoleucine - supports nitrogen balance [5].

These amino acids in the final product will contribute to improving immunity and will act against the adverse effects of certain toxins, since their properties and interaction in the body have been proven by many authors [22, 23].

Thus, the efficiency of using as enriching macronutrient waffle composition, the following alternative raw materials: rice and whole wheat flour, pea protein isolate, chicory syrup and apple fibres has been proved.

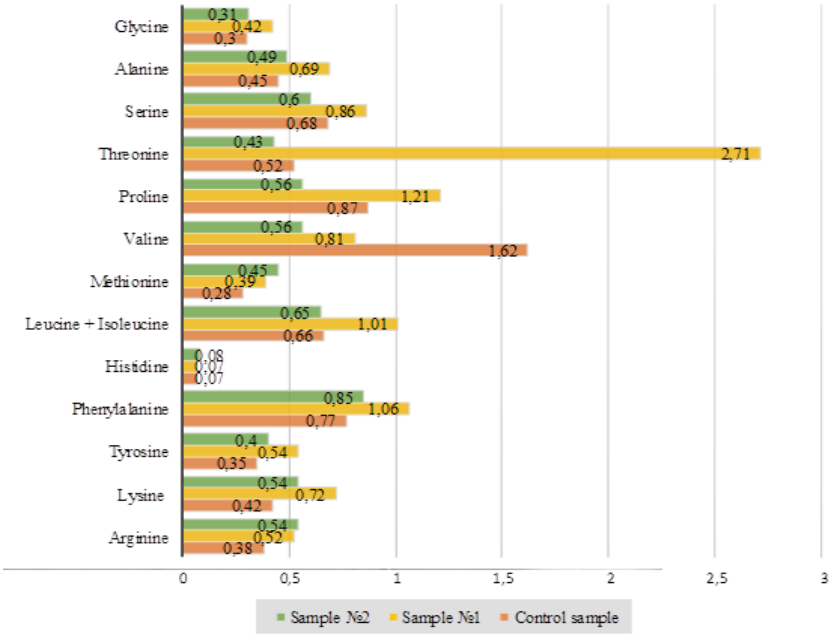

Figure 2 – Comparison chart of amino acids content

Conclusions

As a result, studies were carried out on the influence of pea isolate and apple fiber on increasing the nutritional and biological value of soft waffles.

The introduction of pea protein, chicory root syrup and apple fiber into the composition of flour and confectionery products increases the protein content of the control sample by 3.3% in waffles made of rice flour only and by 5.6% in waffles made of whole grains and rice flour. The amount of sucrose decreased in «Rice» wafers by 2.6% and by 2.3% in «Wheat-rice» waffles, and the amount of fiber on average is 3-4 times more, compared to the control sample.

The data on amino acid composition of soft waffles, showing a significant increase of essential amino acids, especially methionine and lysine, are on average 1.5 times higher than the reference sample without herbal enrichment additives.

The results of the research show that the nutritional and biological value of soft waffles has increased due to such enriching plant additives as the isolate of pea protein and apple fiber. The use of chicory syrup as a sweetener gives the product dietary and prebiotic properties.

In this regard, the use of technology for the production of dietary soft wafers with enriching herbal supplements will expand the range of dietary flour confectionery products with a functional focus.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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