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CHARACTERISTICS AND COMPOSITION OF FRACTIONAL PRODUCTS FROM PUMPKIN SEEDS

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Annotation

The analysis of scientific and technical information on the determination of the chemical composition of pumpkin seeds fractional products is carried out. Recommendations on the use of pumpkin seeds fractional products in food products are given. A set of methods for determining the quality of pumpkin seeds and its fractional products is substantiated. The technological scheme of complex processing of pumpkin seeds is developed, the main elements of which are pressing of seeds and fractionation of crushed cake. Target products were obtained in the amount of: oil – 34 %, flour – 5 %, protein powder – 15 %, fiber – 46 %. The energy and biological value of the obtained fractions is calculated. The fatty acid composition of pumpkin oil and its ratio of fatty acids SFA : PUFA : MUFA = 10:38:42, indicating the feasibility of recommending pumpkin oil as a source of mono- and polyunsaturated fatty acids, are determined. The amino acid composition of protein powder is established, the content of all essential amino acids is proved, which characterizes its high biological value. According to the results of toxicological and microbiological tests of laboratory samples of pumpkin seeds fractional products, a high level of safety of these products has been established. Organoleptic and physico-chemical quality parameters of the obtained samples are determined, which meet the established norms for the analogous products and also testify to the high quality of the food products made by the suggested method. It is recommended to use the obtained products as independent in the diet of people and farm livestock or as supplements of traditional dishes or foodstuffs to enrich the nutrients and essential substances of human diets and foodstuffs for poultry, fish and domestic animals.

Keywords: pumpkin seed fractions; pumpkin oil; pumpkin seed flour; pumpkin seed protein powder; cellulose; functional products.

ХАРАКТЕРИСТИКА І СКЛАД ФРАКЦІЙНИХ ПРОДУКТІВ З НАСІННЯ ГАРБУЗА

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Анотація

Проведено аналіз науково-технічної інформації щодо питань визначення хімічного складу фракційних продуктів з насіння гарбуза. Наведено рекомендації з використання фракційних продуктів з насіння гарбуза у складі харчової продукції. Обґрунтовано комплекс методик з визначення якості насіння гарбуза та його фракційних продуктів. Розроблено технологічну схему комплексної переробки насіння гарбуза, основними елементами якої є пресування насіння та фракціонування подрібненої макухи. Одержано цільові продукти у кількості: олія – 34 %, борошно – 5 %, протеїновий порошок – 15 %, клітковина – 46 %. Розраховано енергетичну та біологічну цінність одержаних фракцій. Визначено: жирнокислотний склад гарбузової олії, співвідношення жирних кислот у якій складає НЖК : ПНЖК : МНЖК = 10 : 38 : 42, що свідчить про доцільність рекомендувати гарбузову олію як джерело моно- та поліненасичених жирних кислот. Встановлено амінокислотний склад протеїнового порошку, доведено вміст усіх незамінних амінокислот, що характеризує його високу біологічну цінність. За результатами токсикологічних та мікробіологічних випробувань лабораторних зразків фракційних продуктів з насіння гарбуза встановлено високий рівень безпечності даних продуктів. Визначено органолептичні і фізико-хімічні показники якості одержаних зразків, які відповідають встановленим нормам для аналогової продукції і також свідчать про високу якість харчової продукції, яка виготовлена запропонованим способом.

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Одержані продукти рекомендовано вживати як самостійні продукти в раціоні людини або тварин фермерських чи приватних господарств, або в якості доповнювачів традиційних страв, або харчових продуктів для збагачення на корисні та ессенціальні речовини раціонів харчування людей та комбікормів для птаха, риби і домашніх тварин.
Ключові слова: фракції насіння гарбуза; гарбузова олія; борошно насіння гарбуза; протеїновий порошок з насіння гарбуза; клітковина; функціональній продукти.

ХАРАКТЕРИСТИКА И СОСТАВ ФРАКЦИОННЫХ ПРОДУКТОВ ИЗ СЕМЯН ТЫКВЫ

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Аннотация

Проведен анализ научно-технической информации по вопросам определения химического состава фракционных продуктов из семян тыквы. Приведены рекомендации по использованию фракционных продуктов из семян тыквы в составе пищевой продукции. Обоснован комплекс методик определения качества семян тыквы и ее фракционных продуктов. Разработана технологическая схема комплексной переработки семян тыквы, основными элементами которой являются прессование семян и фракционирование измельченного жмыха. Получены целевые продукты в количестве: масло – 34 %, мука – 5 %, протеиновый порошок – 15 %, клетчатка – 46 %. Рассчитана энергетическая и биологическая ценность полученных фракций. Определено: жирнокислотный состав тыквенного масла, соотношение жирных кислот в котором составляет НЖК : ПНЖК : МНЖК = 10 : 38 : 42, что свидетельствует о целесообразности рекомендовать тыквенное масло как источник моно- и полиненасыщенных жирных кислот. Установлен аминокислотный состав протеинового порошка, доказано содержание всех незаменимых аминокислот, что характеризует его высокую биологическую ценность. По результатам токсикологических и микробиологических испытаний лабораторных образцов фракционных продуктов из семян тыквы установлен высокий уровень безопасности данных продуктов. Определены органолептические и физико-химические показатели качества полученных образцов, которые соответствуют установленным нормам для аналоговой продукции и свидетельствуют о высоком качестве пищевой продукции, изготовленной предложенным способом. Полученные продукты рекомендуется употреблять в качестве самостоятельных продуктов в рационе человека или животных фермерских, или частных хозяйств, или в качестве дополнителей традиционных блюд или пищевых продуктов для обогащения полезных и эссенциальных веществ рационов питания людей и комбикормов для птицы, рыбы и домашних животных.
Ключевые слова: фракции семян тыквы; тыквенное масло; мука из семян тыквы; протеиновый порошок из семян тыквы; клетчатка; функциональные продукты.

Introduction

Diseases caused by a deficiency of nutrients pose a threat to many countries of the world. First of all, this concerns the population of developing countries, then developed countries are next in line, because due to oxidative stress, most substances are poorly absorbed. In addition to people, pets, fish and poultry on farms also suffer from a lack of nutrients, and their processed products (semi-finished products of varying degrees of readiness) and livestock (eggs, milk, caviar) are of poor quality. Given the inadequate nutrition of animals, meat and animal products cannot meet the nutritional needs of humans. Thus, the food chain seems to be implemented, but in terms of quality it does not meet the standards of rational and / or proper nutrition. Due to the deficiency of vitamins, minerals, protein-carbohydrate deficiency, the number of chronic diseases of the majority of the able-bodied population is growing, diseases of the immune system occur, and this entails complete or partial disability. In addition, poor environmental friendliness of the regions (pollution of the environment with harmful substances) and a change in the lifestyle of the population from active to sedentary and increased stress activity are observed in Ukraine.

Reconsidering the dynamic development of environmental management and the introduction of "green" technologies into production, it became known that the processing of agricultural products should be aimed at maximizing the storage of useful substances from all edible parts. This applies not only to animal husbandry, but also to crop production.

Therefore, industry scientists face a difficult task to develop high-quality traditional products with a certain chemical composition and good physiological and technological properties for sale to the population. It is believed that such products should be affordable and palatable for the majority of the population; should complement the basic diets of all groups; should have a scientifically based composition and experimentally confirmed properties, and this, above all, is the preservation and improvement of health.

Pumpkin is an annual plant. Pumpkin seeds make up 0.75 % to 5.0 % by weight of the fruit. The shape of the seeds is round and flattened. The shell consists of two parts: the outer one is woody, yellowish-white in color, which is easily separated, and the inner one is membranous, greenish-gray in color, tightly adjacent to the embryo. Biological value and medicinal properties have the kernel and its inner shell and the husk of pumpkin seeds . There are varieties of pumpkin, the seeds of which are not covered with a hard shell, and such species belong to gymnosperms [1].

Pumpkin – a berry that is gaining popularity in any country of cultivation (China 7.8 million tons / year; India 5.1 million tons / year; Russia 1.3 million tons / year; USA 1 million tons / year; Mexico, Indonesia, Italy, Cuba, Turkey, Spain, Egypt, South Africa – 0.4–0.65 million tons / year). Ukraine ranks 4th on the list – 1.2 million tons / year [2]. Therefore, for Ukrainians, pumpkin is one of the "superfoods" - a source of functional and useful ingredients; a product that is part of many dishes of national cuisine [1]. To improve health, doctors and nutritionists recommend consuming not only pumpkin pulp, but also seeds, both in native form [3] and in the form of fractional products: oil [4], meal, protein powders (isolates, hydrolysates). protein [5]), flour [5], pumpkin fiber. These products have become interesting for research, because they attract consumers with taste, texture, or aftertaste, which is provided by food products made by traditional technologies and to which they are added as functional ingredients. To emphasize the relevance and necessity of the research, the authors' data were used [7], which proved to improve the quality and increase the physiological value of meat, milk, eggs of animals and birds fed pumpkin waste.

Scientists [8; 9] studied the chemical composition of seeds of some pumpkin varieties grown in Ukraine and considered to be the best by taste and agro-technological properties (Table 1).

Table 1

Chemical composition of seeds of some of the best varieties of pumpkin grown in Ukraine

Name of indicator	«Stolovyy zimhiy»	«Vitaminnyy»	«Holonasinnyy»
Moisture,%	6.36	6.45	6.82
Protein,%	31.36	34.03	35.26
Lipids,%	28.42	29.19	31.79
Carbohydrates,%, including	30.82	26.19	21.39
cellulose	17.25	19.82	4.22
soluble sugar	13.57	6.37	17.17
Minerals,%	3.04	4.14	4.74
Mass fraction of protein fractions,%			
Albumins	25.2	25.5	27.2
Globulins	42.8	46.5	48.3
Glutelins	21.8	19.3	19.9
Insoluble proteins	10.2	8.7	4.6
Vitamins, mg/100 g			
Pyridoxine (B6)	0.71	0.76	0.78
Riboflavin (B2)	0.34	0.32	0.36
Thiamine (B1)	0.22	0.23	0.24
α-tocopherol	26.72	27.44	29.88
β-carotene	3.94	4.05	4.49
Macroelements, mg/100g			
Potassium	536.74	675.95	924.15
Calcium	289.44	346.98	380.48
Magnesium	345.34	350.78	507.64
Sodium	14.96	14.21	16.03
Phosphorus	1388.26	1946.65	2292.15
Microelements, mcg / 100g			
Iron	6210	6540	8220
Manganese	2730	3120	3740
Copper	960	980	1460
Zinc	6540	6980	8330

The data in Table 1 show that pumpkin seeds are indeed a valuable source of functional food ingredients: protein, lipids, fiber, vitamins and minerals. Similar data and proven benefits of pumpkin seed consumption have been obtained

in other countries (Chao, Tian 2022; Amin, Rity et al. 2020; Saleh et al, 2019; Veronezi, Jorge, 2012).

According to pharmacologists [10; 11], pumpkin seeds are biologically active supplements, the use of which reduces the risk of inflammatory processes and gastrointestinal ulcers.

Ukrainian and foreign scientists are studying the use of new raw materials from pumpkin seeds in the technology of functional foods. Thus, Indonesian scientists have developed a recipe for spaghetti with a content of pumpkin seed flour – 54 % [12]; Indian researchers have proposed the use of flour as a protein supplement in bread and cookies [13]; Poltava University of Economics and Trade has developed a recipe for cakes from substituting 20 % of wheat flour for pumpkin seed flour [14]; to stabilize the quality of bread by Korshenko LO the composition of a baking improver using pumpkin flour was created and described [15].

Bachynska Ya. proposed the use of pumpkin seed meal in the amount of 2.76 % by weight of wheat flour for the production of sugar cookies in order to expand the range of confectionery products of high biological value and low-calorie products [16]. Confectionery in Lviv was enriched with powder from dried pumpkin softness [17].

Scientists of the National Academy of Agrarian Sciences of Ukraine [18] developed a recipe for cooked sausages with the addition of fatty oil from pumpkin seeds as a natural component in multifunctional compositions that increase the stability of the product during storage and increase its shelf life by 2–3 days; believe that the antioxidant and antibacterial action of the oil provide tocopherols, carotenoids, phospholipids, vitamins that are part of it.

In the absence of the required amount of dietary fiber in foods, including chips, scientists at the National University of Food Technology, improved the recipe for molded potato chips using pumpkin seed cake for people suffering from gastrointestinal diseases and needing low-calorie foods [19].

Fractional pumpkin products do not contain gluten, which allows them to be consumed by patients with gluten enteropathy and diabetes [20; 21]. The prevalence of gluten enteropathy among adults in most countries is 1 : 100–1 : 300, among children: in Europe 1 : 184, in Russia 1 : 1000 [22]. There are almost no official statistics in Ukraine, but doctors say that there is a steady trend of increasing the number of children with celiac disease [23]. Therefore, the need for gluten-free products is quite high.

The analysis of scientific literature and patent information shows that the chemical composition of pumpkin seed products is not sufficiently studied, so we conducted a set of studies to determine the quality of pumpkin seeds of domestic varieties.

Methods of experimental research

Determination of the amount of protein was carried out in accordance with DSTU ISO 5983: 2003 "Animal feed. Determination of nitrogen content and calculation of crude protein content by the Kjeldahl method".

Determination of the amount of fat was carried out in accordance with DSTU ISO 6492: 2003 "Animal feed. Determination of crude fat content by organic solvent extraction".

Determination of the amount of fiber was carried out in accordance with DSTU ISO 6865: 2004 "Animal feed. Determination of crude fiber content by the method of intermediate filtration".

The mass fraction of carbohydrates is determined by the calculation method.

The energy value of food is determined by the calculation method.

The fatty acid composition of pumpkin seed oil is determined in accordance with GOST 30418-96 "Vegetable oils. Method for determining the fatty acid composition". The solution of methyl esters of fatty acids was used for chromatographic analysis according to DSTU ISO 5508-2001 "Animal and vegetable fats and oils. Analysis by gas chromatography of methyl esters of fatty acids (ISO 5508: 1990, IDT)". Detection of fatty acids was performed on a gas chromatograph "Agilent 7890" made in the USA. Identification of fatty acids was performed by comparing their retention time with known samples. The content of fatty acids is calculated as a percentage of their total amount. Chromatograms were recorded and processed using HP ChemStation software.

The content of vitamin E in pumpkin oil is determined in accordance with DSTU EN 12822: 2005 "Food products. Determination of vitamin E content by high performance liquid chromatography "α", "β"-, "γ"- and "δ"-tocopherols".

The content of vitamin A in pumpkin oil is determined in accordance with DSTU EN 12823-2: 2006 "Food products. Determination of

vitamin A content by high performance liquid chromatography. Part 2. Determination of β-carotene content".

The quantitative amino acid composition of pumpkin seed protein was determined by ion-exchange liquid column chromatography on an automatic amino acid analyzer T 339 (Czech Republic). For the separation of amino acids used fine-grained cation exchangers (resins), which are a copolymer of styrene and divinylbenzene spherical shape with a functional group -SO3-. The method of hydrolysis with hydrochloric acid was used to prepare the samples. To separate the amino acid mixture on the column, the cation exchanger is pre-equilibrated with a lithium citrate buffer solution.

To calculate the number of amino acids in the test sample, a standard mixture of amino acids with a known concentration of each amino acid was previously applied to the column of the automatic amino acid analyzer. The peak area of each amino acid was calculated on the chromatogram.

Determination of mycotoxins and pesticides in protein powder from pumpkin seeds was carried out in accordance with GOST 28001-88 "Grain feed and products of its processing, feed. Methods for determination of mycotoxins: T-2 toxin, zearalenone (F-2) and ochratoxin A (Grain for feed, products of its processing, feed. Methods for determination of mycotoxins: T-2 toxin, zearalenone (F-2) and ochratoxin A)"; DSTU ISO 6651: 2003 Animal feed. Determination of aflatoxin B1 content.

The content of organochlorine pesticides (γ-HCCH, 4.4' DDE, 4.4' DDD, 4.4' DDT) was determined according to GOST 13496.20-2014 "Interstate standard for feed, compound feed, compound feed raw materials. method for determining the final quantities of pesticides".

The determination of the number of bacteria of the group of Escherichia coli was carried out in accordance with DSTU 7469:2013 "Fodder flour of animal origin. Methods of bacteriological analysis".

Determination of the number of pathogenic microorganisms, including Salmonella according to DSTU EN 12824:2004 "Microbiology of food and animal feed. Horizontal method for the detection of Salmonella (EN 12824:1997, IDT)".

Determination of the amount of molds and yeast fungi was carried out by DSTU ISO 7954:2006 "Microbiology of food and animal feed. General instructions for counting yeasts and microscopic fungi. Technique for counting colonies cultured at 25 °C".

Determination of color, smell, taste of flour, fiber, protein powder from pumpkin seeds was carried out organoleptically according to GOST 27558-87 "Flour and bran. Methods for determining color, smell, taste and crunch".

Determination of transparency, color, smell, taste of pumpkin seed oil was carried out organoleptically according to GOST 5472-50 "Oils. Determination of smell, color and transparency".

The mass fraction of moisture and volatile substances in flour, fiber, protein powder from pumpkin seeds was determined according to DSTU 7621:2014 "Products of vegetable protein origin. Cakes and meal. Method for determination of moisture content and volatile substances".

The mass fraction of fat in flour, fiber, protein powder from pumpkin seeds was determined according to DSTU 7458:2013 "Plant protein products. Cakes and meal. Method for determination of fat content".

Determination of acid number (AN) in flour, fiber, protein powder from pumpkin seeds was carried out according to DSTU 4350:2004 "Oils. Methods for determining the acid number.

The content of crude protein in flour, fiber, protein powder from pumpkin seeds was determined according to DSTU ISO 5983:2003 "Animal feed. Determination of nitrogen content and calculation of crude protein content by the Keldahl method".

The content of crude ash in flour, fiber, protein powder from pumpkin seeds was determined according to DSTU ISO 5984:2004 "Animal feed. Determination of raw ash content".

The content of crude fiber in flour, fiber, protein powder from pumpkin seeds was determined according to DSTU ISO 6865:2004 "Animal feed. Determination of crude fiber content by intermediate filtration method".

Purity, pest infestation of flour, fiber, protein powder from pumpkin seeds was determined according to DSTU 4138-2002 "Seeds of agricultural crops. Methods for determining quality". Acid number was determined according to DSTU 4570:2006 "Vegetable fats and vegetable oils. Method for determining the acid number". The peroxide value of the oil was determined by DSTU 4570:2006 "Vegetable fats and oils. Method for determining the peroxide number". Determination of phosphorus-containing substances – according to DSTU 7082:2009 "Oils. Methods for determining the mass fraction of phosphorus-containing substances". Determi-

nation of the mass fraction of non-fat impurities – according to DSTU ISO 663-2003 "Animal and vegetable fats and oils. Determination of the content of insoluble impurities (ISO 663:2000, IDT)". Determination of the mass fraction of moisture and volatile substances according to DSTU 4603:2006 "Oils. Methods for determining the mass fraction of moisture and volatile substances". Determination of anisidine number according to DSTU ISO 6885-2002 Animal and vegetable fats and oils. Determination of the anisidine number. Determination of iodine number according to DSTU ISO 3961:2004 "Animal and vegetable fats and oils. Determination of iodine number".

Results and discussion

The general technological scheme of obtaining fractional products from pumpkin seeds is shown in Fig. 1.

To obtain pumpkin seed oil, press the seeds on a press at a temperature not exceeding 50 ° C. A by-product of degreasing pumpkin seeds is cake, which is ground in a mill. The crushed cake is sifted on a vibrating screen, as a result of sieving fractions are obtained: flour, protein powder, fiber, which are different in size and chemical composition. After processing pumpkin seeds, the target products are obtained in the amount of: oil – 34 %, flour – 5 %, protein powder – 15 %, fiber – 46 %.

To assess the quality of fractional products of pumpkin seed processing, it is necessary to conduct the following studies.

Determining the amount of proteins, fats, carbohydrates, fiber, caloric content of fractional products from pumpkin seeds. The data are given in Table 2.

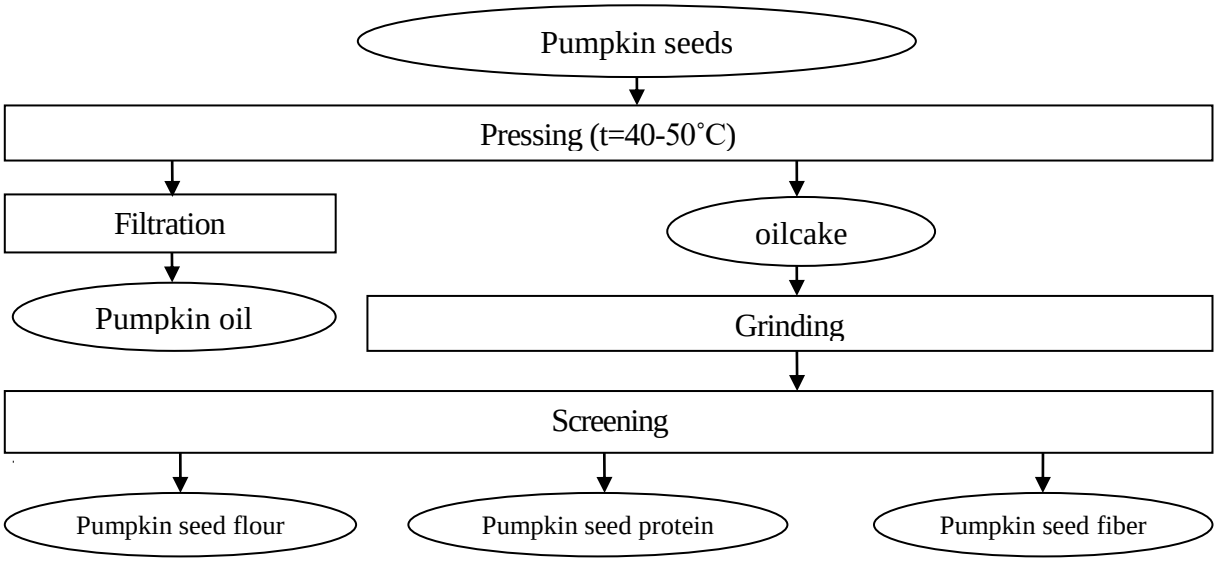

Fig. 1. General technological scheme of pumpkin seed processing

Table 2

Харчова та енергетична цінність фракційних продуктів гарбузового насіння

Quality indicator	in 100 g of product			
	oil	protein powder	flour	cellulose
Energy value, kJ / kcal	3747/896	1555/372	1396/334	1338/320
Proteins, g	0	61÷63	39÷40	44÷46
Carbohydrates, g	0	11÷12	19÷21	15÷16
Fats, g	99.5÷99.6	7÷8	9÷10	7÷8
Fiber, g	0	9÷10	12÷13	30÷32

Table 2 shows that:

- the main content of oil are fats, which were analyzed for fatty acid composition, which is presented in Table 3;

- protein powder in the predominant amount contains proteins, in which the amino acid composition and pesticide content were determined, which are presented in Table 5 and Table 6;

- flour contains a significant amount of vegetable protein and a relatively low amount of

fiber, which allows you to use it to enrich vegetable protein bakery products;

- fiber is mainly represented by proteins and fiber, which makes it a unique supplement in a healthy diet.

Fatty acid and vitamin composition of pumpkin oil was studied by chromatography of samples. The results are given in Tables 3 and 4.

Table 3

Жирнокислотний склад олії гарбузової

Fatty acids	in 100 g of product
Saturated (SFA), g	< 10
Monounsaturated (MUFA), g	37.0 – 38,0
Polyunsaturated (PUFA), g	41.0 – 42.0

Table 3 shows that the ratio of fatty acids is SFA : PUFA : MUFA = 10 : 38 : 42. According to researchers, the optimal ratio of fatty acids in the daily diet is 20 : 55 : 25 [24], according to WHO experts, the recommended rational fat component in equal amounts of fatty acids, namely: SFA : PUFA : MUFA = 1 : 1 : 1 [25]. The human diet is mostly saturated with saturated fatty acids, which leads to cardiovascular disease, so it is important to consume pumpkin oil, rich in fatty acids MUFA and PUFA.

Table 4

The composition of fat-soluble vitamins in pumpkin oil

Name	in 100 g of product	daily requirement of the human body, mg / day
Vitamin E, mg	15.0 – 16.0	12.0 – 15.0
Vitamin A, mg	1.2 – 1.3	0.9 – 1.0

The vitamin composition of the oil contains a sufficient amount of vitamins E and A, which is equivalent to the recommended daily allowance of specialists [26] if a person consumes 100 g / day of oil. Of course, this is a large portion for daily consumption, but it is known that these vitamins a person receives from other foods and increased content in the diet of pumpkin oil is possible only in conditions of malnutrition.

In the laboratory, the shelf life of pumpkin seed oil extracted by the above method is set. Shelf life is 7 months under conditions of storage in a container that does not transmit sunlight in rooms at a temperature not exceeding +20 °C; after opening, it is recommended to use the product for 30 days if stored at a temperature of 0–8 °C. These data need to be clarified in terms of improving the extraction method and packaging conditions, as there are analogues that allow to obtain a product with longer shelf life and storage conditions that do not require cooling after opening the packaging unit, but involve more specialized equipment.

The amino acid composition of protein powder obtained by fine grinding of low-fat pumpkin seeds was established. Data from chromatographic examination of samples are presented in Table 5 together with a comparison with the "ideal" protein.

Table 5

Amino acid composition of protein powder from low-fat pumpkin seeds

Name	Amino acid content, g / kg in protein powder	Amino acid content, g / kg of "ideal protein" (FAO / WHO standard)
essential amino acids		
Valine	25.77	50
Isoleucine	9.98	40
Leucine	37.59	70
Lysine	14.29	55
Methionine	6.77	35
Threonine	31.01	40
Phenylalanine + Tyrosine	42.23	60
Tryptophan	*11.0	10
Replaceable:		
Alanine	16.60	-
Arginine	50.98	-
Aspartic acid	24.94	-
Histidine	4.64	-
Glycine	39.13	-
Glutamic acid	66.78	-
Proline	31.00	-
Serine	14.36	-

*it is impossible to analyze the content of tryptophan in Ukraine in the absence of equipment; according to literature sources, the content of tryptophan in pumpkin seeds is known [27]

The International Organization for Nutrition and Agriculture at the UN (FAO / WHO) has established the composition of amino acids in 100 g of "ideal" protein. According to the FAO/WHO methodology, the biological value of food proteins is determined by a method based on comparing the amino acid composition of the protein under study with the composition of the ideal protein [28].

The data presented in Table 5 indicate that the protein powder from pumpkin seeds contains the entire complex of amino acids, including essential ones, characterizing its high biological value, but in a smaller amount of ~ 50 % compared to the "ideal" protein. This allows us to recommend the consumption of protein powder from pumpkin seeds in its pure form (dry drinks, cocktails), as a component in salads, dressings in salads, components of sauces for desserts and sweet dishes, replacement of flour for bread, bakery, flour confectionery and culinary products, as well as an ingredient in meat, vegetable, fish fillings, cream soups and puree soups, pastes, including legumes.

The proposed methods for enriching classic dishes and food products will improve the diets of those, who actively consume plant foods or suffer from a number of diseases, in which it is necessary to limit the amount of consumption of animal proteins.

Table 6

The content of mycotoxins in protein powder from pumpkin seeds

Name	Actual value, mg / kg	Norm, mg / kg
Zearalenone	not found	0.5
Aflatoxin B1	0.002	0.01
γ-HCCH	not found	0.5
Heptachlor	not found	not allowed
4.4 'DDE	not found	0.05
4.4 'DDD	not found	0.05
4.4 'DDT	not found	0.05
Dichlorphos	not found	0.02
Metaphos	not found	0.5

Pumpkin seed protein powder is one of the best adaptive foods for a plant-food transition.

The content of mycotoxins in protein powder from pumpkin seeds was determined, the data of which are presented in Table 6.

Based on the data in Table 6, we can see that the content of mycotoxins in the test sample meets the requirements of regulatory documents. And these data are important because they prove the safety of soils and methods of their preparation for growing pumpkins, that is, they emphasize the need to increase the yield in this particular area, which is a strategically important fact for the development of the outlined region. The agricultural technologies used prove the need to scale them up to obtain healthy food products.

Under laboratory conditions, the shelf life of protein powder from pumpkin seeds has been established. It is 6 months when stored in dry, well-ventilated rooms, protected from sunlight at a temperature not exceeding 20...25 °C. The period of consumption after opening the package should not exceed 60...70 days when stored under the same conditions as the packaged unopened product. This became useful when choosing a packaging unit and its materials. It is recommended to pack the product in consumer containers or packaging: jars made of polymeric materials with a net weight of 500 to 1000 g with a screw-on lid and an insert made of materials that prevent the penetration of moisture from the air or sealed with a metallized film (aluminum foil); in paper bags weighing from 400 to 1000 kg with a polyethylene layer from the ingress of moisture from the air with a "ZIP" fastener and metallized bags made of combined material with a "ZIP" fastener.

According to available information, pumpkin seed flour contains a complex of B vitamins, vitamin C, carotenoids, macro- and microelements (K, Ca, P, Mg, Zn), dietary fiber. The product normalizes metabolism, stimulates the immune system, improves the functioning of the main systems of the human body, primarily cardiovascular, hematopoietic, and excretory. The complex of vitamins and minerals increases mental activity and physical activity [29; 30].

In laboratory conditions, the shelf life of pumpkin seed flour is set at 12 months under conditions of storage in dry, well-ventilated rooms, protected from sunlight, at a temperature of 20… 25 ° C. The shelf life after opening the package should not exceed 180 days, provided that it is stored in the same conditions as the packaged unopened product.

Pumpkin seed fiber is recommended as a physiologically active supplement to the human diet to normalize fat metabolism and blood cholesterol levels, to improve the general condition of the body, normalize prostate function, to prevent cardiovascular and nervous system, normalize digestion and excretion toxic substances from the human body [31].

People who are overweight can replace one meal with pumpkin seed fiber, drinking plenty of clean water. It is useful to add fiber to any dish (sour milk and juice drinks) or use for breading; possible daily consumption as a substitute for bread.

In laboratory conditions, the shelf life of pumpkin seed fiber is set at 12 months under conditions of storage in dry, well-ventilated rooms, protected from sunlight, at a temperature of 20…25 °C. The shelf life after opening the package should not exceed 180 days, provided that it is stored in the same conditions as the packaged unopened product.

A study to determine the content of pathogenic microorganisms in oil, protein powder, flour and fiber from pumpkin seeds. The obtained data indicate the absence of pathogenic microorganisms and the amount of opportunistic microflora that does not exceed the permissible levels specified in the regulatory documentation for this type of product.

Organoleptic and physicochemical indicators of quality of fractional products from pumpkin seeds are determined. According to organoleptic quality indicators, the samples met the requirements of regulatory documentation and were recommended for quality control according to the following indicators and characteristics given in table. 7, 8.

Table 7

Requirements for organoleptic quality indicators of flour, fiber, protein powder from pumpkin seeds

Indicator	Characteristic		
	pumpkin seed flour	fiber from pumpkin seeds	protein powder from pumpkin seeds
General view	Powdered mixture of homogeneous mass	Dry loose product without dense lumps	Powdered mixture of fine particles
Color	Yellow	Dark yellow	Yellow-green
Odour	Inherent in pumpkin seed products, odorless		
Taste	Inherent in pumpkin seeds, without bitterness, acid and other foreign flavors		

Table 8

Requirements for organoleptic quality indicators of pumpkin seed oil

Indicator	Characteristics of unrefined oil
Transmittance	Not transparent due to its dark color
Color	From dark green to dark red
Odour and taste	Inherent in pumpkin seed oil, odorless, tasteless and bitter

According to physico-chemical parameters, fractional products from pumpkin seeds must meet the requirements presented in table 9, 10.

Table 9

Requirements for physico-chemical quality indicators of flour, fiber, protein powder from pumpkin seeds

Назва показника	Norm		
	flour	cellulose	protein powder
Mass fraction of moisture and volatile substances,%, not more than	4.0 – 8.0	4.0 – 8.0	4.0 – 8.0
Mass fraction of fat,%, on dry matter, no more than	11.0 – 17.0	7.0 – 9.0	6.0 – 7.0
Mass fraction of protein,%, on dry matter, not less than	40.0 – 43.0	40.0 – 46.0	60.0 – 67.0
Mass fraction of total ash,%, on dry matter, not more than	5.0 – 7.0	4.0 – 6.0	6.0 – 8.0
Mass fraction of fiber,%, on dry matter, no more than	14.0 – 16.0	30.0 – 32.0	7.0 – 9.0
Impurities	is not allowed	is not allowed	is not allowed
Infection with pests	is not allowed	is not allowed	is not allowed
Acid number of fat, mg KOH, no more	2.8	2.8	2.8

Table 10

Requirements for physico-chemical quality indicators of pumpkin seed oil

Indicator	Norm
Acid number, mg KOH, not more than	1.5…6.0
Peroxide number, ½ O mmol / kg, not more than (at the end of the shelf life)	6.0…10.0
Mass fraction of phosphorus-containing substances,%, not more than - in terms of stearooleolecithin - in terms of P_2O_5	 0.1 0.01
Mass fraction of non-fatty impurities,%, not more than	0.05…0.1
Mass fraction of moisture and volatile substances,%, not more than	0.15…0,2
Anisidine number, mind. units, not more than	3.0…4.0
Mass fraction of vitamin E, total mg / kg, not less than	150.0
Mass fraction of vitamin A, mg / kg, not less than	12,0
Iodine number, g I_2 / 100 g, not more than	108…110

Conclusions

The analysis of scientific and technical information on the determination of the chemical composition of pumpkin seeds fractional products is carried out. Recommendations for the use of pumpkin seeds fractional products in food products are given. According to the results of the analytical study, a set of methods for determining the quality of pumpkin seeds and its fractional products is substantiated. The technological scheme of complex processing of pumpkin seeds is developed, the main elements of which are pressing of seeds and fractionation of crushed cake. Target products were obtained in the amount of: oil – 34 %, flour – 5 %, protein powder – 15 %, fiber – 46 %.

The energy and biological value of the obtained fractions is calculated.

The fatty acid composition of pumpkin oil and its ratio of fatty acids SFA : PUFA : MUFA = 10:38:42, indicating the feasibility of recommending pumpkin oil as a source of mono- and polyunsaturated fatty acids, are determined.

The content of fat-soluble vitamins in pumpkin oil was determined, which corresponds to the recommended daily allowance in case of consumption of 100 g of oil per day. The amino acid composition of protein powder is established, the content of all essential amino acids is proved, which characterizes its high biological value. The results of toxicological and microbiological tests of laboratory samples of pumpkin seeds fractional products are given, which established a high level of safety of these products and recommended an increase in pumpkin yield in this area.

Organoleptic and physico-chemical quality parameters of the obtained samples are determined, which meet the established norms for the analogous products and also testify to the high quality of the food products made by the suggested method.

It is recommended to use the obtained products as independent in the diet of people and farm livestock or as supplements of traditional dishes or foodstuffs to enrich the nutrients and essential substances of human diets and foodstuffs for poultry, fish and domestic animals.

The obtained results allowed to develop technical conditions for new food products (Pumpkin seed oil. Technical conditions TU U 10.4-39224310-004: 2019. Pumpkin seed flour, pumpkin seed fiber, pumpkin seed protein powder. Technical conditions. TU U 10.41 - 39224310-004: 2021), as well as to test the technology in the production conditions of LLC "Desnaland".

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