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RESEARCH ARTICLE
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Marketing Research of the Confectionery Sugar Products Market and Improvement of the Technology of Prebiotic Fillings from Non-Traditional Raw Materials

Tolmacheva T.A.*, Gasparyan S.V. and Nugmanov A.Kh.-Kh.

Russian State Agrarian University – Moscow Timiryazev Agricultural Academy, Moscow, 127422
*Corresponding author: tolmacheva-tat@mail.ru

ABSTRACT

People of all age groups favor sugar confectionery items, forming a prominent sector within the industry. This group of products spans a wide range. It includes sweets with significant sugar content and high nutritional value, such as pralines, which are highly dispersed structures based on sucrose crystals and particles of hard-roasted nuts. Such a multiphase system is a mixture of nut fats, cocoa butter, or confectionery fat. Praline can incorporate additives like milk powder, oatmeal, and cereal flour. The use of flax seeds and processed products is growing in popularity to enrich and enhance the beneficial properties of sweet products. That is why the idea of creating enriched confectionery products that comply with a healthy diet is relevant. The food industry's developing branches annually include the confectionery market in their budgets. This industry ranks fourth in terms of finished product output among bakery and dairy products. This article showcases studies that utilize traditional methods and techniques in confectionery factories. Based on research done in the lab, the nut-flax mass was chosen as a percentage of the ingredients in making glazed praline candies with more macro- and microelements of vegetable flax. We calculated the nutritional value of the obtained prototypes. The data obtained confirmed the effectiveness of the chosen raw material composition, such as the 27% fat content in the final product. The research yielded a new filling type with increased nutritional and biological value, expanding the range of enriched confectionery products.

Keywords: Confectionery industry, Sugary products, Pralines, Nut and linseed mass, Nutritional value, Organoleptic analysis

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INTRODUCTION

In recent decades, the growing consumer interest in a healthy lifestyle and proper nutrition has led to increased efforts by the scientific community to develop functional foods that promote optimal nutrition and health strengthening (Tkeshelashvili et al., 2019; Tipsina et al., 2021; Tipsina & Tolmacheva, 2022). One of the key tasks in the development of food products with improved properties is to provide various health benefits while maintaining their unsurpassed taste. In this context, scientists and technologists in the food industry have turned to confectionery products, which are among the most in demand on the market (Vinogradova & Tolmacheva, 2014; Tkeshelashvili et al., 2017). Confectionery products, including sugary pralines, pastes, fruit fillings and berry fillings with a prebiotic orientation, serve as a valuable source of a rich biologically active composition. These products predominantly contain polyphenolic compounds, which have demonstrated a high level of antioxidant activity, offering numerous health benefits (Nugmanov et al., 2015; Guiné & Florença, 2024; Kaur et al., 2024). It is known that flavonoids not only act as a direct chemical defense agent but also regulate various metabolic and signaling enzymes, which is undoubtedly beneficial to human health (Knorr & Augustin 2023). Despite the remarkable biologically active properties of the component composition of sugary confectionery products, the rapidly changing market, which daily adopts new trends, requires constant innovation

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in all areas of food production and, consequently, in the hospitality industry, especially in confectionery production (Lipatov, 1990). Until now, researchers have created a diverse array of functional cocoa-based products, such as those with whey proteins, glucomannan, and insoluble cocoa fibers (Masoodi et al., 2024). However, there have only been a handful of endeavors to create inventive prebiotic fillings (Farisieiev et al., 2023), that incorporate unconventional ingredients for the confectionery sector, like flax processing products. Additionally, these fillings may incorporate roasted almond and hazelnut pasta recipes (Korkach et al., 2024).

Flaxseed is scientifically known as *Linum usitatissimum* L., which means "the most useful" in Latin. Growers grow this perennial crop to produce oil or fiber. Flaxseed is one of the oldest crops, growing for thousands of years. Consumers value this culture for a variety of beneficial properties necessary for human health (Shayan et al., 2020). Nutrient databases include a variety of phytochemicals found in hazelnuts, including carotenoids, phenolic acids, phytosterols, and polyphenolic compounds like flavonoids, proanthocyanidins, and stilbenes, but they do not include phytates, sphingolipids, alkylphenols, and lignans (Ivanec et al., 2014; Borodulin et al., 2020; Turova et al., 2021; Khokonova et al., 2021). The content of phytochemicals in tree nuts can vary significantly depending on the type of nut (Cambridge University Publishing House and Assessment, 2024), genotype, pre- and post-harvest conditions, as well as storage conditions. All of the aforementioned points highlight the importance of conducting research to create an assortment and develop technology for prebiotic fillings made from non-traditional raw materials for the confectionery industry, as maintaining the traditional taste of products while providing the necessary health benefits is a crucial task in the development of functional food products.

MATERIALS & METHODS

To develop enriched confectionery products, this study focused on incorporating flax seeds and their processing by-products to enhance the nutritional properties of sweets. Sugary confectionery products containing a high content of flax processing products were chosen as the study's object, with formulations we added a paste made from roasted almond and hazel kernels (Gorach, 2023).

Production of Praline Candies

In the production of praline candies, almond and hazel were used. Nut-bearing raw materials were supplied in purified form, by eliminating all unsuitable parts before processing. Sweet almonds, free from shells, and shelled hazelnuts were obtained and utilized in the formulation of praline products (Patent No. 2801752 C1 Russian Federation, 2023). These were used due to their desirable nutritional characteristics. A unique formulation was used, developed by scientists from the RSAU–MAA named after K. A. Timiryazev. This formulation replaced a portion of the primary nut raw material with a powdered filler made from whole-ground flax flour. Whole flax seeds were ground to achieve a moisture content of 5%–8%, yielding a filler that constituted 15%–20% of the total mass of recipe components (Patent No. 2801752 C1 Russian Federation, 2023).

Consumer Survey

To obtain authentic data on the attitude of consumers to sugary products and for a conscious understanding of the importance of enriching praline sweets, we conducted a sociological survey of residents of the targeted region by using the method of selective questioning. This sociological survey is part of the structure of marketing research using selective questioning. We study consumer preferences to resolve the purchase issue, taking into account the individuality of the buyer, the impact of their environment, and the evaluation of their satisfaction with the chosen confectionery products (Frolova et al., 2012).

Techno-Chemical and Safety Quality Control

Techno chemical quality control and finished product safety are the main components of food enterprises. Throughout the entire technological process, it is regulated by technical and regulatory documents of the controlling state supervisory authorities. Quality control methods were based on national and international standards for food products (Prylipko et al., 2021). The main parameters of food quality control were; organoleptic parameters (taste, color, smell, consistency) and physical-chemical parameters (moisture, proteins, fats, fiber, ash). These indicators are sufficient to confirm/reject the results of the ongoing study, the purpose of which is to develop an assortment and technology of prebiotic fillings with a high content of flax processing products, with the addition of pasta from roasted nut raw materials, depending on the formulation.

Analytical Instrumentation

The scientific laboratory of the RSAU-MAA, named after K. A. Timiryazev, used the SpectarStar XT device to obtain the physical-chemical parameters of the resulting product. The infrared analyzer (BIC) was used to determine indicators such as fiber, fat, ash, proteins, starch, and more in liquid, pasty, ground, and non-ground products.

Organoleptic Evaluation

The organoleptic research method relies on sensory receptors to determine the quality of a food product. According to organoleptic parameters, the obtained praline products must meet the requirements specified in the standard for this type of product (taste, smell, color, consistency) (GOST 4570-2014, 2020).

RESULTS & DISCUSSION

According to the research plan, we conducted a sociological survey of buyers on the territory of Moscow and Zelenograd using a selective questionnaire. We conducted the survey based on age, gender, and education level. The number of voters was 60 respondents (Table 1). The developed questionnaire included 17 questions, the main part of which was of the greatest importance, as it allowed to identify consumer preferences

for a certain type of product. Fig. 1 to 6 showed both the survey's results and the main part of the questions in the form of specific confectionery products. The results showed that chocolate and sweets were the most popular products, accounting for 73.3% and 45% of the votes cast, respectively. The decision to choose praline candy mass as an enrichment product was based on the high demand for this type of sweet in the Russian Federation. Consumers began to prefer domestic sweets with a more natural composition, without additional flavor additives (Djekić et al., 2023). Due to this trend, the development of new technologies for praline candies with the introduction of natural raw materials is a fairly promising direction (Warrier & Aparna, 2021).

Table 1: The effect of the film coating on the content of amino-amiacic nitrogen in delicatessen products (GOST R 55479-2013)

Indicator	Sample population (%)
Gender	
Female	76.7
Male	23.3
Age	
Under 18 years old	3.3
18-25 years old	48.3
26-35 years old	15
36-50 years old	30
51 and older	3.3
Education	
Elementary	1.7
Secondary	36.7
Higher	61.7

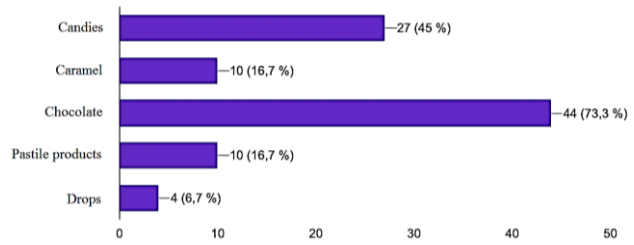

Fig. 1: Consumer preferences in the choice of sugary confectionery products.

When asked about the preferred filling of sweets, an undeniably higher percentage of those who voted (53.3%) chose praline sweets (Fig. 2). The presented ratio reflects that 60% of customers have a positive attitude towards this type of product. People in the age group of 36–50 expressed indifference, suggesting that the younger generation is more interested in the importance of eating fortified foods.

Such statistics may also indicate a lack of consumer awareness about products with beneficial properties made from non-traditional plant raw materials (Fig. 4B), which leads to low demand for new types of sweet products (Fig. 4A). To promote a healthy lifestyle, it is important to place product information on the packaging material and use advertising (Hovhannisyan et al., 2024).

Customers are now paying more attention to the quality of the goods and the assortment presented on the shelves (Knorr & Augustin, 2021). The media's constant awareness of the harmful effects of artificial food additives on the body has led customers to prefer natural food products (Masoodi et al., 2024). Thus, the survey data show that the appearance, taste, composition, and safety of the product are of great importance (Fig. 5). Only 22.4% of surveyed buyers (mostly men) did not pay attention to ingredients.

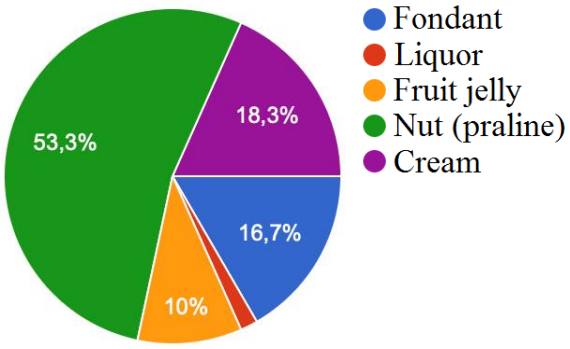

Fig. 2: Preferred candy type by consumers.

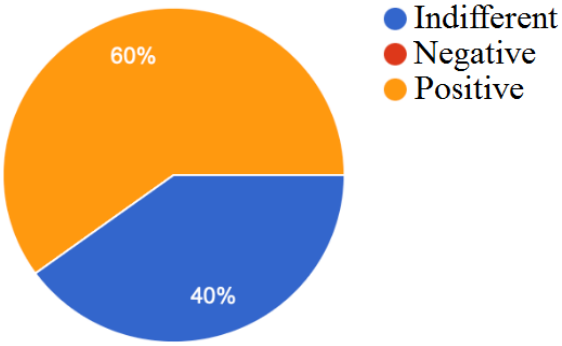

Fig. 3: The attitude of the population towards praline fillings enriched with biologically active components.

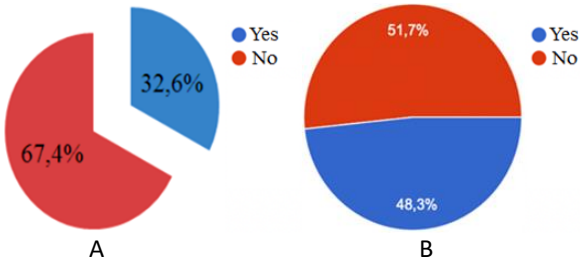

Fig. 4: Survey research results, A) Awareness of products with beneficial properties; B) Purchase of sweets with non-traditional raw materials.

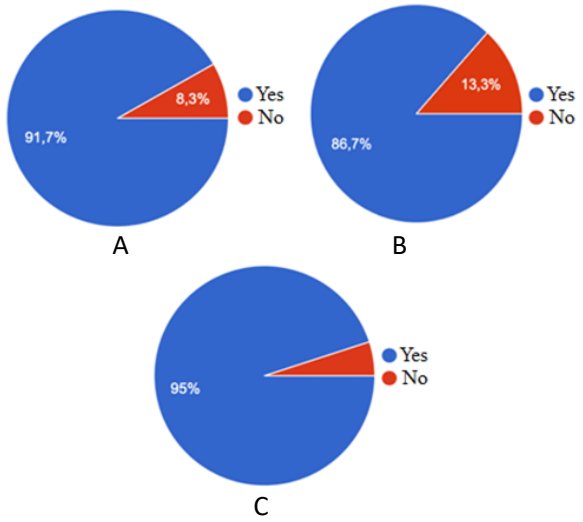

Fig. 5: Survey results: Consumer's attitude to A) the organoleptic characteristics of sweets, B) the composition of the product, and C) new product safety.

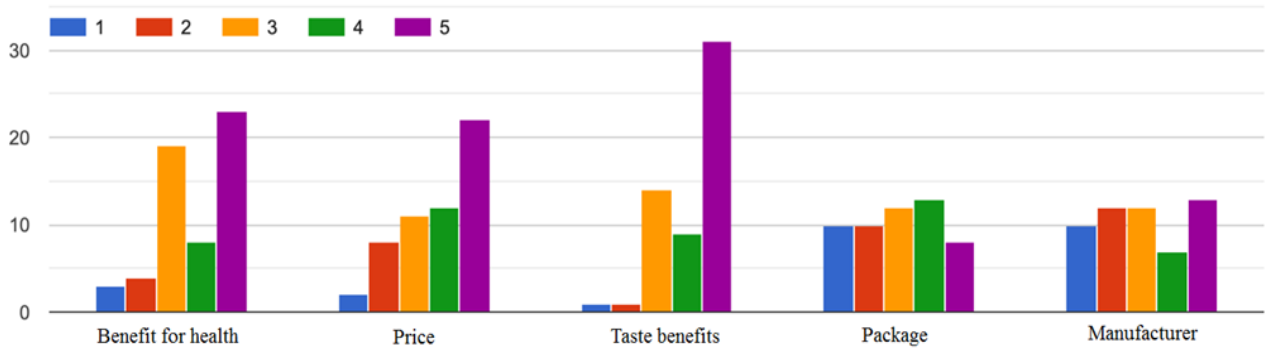

Fig. 6: Factors motivating the purchase of this type of product.

We proposed to conduct a ranked assessment from one to five factors that consumers focus on when buying products enriched with non-traditional types of raw materials (health benefits, taste, price, packaging, manufacturer). Taste received the highest rating from respondents, and the distribution of factors was as follows: health benefits, price, manufacturer, and packaging (Fig. 6).

The marketing analysis revealed that when a new sugary confectionery product enters the market, it caters specifically to the consumer. It may require some time for the buyer to show interest and recognize the advantages of the enhanced product. However, the population is willing to choose an alternative product over the traditional one, even if it comes at a higher price (Djekić et al., 2023).There are three technologies for praline mass production: custard praline, classic praline, and accelerated cooking (Tolmacheva & Nikolaev, 2022). The production of praline candies, regardless of the specific technology employed (e.g., custard praline, classic praline, or accelerated cooking), follows several key stages, each involving specific operations critical for ensuring product quality. The main stages of the production process are as follows:

Preparation of Raw Materials and Semi-Finished Products

The nuts used in the praline mass undergo storage, cleaning, roasting, grinding, and precise dosing. These steps are essential to ensure the quality and consistency of the nut component. The sugar is stored, sieved, and ground to achieve a uniform particle size that enhances the texture of the praline mass. Bulk ingredients, such as cocoa or milk powder, are stored and sieved to ensure homogeneity. Fats are stored, tempered, and filtered to remove any impurities and to achieve the desired consistency for mixing.

Preparation of Ingredient Mixture

Preparing a mixture of ingredients included in the formulation involves dosing and mixing the recipe components, as well as grinding the recipe mixture.

Preparation of Candy Mass

The preparation of the candy mass involves the dosing and mixing of recipe components, kneading, and cooling of the candy mass.

Formation of Candy Bundles

The production process involves the formation, cooling, and cutting of candy bundles, as well as the cooling of candy blanks.

Glazing

The process involves glazing the candy cases, which includes preparing, tempering, and serving the glaze, applying it to the cases, and then cooling them. The process involves orienting sweets in longitudinal rows, wrapping candy, and packaging them in transport containers.

Fig. 7 illustrates the structural technological scheme for producing sweets with praline fillings, using hazel and almond as nut raw materials. The original idea behind the presented technology was to partially replace the incoming nut kernels with native flaxseed flour, ground from roasted flax seeds (Patent No. 2801752 C1 Russian Federation, 2023; Ahmadinia et al., 2023). According to the standard technological chain, this flour is then fed to the stage of mixing and grinding with sugar and fat, thereby not only reducing technological operations for processing nuts but also removing part of the hardware design of these processes.

Fig. 8 displays two samples of the praline masses that were made: a control sample made with standard methods and an experimental sample made with native flaxseed flour added. The organoleptic characteristics of the praline masses should reflect the basic composition of the finished product components, which have a pronounced nutty taste and smell (Sarath, 2023). The presence of any foreign or off-flavors is unacceptable. Praline masses containing fatty products should not have a rancid, tallowy, or any other undesirable off-flavor and aftertaste. Large fractions of sugar and other composition components should not be present when biting; the structure should have a delicate consistency (Chaikivskyi & Zbarzhevetska, 2023).

Table 2 presents the evaluation results. Based on the tabular data, it follows that in the experimental sample the taste of the introduced flax seeds is weakly expressed, since after roasting it acquires a characteristic nutty taste, while the smell both in the control and in the experiment corresponds to the product. The control color is dark brown, while the experimental color is light brown. In the control version, the consistency is soft, semi-liquid, with no large particles of recipe components; in the experimental version,

Table 2: Organoleptic parameters of praline mass

Indicators	Sample of praline mass	
	Row Header 2	Row Header 2
Taste	Characteristic of this product type, without foreign taste	Characteristic of product type with a pronounced flaxseed flavor
Odor	Characteristic of this product type, odorless	Characteristic of this product type, odorless
Colour	Dark brown	Light brown
Consistency	Soft, semi-liquid	Solid, dense

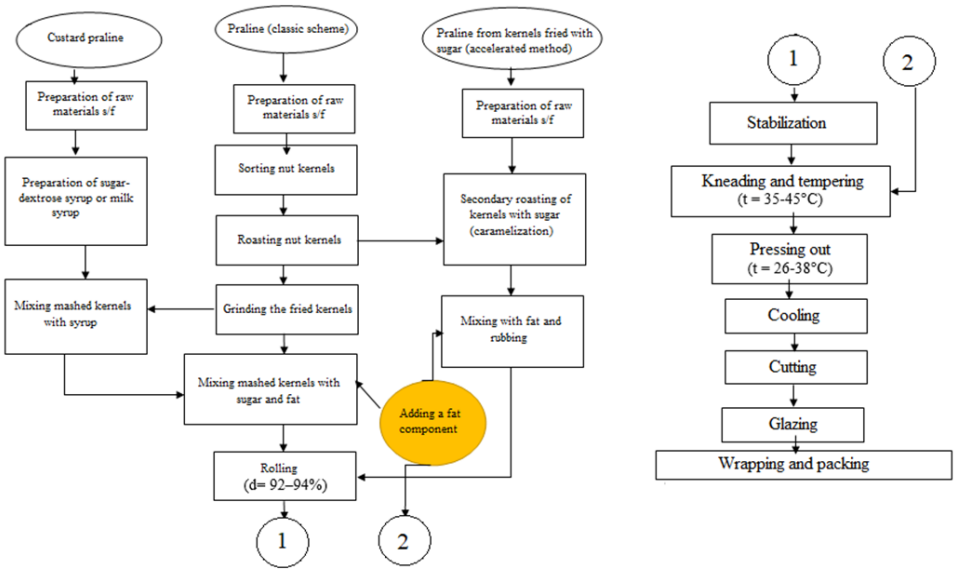

Fig. 7: Structural technological scheme for the production of sweets with praline fillings.

Fig. 8: Samples of praline masses: A – control sample; B – experimental sample.

it is denser because there are no introduced liquid fats. We used the Chizhov device to dehydrate the samples in special bags made of weakly glued paper. We placed 5g of crushed samples from the studied product in these bags. We dried the prepared envelopes for 3–4min at a temperature of 160°C. We weighed the samples after drying and cooling them, then stored them in a desiccator for a maximum of 2 hours.

As previously indicated, we used the SpectarStar XT device to determine the biochemical composition of the experimental and control samples. The operation of the spectrophotometer is based on measuring the degree of absorption of the monochromatic flux, which makes it possible to determine the concentrations of biological components in paste-like masses (Wu et al., 2023). The device displays all received data for further analysis. The Table 3 presents the results of the biochemical composition determination.

Table 3: The content of the biochemical components (%) of the praline mass

Sample	Proteins	Fats	Fiber	Ash	Moisture
Control	17.17	2.88	4.31	11.68	0.71
Experiment	12.39	3.46	3.71	7.22	0.93

From the determination of the moisture of the control and experimental samples, it follows that the moisture in the experimental sample exceeds the moisture of the control by 30%, which is due to the presence of flax seeds. Based on the biochemical makeup of praline masses, it is clear that the amount of fat in praline candies goes up from 2.88g in the control sample to 3.46g in the sample where flaxseed flour is used instead of the added fat.

The complete absence of sunflower oil in the experimental sample had no effect on its fat composition. At the same time, an additional introduction of a fat component is required to form a plastic homogeneous candy structure. In this scenario, we recommend adding native flax flour to praline candies at a ratio of no more than 20% by weight of the nut raw materials. Such a replacement results in candy masses that are technologically advanced, acquire sufficient strength, and exhibit good molding. During the storage of praline candies, they undergo a drying process. Native flax flour introduces a fat component that slows down this process, thereby increasing the shelf life of the finished product. Based on the conducted research, it can be concluded that it is advisable to use flaxseed flour as a substitute for sunflower oil in the production of nut candy masses (Mueed et al., 2023).

The nutritional value of the product reflects the fullness of useful properties and the concentration of various nutrients (proteins, fats, carbohydrates), as well as their ratio for the whole body's harmonious functioning. The biological value is the balance of the content of active substances in the product's composition, which includes essential amino acids, polyunsaturated fatty acids, vitamins, and minerals (Suárez et al., 2021).

To calculate the nutritional value of ready-to-eat products, one must precisely identify the products in the formulation, including their grade, fat content, category,

Table 4: Calculation of the nutritional value of praline mass with native flax seed flour

Product name	Net weight, g	Content of nutrients per 100g of product		The content of nutrients in the finished product, g			
		Proteins	Fats	Proteins	Proteins	Fats	Carbohydrates
Roasted almonds	19.5	18.6	57.7	16.2	3.6	11.2	3.16
Roasted hazel	19.5	16.1	66.9	9.9	3.14	13	1.93
Flax seeds	10.9	18.3	42.2	28.9	1.99	4.59	3.15
Sugar	80	-	-	99.7	-	-	79.76
Powdered sugar	10	-	-	99.8	-	-	9.98
Water	23	-	-	-	-	-	-

and quantity in grams. Table 4 presents the calculated nutritional value of the experimental product.

After analyzing the nutritional value of the experimental sample, it is clear that praline candies are a highly nutritious product. The introduced flax seeds enrich it with polyunsaturated fatty acids, valuable vegetable fats, and a high content of fiber with a prebiotic effect, which is beneficial for the human body.

Conclusion

The analysis of functional food products currently available on the Russian market suggests that the use of flax seed processing products is an urgent problem and an effective solution to many issues related to expanding the range of sugary products.

Improving the technology of sweets with praline filling by adding native flour is an effective solution to the problem of a shortage of nutritious and essential micronutrients in products of this type.

Organoleptic and physical-chemical assessment methods have shown that flax seeds have excellent taste characteristics and change the structure of the finished semi-finished product for the better, contributing to the improvement of its properties.

The analysis of the biochemical composition indicates that the newly developed product has a high importance for practical application in human nutrition. A variety of nutrients (proteins, fats, and carbohydrates) contribute to the organization of a more rational diet and enrichment by replacing the usual vegetable oils with alternative ones with increased enriching ability.

By adding biologically active substances to flax processing products, we can help stop diseases that are linked to poor nutrition and improve the nutritional status of the population.

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