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USE OF SUNFLOWER PROTEIN ISOLATE AND BRANS IN THE TECHNOLOGY OF PRODUCTION OF SPORTS BARS

Abstract

Modern dietary trends, driven by urbanization and a fast-paced lifestyle, have increased demand for convenient, nutritious products, particularly sports protein bars. These bars serve as a source of protein and brans, making them popular among athletes, office workers, and students. Traditional protein bar formulations use animal- and plant-based protein isolates, such as whey and soy proteins. However, modern requirements for food safety and sustainable production encourage the search for alternatives. A promising ingredient is sunflower protein isolate, derived from sunflower press cake - a byproduct of the oil and fat industry. Ukraine, as one of the world's leading sunflower producers, has significant potential for utilizing this protein in functional products. Sunflower protein is characterized by a balanced amino acid composition, the absence of antinutritional factors, and hypoallergenic properties, making it a competitive alternative to traditional protein sources. Besides protein, brans play a crucial role in protein bar formulations by supporting digestion, promoting gut microbiota health, reducing glycemic load, and improving texture. Using brans from grain processing byproducts (wheat, oat, and corn brans) and buckwheat hull fiber helps reduce production costs and enhance nutritional value. Studies have shown that oat bran has the highest water-holding capacity (WHC), helping retain moisture in bars, while wheat bran provides a balance between texture stability and softness. Buckwheat hull fiber, rich in antioxidants, increases functional value, whereas corn bran contributes to a denser structure. Market analysis of protein bars in Ukraine revealed formulation differences among manufacturers. Some brands, such as Lipo Bar, offer high-protein bars (up to 40%) with sufficient bran content, while others, such as PowerPro, use lower-cost protein components and high sugar content, reducing nutritional value. This study confirms that sunflower protein isolate is a promising alternative protein source for sports nutrition. However, due to its relatively low lysine content, it is recommended to combine it with lysine-rich proteins such as pea or rice protein. The addition of brans from local sources improves texture, enhances functional properties, and extends product shelf life.

Keywords: protein bars, sunflower protein, brans, sports nutrition, alternative protein sources, functional foods.

Introduction

The rise of urbanization and an accelerated pace of life have significantly influenced modern dietary culture. Most consumers prefer products that provide balanced nutrition in a convenient format without requiring significant time for preparation. Studies indicate that 60% of modern individuals eat "on the go," 70% spend 10 minutes or less on breakfast, and 95% complete their lunch in under 30 minutes. Additionally, 25% of young people (aged 18–44) use automated food ordering systems [1, 2]. These trends have driven the growing popularity of protein bars, which combine convenience, nutritional value, and mobility, particularly among physically active individuals.

Protein bars are a versatile product offering several advantages, including a balanced protein concentration, rapid digestibility, extended shelf life, and the ability to be tailored to individual dietary needs. This makes them appealing not only to athletes but also to a wide range of consumers, including office workers, students, and individuals with active lifestyles.

Traditionally, the primary protein components in protein bar formulations include whey, soy, and pea protein isolates. However, modern trends demand the exploration of new protein sources that combine high nutritional value, economic feasibility, and stability in industrial processing. One such promising ingredient is sunflower protein isolate, derived from sunflower seed meal - a byproduct of the oilseed processing industry.

Ukraine is one of the world's largest sunflower producers, creating opportunities for the efficient utilization of secondary production outputs. Sunflower protein is characterized by a well-balanced amino acid profile, the absence of antinutritional factors, and hypoallergenic properties, making it a promising alternative to soy protein in sports nutrition bars [6]. Beyond protein sources, the incorporation of brans in sports bars is a crucial factor influencing product texture, nutritional quality, and glycemic index [3]. The incorporation of wheat, oat, and corn brans, as well as buckwheat hull fiber, is a practical approach to enhancing the nutritional value of the product while promoting the sustainable utilization of grain raw materials.

Literature review

In recent years, Ukraine has witnessed significant growth in the functional food sector, particularly in the production of sports protein bars, which serve as a convenient source of protein for a wide range of consumers. Global trends in healthy eating, mobile food consumption, and the promotion of active lifestyles have driven increasing demand for products that combine high nutritional value, convenience, and accessibility [1].

Despite this growth, rising prices for animal-

based protein isolates, dependence on imported raw materials, and the need for recipe optimization are prompting manufacturers to explore alternative protein sources. One promising solution is the use of sunflower protein isolate, derived from sunflower press cake - a byproduct of the oilseed processing industry. Given Ukraine's strong position in sunflower oil production, integrating this protein into formulations not only enhances nutritional value but also supports local resource efficiency.

In addition to protein components, optimizing the bran content of sports bars is a crucial factor in improving their formulation. Incorporating brans not only enhances the nutritional profile of the product but also supports digestive health, lowers glycemic load, and improves the structural characteristics of the final product. The use of brans from domestic raw materials allows manufacturers to reduce production costs while simultaneously fostering local economic development through the efficient utilization of wheat, oat, and corn brans, as well as buckwheat hull fiber [3].

Brans from wheat, oat, and corn contribute to prolonged satiety and support intestinal health due to their prebiotic effects. Additionally, buckwheat hull fiber contains polyphenolic antioxidants, which may positively impact cardiovascular health. The inclusion of wheat and oat bran has been shown to lower the glycemic index of the product and improve blood cholesterol levels, making these brans particularly beneficial for consumers monitoring their glucose levels and lipid profiles [3, 5, 11, 14].

An analysis of the sports protein bar market in Ukraine reveals significant variations in formulations among manufacturers. Studies indicate that brands such as Lipo Bar offer protein bars with up to 40% protein content and an adequate bran content (4.4 g per serving), aligning with modern functional food standards [10]. However, the high cost of imported protein raw materials limits the economic feasibility of large-scale production. Other manufacturers, such as PowerPro, utilize lower-cost protein components (whey concentrate, soy protein, and collagen hydrolysate) and incorporate sweeteners, which may reduce the overall nutritional quality and bioavailability of the product [9].

A notable market player is Sporter, which produces Zero One protein bars. In 2022, this product ranked second in sales among Ukrainian consumers according to the BelokUA ranking, confirming its popularity. Sporter bars contain 32% protein, a competitive level in the market. However, the inclusion of collagen hydrolysate and soy protein isolate suggests a potential reduction in the biological value of the protein component, likely as a cost-optimization strategy. With 11 g of brans per serving, Sporter leads among Ukrainian brands in bran content, yet its primary bran source is isomaltooligosaccharides (IMO), which, despite their positive effects on gut microbiota, may cause digestive discomfort when consumed in excess [9, 10].

One of the most promising directions for the Ukrainian market is the introduction of sunflower protein isolate in the production of sports bars. Historically, sunflower press cake was predominantly used in animal feed; however, advancements in processing technology now allow for the extraction of high-quality protein isolates. Sunflower protein offers several advantages, including the absence of antinutritional factors, which enhances its digestibility compared to soy protein. Additionally, its widespread availability in Ukraine ensures low production costs and stable supply chains. The high arginine content of sunflower protein promotes improved blood circulation and muscle recovery, while its hypoallergenic properties make it suitable for consumers with dietary sensitivities. Moreover, the environmental benefits of sunflower protein production, requiring less water and energy than soy or dairy proteins, position it as a sustainable alternative.

Due to growing interest in alternative protein sources, sunflower protein presents a viable solution for functional food development. Unlike soy protein, sunflower protein does not contain antinutritional factors such as trypsin inhibitors, which can hinder protein absorption. While the protein content in sunflower isolate (55–80%) is lower than that of soy isolate (90%), its bioavailability may be higher due to the absence of antinutritional components and phytoestrogens, which is particularly important for individuals with digestive sensitivities or endocrine imbalances [12, 13, 14]. Sunflower protein isolate is a promising plant-based protein source with a well-balanced chemical composition, making it suitable for functional food applications. It typically contains 72–87% protein on a dry weight basis, depending on the extraction method used. The primary protein fractions are globulins (Helianthinin), which constitute about 40–90% of the total protein content, and albumins, which make up approximately 10–35%. Sunflower protein is rich in sulfur-containing amino acids, such as methionine and cysteine, which are often limited in other plant-based proteins. However, it has a relatively low lysine content, making it beneficial to supplement with lysine-rich proteins like pea or rice protein to achieve a more balanced amino acid profile. The isolate also contains approximately 4% fat, 6% carbohydrates, and 8% fiber, contributing to its nutritional value and functional properties.

From a textural standpoint, incorporating sunflower protein in sports bars requires formulation adjustments, as its hygroscopic properties can influence product density. The inclusion of brans, particularly wheat, oat, and corn, can enhance texture while simultaneously increasing the nutritional value of the product. The addition of buckwheat hull fiber has been shown to slow carbohydrate absorption, which is critical for maintaining blood glucose control [3, 11, 13].

Overall, the use of sunflower protein and brans in sports bar production represents a promising approach for optimizing amino acid profiles, improving the functional properties of the product, and reducing reliance on imported protein raw materials. However, further research is needed to determine the optimal proportions of these components in formulations and to assess their impact on the sensory characteristics of the final product.

Formulation of the problem

The objective of this study is to evaluate the potential of sunflower protein isolate in sports bar production by assessing its functional properties in comparison to traditional protein isolates (soy and collagen) and analyzing the impact of wheat, oat, and corn brans, as well as buckwheat hull fiber, on the structural characteristics

of the final product. The research involves formulating sports bar recipes incorporating these ingredients, investigating their water-holding capacity, and providing recommendations for optimizing protein blends to enhance the product's nutritional profile.

Materials and Methods

The study utilized sunflower protein isolate, soy protein isolate, whey protein isolate, and collagen hydrolysate as the primary protein components for comparison. The sunflower protein isolate was obtained from Ukrainian agro-processing enterprises, ensuring its compatibility with local production conditions. It contains 87% protein, 3% fat, 2% carbohydrates. The soy protein isolate was purchased from Willmax (Ukraine), which sources raw materials from European countries such as the Netherlands, Lithuania, France, and Germany. It consists of 90% protein, less than 1% fat, 3% carbohydrates. The collagen hydrolysate was supplied by UHTrade (France) and is composed of 98% protein with negligible fat and carbohydrates. These protein isolates were selected based on their market availability, high consumer ratings, and their ability to complement each other in terms of amino acid composition and functional properties.

Additionally, wheat, oat, and corn brans, as well as buckwheat hull fiber, were incorporated to assess their impact on structural stability, digestion, and the functional properties of the bars. Wheat and oat bran were sourced from TM "Kozub" (Ukraine), corn bran from "Naturalis" (Ukraine), and buckwheat hull fiber was acquired from a local farmer. The use of these ingredients ensures local raw material sourcing, reduces production costs, and enhances the functional properties of the final product.

The protein content in the analyzed samples was determined using the Kjeldahl method, following AOAC standard 2001.11, which is based on measuring total nitrogen content and converting it to protein content. This method includes sample digestion with concentrated sulfuric acid in the presence of catalysts, neutralization with alkali, and titration of the released ammonia with boric acid. The Kjeldahl method is widely recognized in the food industry for protein analysis [2].

The amino acid profile of sunflower protein isolate was determined using ion-exchange liquid chromatography. Protein hydrolysis was performed with 6N HCl at +110°C for 24 hours in sealed ampoules. After hydrolysis, the samples were neutralized, filtered, and analyzed using an amino acid analyzer with ninhydrin detection. The obtained data were used to evaluate the profile of essential amino acids, including leucine, lysine, and arginine.

The physicochemical properties of wheat, oat, and corn brans, as well as buckwheat hull fiber, were assessed by determining their water-holding capacity (WHC) [3]. Bran samples were weighed, mixed with a known volume of distilled water (10 mL of water per 1 g of dry sample), and incubated at room temperature for 30 minutes. After centrifugation at 3000 rpm for 10 minutes, excess water was removed, and the samples were re-weighed. WHC was calculated as the ratio of retained water mass to the dry sample mass.

Results of the study and their discussion

The results of protein content analysis using the Kjeldahl method revealed that sunflower protein isolate contains approximately 80% protein, which is lower than soy protein isolate (90%) and collagen isolate (97%). This indicates that when using sunflower protein in sports bar formulations, achieving a high protein content requires either increasing its concentration in the product or combining it with other protein sources.

The amino acid composition analysis of protein isolates demonstrated that sunflower protein has a competitive profile compared to soy protein and significantly surpasses collagen protein in essential amino acid content (Table 1). This study specifically compares these protein sources as they are among the most commonly used in sports bars, excluding whey protein. The primary goal was to assess the practical value of these plant-based isolates in protein bar production, rather than comparing them to an 'ideal' protein such as egg protein, which is rarely found in such products. This approach provides a more relevant evaluation of their functional properties, amino acid profiles, and technological suitability for manufacturing high-protein bars.

The leucine content in sunflower protein (7–8 g) is slightly lower than in soy protein (8 g) but significantly higher than in collagen protein (~3 g). Since leucine is a critical amino acid for activating the mTOR pathway, which regulates muscle protein synthesis, this confirms the effectiveness of sunflower protein in sports nutrition.

Table 1 - Comparative Analysis of the Amino Acid Composition of Sunflower, Soy, and Collagen Isolates, g

Amino Acid	Sunflower Protein Isolate	Soy Protein Isolate	Collagen Protein Isolate
BCAA (Leucine, Isoleucine, Valine), g	17-19	18-20	Almost absent
Leucine (muscle growth), g	7-8	8	3
Isoleucine, g	5-6	4.5	Absent
Valine, g	5-6	5	Absent
Arginine (blood circulation, endurance), g	6-8	7	5
Glutamic Acid (muscle recovery), g	16-18	15	12
Tryptophan (serotonin production, recovery), g	1.3-1.5	1,3	0
Lysine (muscle maintenance), g	2-3	6	3-4
Methionine + Cysteine (antioxidant protection), g	2.5-3	3	0.5-1

Isoleucine and valine in sunflower protein are present at levels of 5–6 g, exceeding those in soy protein (4.5–5 g) and significantly surpassing collagen protein.

Sunflower protein contains 6–8 g of arginine, which is substantially higher than in collagen protein (5g) and close to the level in soy isolate (7 g). Due to its high arginine content, which serves as a precursor to nitric oxide (NO), this protein may contribute to improved blood circulation, enhanced physical endurance, and post-exercise recovery. The glutamic acid content in sunflower protein (16–18 g) exceeds that of soy protein (15g) and significantly surpasses collagen protein (12 g), further confirming its effectiveness for muscle recovery.

However, a significant drawback of sunflower protein is its low lysine content (2–3 g), which is considerably lower than that of soy protein (6 g) and comparable to collagen protein (3–4 g). Since lysine is a key amino acid for muscle tissue regeneration and collagen synthesis, it is recommended to combine sunflower protein with lysine-rich sources such as pea or rice protein. By incorporating 10–15% pea protein, the total lysine content in the final product increases from 2–3 g/100 g to approximately 5–5.5 g/100 g, meeting the recommended dietary intake for sports nutrition. However, if rice protein is used instead, to reach a comparable lysine level of 5.5–6.0 g/100 g, the ratio of sunflower to rice protein should be adjusted to 70% sunflower protein and 30% rice protein.

Sunflower protein also contains 1.3–1.5 g of tryptophan, which is equivalent to soy protein (1.3 g) and significantly higher than collagen protein, where tryptophan is entirely absent. Tryptophan is a precursor to serotonin, contributing to improved recovery and nervous system regulation. A significantly higher methionine and cysteine content (2.5–3 g) in sunflower protein, compared to collagen protein (0.5–1 g), and close to soy isolate (3 g), highlights its potential in providing antioxidant protection and supporting detoxification processes.

The results indicate that sunflower protein is a promising alternative to soy protein in sports nutrition, particularly due to its high levels of arginine, glutamic acid, and total BCAA content. However, due to its low lysine content, it should be combined with other protein sources, such as pea or rice protein, to enhance the overall biological value of the product.

The incorporation of sunflower protein isolate into protein bar formulations necessitates careful consideration of its technological properties and recipe optimization to ensure a high-quality final product. A critical aspect is determining the form in which the protein is introduced - either dry or pre-hydrated. Utilizing dry sunflower protein facilitates even distribution within the mixture and allows for precise moisture control. However, it may lead to increased crumbliness in the bars, requiring the addition of stabilizing agents to maintain the desired texture. Pre-hydration of sunflower protein enhances its texturizing properties, increases the plasticity of the mass, and prevents excessive dryness in the final product, which is essential for achieving the desired consistency [6].

One technological challenge is the distinctive taste of sunflower protein, which may affect the sensory properties of the final product. To mitigate undesirable taste characteristics, incorporating flavoring agents such as cocoa powder, vanilla, or citrus extracts can help adjust the aftertaste. The inclusion of plant-based fats, such as coconut oil or cocoa butter, improves texture and reduces the graininess of the protein. A promising technological approach involves the use of enzymatically modified sunflower protein, which has been shown to reduce bitterness and enhance functional properties [7-8].

Additionally, the physicochemical properties of wheat, oat, and corn brans, as well as buckwheat hull fiber, were evaluated, focusing on their water-holding capacity (WHC) - a critical parameter for the stability and textural characteristics of sports bars. The results indicated that oat bran exhibited the highest WHC (4.2 ± 0.3 g/g), highlighting its strong water retention ability and its role in providing a soft texture (Table 2). Wheat bran also demonstrated a high WHC (3.9 ± 0.4 g/g), making it a promising ingredient for moisture stabilization. Buckwheat hull fiber (WHC = 3.5 ± 0.2 g/g) exhibited moderate water retention, contributing to an optimal texture. In contrast, corn bran had the lowest WHC (2.8 ± 0.2 g/g), which may limit its ability to retain moisture, necessitating its combination with other fiber sources.

Table 2 - Water-Holding Capacity (WHC) of the Studied Brans and Buckwheat Hull Fiber

Type of Fiber	WHC (g water/g dry sample)
Oat bran	4.2 ± 0.3
Wheat bran	3.9 ± 0.4
Corn bran	2.8 ± 0.2
Buckwheat hull fiber	3.5 ± 0.2

The incorporation of brans can vary depending on their structure and functional properties. The most effective approach involves using pre-hydrated fibers, which enable better moisture control and prevent uneven distribution of components within the bar matrix. While dry fiber can also be incorporated, it requires thorough mixing, as its fine particle size can affect texture formation. Studies indicate that pre-hydrating wheat, oat, and corn brans facilitates uniform water distribution within the product matrix, minimizing the risk of dry or excessively moist areas in the final product [10]. This is particularly critical in high-protein formulations, where protein structures interact with water and fibers to form a stable gel-like matrix [11].

The formulation modeling of sports bars was based on the obtained data regarding the amino acid composition of protein isolates, the physicochemical characteristics of brans and buckwheat hull fiber, and a literature analysis [12-14]. The primary criterion was achieving an optimal amino acid profile while maintaining a well-balanced macronutrient composition. To compensate for the limitations of sunflower protein in essential amino acids, particularly lysine, it was combined with lysine-rich protein sources such as pea or rice protein, ensuring a more balanced amino acid composition. The ratio of protein ingredients was determined not only to optimize amino acid content but also to maintain the overall macronutrient profile of the product. The final

formulation provides a protein content of 35–40%, with fats and carbohydrates carefully adjusted to ensure sustained energy release, muscle recovery, and digestive support, aligning with the requirements for sports nutrition.

When evaluating wheat, oat, and corn brans, as well as buckwheat hull fiber, their impact on WHC (water-holding capacity), texture, and nutritional value was considered. The incorporation of brans into the formulation contributes to optimal moisture retention, preventing excessive drying and extending shelf life. Conversely, corn bran contributes to a denser texture and enhances the structural stability of the product. The optimal bran content in the formulation was determined to be 15–20%, as excessive amounts could increase brittleness or cause undesirable consistency changes.

The fat component plays a crucial role in textural stability and organoleptic properties of the bars. The addition of cocoa butter or coconut oil (5–8%) improves plasticity and promotes even distribution of ingredients within the matrix. These fats also enhance the palatability and mouthfeel of the final product.

The carbohydrate component consists of isomaltooligosaccharides and natural sweeteners, such as ground dates, providing natural sweetness without the use of refined sugar. While dates have a naturally higher glycemic index, their proportion in the formulation is balanced by the presence of fiber and protein, which slow down glucose absorption. As a result, the estimated glycemic index (GI) of the final product remains in the range of 35–40, classifying it as a low-GI food suitable for sports nutrition and individuals seeking controlled energy release.

Based on the obtained data, a formulation was developed, incorporating 30–35% sunflower protein isolate, 10–15% lysine-rich protein, 15–20% brans, 8–12% fats, and 20–30% carbohydrates, resulting in a protein content of 35–40 g per 100 g of product. This composition aligns with the nutritional requirements of sports nutrition, ensuring a high protein density while maintaining functional properties. The macronutrient ratio supports muscle protein synthesis, controlled glycemic response, and digestive health, making the formulation suitable for prolonged energy release and post-exercise recovery. The results highlight the feasibility of sunflower protein and brans as key ingredients in protein bars, enhancing nutritional value, amino acid balance, and technological adaptability for functional food production.

In conclusion, the integration of sunflower protein into the production technology of sports bars requires a comprehensive approach to recipe development and optimization of technological parameters. The strategic use of protein blends, stabilizers, natural sweeteners, and brans enables the creation of a competitive product with improved nutritional characteristics and stable texture. This approach opens up prospects for the development of the sports nutrition market and the creation of products that meet global quality standards.

Conclusion

Market analysis of protein bars has shown that most manufacturers rely on conventional protein sources (soy isolate, collagen hydrolysate), which have certain limitations in terms of biological value and fiber content. The study confirmed that sunflower protein isolate is a promising alternative due to its high arginine content (6–8 g/100 g) and BCAA levels (17–19 g/100 g). However, its low lysine content (2–3 g/100 g) necessitates combination with other protein sources, such as pea or rice protein, to achieve a balanced amino acid profile.

Physicochemical evaluation of wheat, oat, and corn brans, as well as buckwheat hull fiber, revealed that oat bran exhibits the highest water-holding capacity, contributing to improved bar texture, whereas corn bran increases texture density and enhances structural stability. The obtained data were used to model formulations that combine protein isolates and brans to enhance the technological and functional properties of the bars.

Thus, sunflower protein isolate has significant potential for use in sports protein bars, particularly when combined with complementary protein sources to optimize the amino acid composition. The addition of brans improves moisture retention, structural stability, and textural properties, making the final product competitive in the functional food market.

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ВИКОРИСТАННЯ БІЛКА СОНЯШНИКОВОГО ІЗОЛЯТУ ТА ВИСІВОК У ТЕХНОЛОГІЇ ВИРОБНИЦТВА СПОРТИВНИХ БАТОНЧИКІВ

Анотація

Сучасні харчові тенденції, зумовлені урбанізацією та швидким ритмом життя, сприяють зростанню попиту на зручні, поживні продукти, зокрема спортивні протеїнові батончики. Вони є джерелом білка та висівок, що робить їх популярними серед спортсменів, офісних працівників і студентів. У традиційних рецептурах батончиків використовуються білкові ізоляти тваринного та рослинного походження, зокрема сироватковий та соєвий білки. Однак сучасні вимоги щодо харчової безпеки та стійкості виробництва стимулюють пошук альтернатив. Перспективним інгредієнтом є ізолят соняшникового білка, отриманий із соняшникового шроту – побічного продукту олійно-жирової промисловості. Україна є одним із провідних світових виробників соняшнику, що створює значний потенціал для його застосування у функціональних продуктах. Соняшниковий білок має збалансований амінокислотний склад, відсутність антипоживних речовин і гіпоалергенність, що робить його конкурентоспроможною альтернативою традиційним білковим компонентам. Окрім білка, важливу роль у складі спортивних батончиків відіграють висівки, що сприяють здоровому травленню, підтримують мікрофлору кишечника, знижують глікемічне навантаження та покращують текстуру. Використання висівок із побічних продуктів переробки зернових (пшеничних, вівсяних, кукурудзяних висівок) та висівок гречки дозволяє зменшити собівартість та підвищити харчову цінність. Дослідження показало, що вівсяні висівки мають найвищу вологоутримуючу здатність, що допомагає зберігати вологість продукту, тоді як пшеничні висівки забезпечують баланс між стабільністю текстури та її м'якістю. Висівки гречки, багаті на антиоксиданти, підвищують функціональну цінність, а кукурудзяні висівки можуть формувати більш щільну структуру. Аналіз ринку спортивних батончиків в Україні показав відмінності у рецептурах. Деякі бренди, як Lipo Bar, пропонують батончики з високим вмістом білка (до 40%) та достатньою кількістю висівок, тоді як інші, зокрема PowerPro, використовують дешевші білкові компоненти та високий вміст цукру, що знижує харчову цінність продукції. Проведений аналіз підтвердив, що соняшниковий білок є перспективним альтернативним джерелом для спортивного харчування. Однак через його відносно низький вміст лізину рекомендовано комбінування з білками, багатими на цю амінокислоту (гороховий, рисовий білок). Додавання висівок із вітчизняної сировини дозволяє покращити текстуру, функціональні властивості та подовжити термін зберігання продукту.

Ключові слова: протеїнові батончики, соняшниковий білок, висівки, спортивне харчування, альтернативні білкові джерела, функціональні продукти.

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