UDC 664.682.9
DOI: 10.15587/2312-8372.2017.96665

Bochkarev S.,
Matveeva T.,
Krichkovska L.,
Petrova I.,
Petrov S.,
Belinska A.

RESEARCH OF THE OILSEEDS RATIO ON THE OXIDATIVE STABILITY OF THE PROTEIN-FAT BASE FOR SPORTSMEN

Досліджено окисну стабільність обраного олійного насіння і його сумішей при різних співвідношеннях компонентів. Здійснено розрахунок з використанням методу математичного планування експерименту оптимального вмісту олійного насіння в білково-жировій основі з метою уповільнення окисних процесів. Використання такої основи в технологіях харчової, зокрема кондитерської промисловості, відкриває широкі можливості для розширення асортименту продукції спеціалізованого призначення для спортсменів.

Ключові слова: *олійне насіння, незамінні амінокислоти, поліненасичені жирні кислоти, окисна стабільність, харчування спортсменів.*

1. Introduction

The challenge with increase in physical working capacity and acceleration of recovery processes after physical activities belongs to the most urgent problems within work, medicine and sport. Nutrition is the main operatable factor which provides health and human life's quality, active longevity, normal development of a human organism, working capacity. In modern conditions the product assortment due to achievements of genetic engineering, implementation of modern technologies, application of new chemical compounds, cultivation of plants with changed gene code extends. The main agents of negative impact caused by such foodstuff on humans are the dangers of a microbiological and technogenic origin connected with environmental pollution and food components. It should be noted that a daily diet, according to [1–3], can't provide a human organism, and in particular the athlete, with all necessary biologically active substances in the required quantity. Scientists [4, 5] consider that for acceleration of organism's recovery and active replenishment of the spent energy resources and that needs for flexibility in sport it is necessary to use the dietary supplements (DS). There are statistical data [6] that from 59 to 88 % of athletes in the world regularly use polyvitamins, mineral additives, proteins and others active substances. Distribution and impact of dietary supplements into sport is caused by a number of circumstances. The athlete cannot always fill up a disadvantage of vitamins and mineral substances using just a traditional nutrition. These results caused by the fact that during the daily trainings the speed of a catabolism of muscle fibers proteins exceeds the speed of normal digestion of food in an organism and therefore it influences supply of necessary substances to all parts and fibres of the human body. And the lack of necessary substances leads to reduction in the rate of restoration of energy and plastic resources in an organism, which is reflected in sports working capacity [7, 8]. Authors [6] consider that, despite the ambiguous attitude to dietary supplements that both scientific, and ordinary people have, the use of dietary supplements is necessary for maintenance and health preservation for the persons playing amateur or professional sports.

One of the perspective trends in efficiency improvement of athletes' implementation in diets is the introduction qualitatively new foodstuff which meets requirements for their organism. The products which are characterized by the high caloric content, high content in carbohydrates, fats and proteins, in particular candies, sweets sand confectionary products can become an example of such products. But modern confectioneries have two main shortcomings – low expiration dates and compositional imbalance.

The increase in the shelf life is already solved today by the introduction of antioxidants [9], most often of the synthetic origin, but they can be replaced by natural. The vegetable fats used in production of confectionery are unbalanced in relation to composition of fatty acids [10, 11], but this problem is solvable. So, having solved these two problems, these products can already today become products for health purposes. Thus, study and development of high-quality Ukrainian products with biologically valuable components, such as polyunsaturated fatty acids (PUFA) and full-fledged proteins, with long storage duration for a daily diet of athletes, are urgent and reasonable.

2. The object of research and its technological analysis

The object of this research is the composition of a protein-fat basis for a balanced diet for athletes. This product will promote decrease in deficit in quantity of nutritional substances, including PUFA and irreplaceable branched-chain amino acid (BCAA) amino acids – leucine, isoleucine, valine. In order to obtain this basis, we used oil-containing raw materials, namely seeds of sunflower, flax and sesame. In the previous work, the authors of [12] substantiated the choice of this basis using an integrated approach based on modern knowledge in the field of food chemistry and nutrition.

However, the greatest problem of the product obtained remains low shelf life. The problem of extending the shelf

life can be solved not only by the addition of antioxidants. The optimum ratio of oil seeds in the product can significantly increase its shelf life.

3. The aim and objectives of the study

The aim of research is assessment of triglycerides oxidation processes in a protein-fat basis which can be used for the development of the balanced diet of athletes.

For effective achievement of this aim it is necessary to solve the following:

1. To investigate the oxidative stability of sunflower, sesame and flax seeds.

2. To investigate the oxidative stability of seed mixtures with different component ratios.

3. To determine the influence of the mixture components ratio during the oxidation induction period and establish a range of ratios for the selected oil seeds in the mixture, at which a high period of induction of oxidation is observed.

4. Research of existing solution of the problem

The key point of the athlete's working capacity is the optimal energy supply for the muscular activity. The main material for muscle work is proteins that give them the flexibility [13]. Protein provides growth and renewal of muscle fibers. The average daily physiological quantity of proteins that a person need is constantly investigated for 150 years and periodically highlighted in decisions of FAO, WHO and national organizations of different countries [14].

For 1991, according to [13], the recommended norms of protein intake are 2.4–2.8 g per kg of body weight for athletes within certain sport disciplines (in particular speed-strength). For women, the protein intake per day as a whole is somewhat lower and amounts to 1.0–1.5 g per kg of body weight [13]. At present, scientific views on the challenge to meet the increased needs of athletes in the protein are far away from the notion of the benefits of diets with a very high its content. The results of studies carried out by scientists [15] indicate that with an increase in the amount of protein in the diet to 2.4 g/kg of body weight, further increase in protein synthesis no longer occurs.

Today, there is no unequivocal answer to the question about the «norm» of protein for athletes. It is considered that in order to meet the increased needs of athletes it is enough to increase consumption of protein by 50–125 % in comparison with the standard norms. There are the following recommendations for protein intake for athletes per day:

– 1.2–1.4 g per kg of body weight within sport disciplines that require endurance [16];

– 1.7–1.8 g per kg of body weight within power sport disciplines [17];

– up to 2 g per kg of body weight in speed-strength sport disciplines [18].

Regardless of scientific views, athletes often practice the use of protein in amounts of 300–775 % of the recommended intake rates [18]. In power sports opinion roots for a long time and firmly on the benefits of diets with very high protein content in order to increase muscle mass and, accordingly, strength.

There are many different types of components which can use in creating special purpose foods for athletes.

A composition for the production of fitness sweets is provided in [19, 20], containing the following components:

– succinic acid;
– L-carnitine;
– buckwheat flakes;
– starch syrup;
– dry whey protein concentrate;
– cake from pine nut kernels;
– hemoglobin powdery;
– powder of pomegranate seeds;
– citric acid;
– glycerin;
– a sweet component consisting of erythritol with sugar 1:20.

This invention makes it possible to improve the organoleptic and ergogenic properties of the product, to reduce the sugar content of the composition. The object of the invention is to create and expand an assortment of food products for athletes in the form of fitness sweets that have excellent consumer properties.

The composition for the production of a cereal sweet is presented in [21]. Such a preparation includes:

– autolysate of brewer's yeast;
– vitamin premix;
– calcium lactate;
– magnesium citrate;
– succinic acid;
– L-carnitine;
– buckwheat flakes;
– extruded rice;
– nuts roasted and crushed;
– starch syrup;
– honey;
– granulated sugar;
– citric acid;
– glycerin;
– flavoring «vanilla».

This product serves as a source of irreplaceable and substitutable amino acids for athletes and people with the active lifestyle, and also allows expanding the range of confectionery products with improved quality indices and high nutritional properties.

In composition for the production of sweets for athletes with improved organoleptic and ergogenic properties [22] include the following components:

– autolysate of brewer's yeast;
– succinic acid;
– L-carnitine;
– a mixture of flour from chick pea and CO_2-coffee cake in a ratio of 7:1;
– starch syrup;
– hemoglobin powdery;
– dihydroquercetin;
– dry licorice roots extract;
– citric acid;
– glycerin;
– sugar.

This base can be used for the production of sugar confectionery for people engaged in fitness and experiencing low power loads.

The main source of proteins in Ukraine can be the seeds of oilseeds, namely sunflower, flax and sesame.

ISSN 2226-3780

Sunflower is the most widespread oilseed crop, both in Western and Eastern Europe, particularly in Ukraine. Sunflower seeds contain 13–20 % of protein and a large amount (about 65 %) of linoleic acid (ω-6 PUFA). In addition, it contains a great number of useful nutrients. Seeds are used in both raw and roasted form in the food industry, not only for the production of oil, but also, for example, as a component of dough for the production of bread. Sunflower seeds have found their application in medicine: a decoction of sunflower seeds is used to clean blood vessels, improve blood circulation. The sunflower seed protein is relatively easily digestible, highly valuable and fairly balanced in amino acid composition [14]. However, in comparison with soy protein, it is characterized by a lack of lysine and a number of essential amino acids, but much richer in sulfur-containing amino acids. In its composition, the protein of sunflower seeds does not contain significant anti-nutrients. A large set of useful nutrients has also affected the use of seed processing products in cosmetics, for example, in the manufacture of various creams [13].

Flax seeds have a high content of α-linolenic acid (about 60 %) and are practically the only source of ω-3 PUFA. This fatty acid increases the intensity of metabolism and normalizes it in much pathologies, increases oxygen uptake by tissues. The protein content of the seeds is approximately 25 % [23].

Sesame seeds contain antioxidants, sesamol and sesamolin, which increase the resistance to oxidation not only of sesame seeds but also of other seeds in the mixture [24].

It should be noted that the proteins of sunflower seeds and sesame seeds are the most valuable in the content of essential amino acids. According to the fatty acid composition the most valuable are flax seeds.

5. Methods of research and experimental part

The following materials were used for research:
– sunflower seeds according to DSTU 7011:2009;
– flax seeds according to GOST 4967:2008;
– sesame seeds according to GOST 7012:2009.

Organoleptic and physicochemical parameters of protein-fat basis, fat content in seeds are determined by standard methods, given in DSTU 7011:2009. The amino acid composition is determined according to the recommendations of ISO 13903:2005. Oxidative stability is determined by the accelerated method of «active oxygen» at a temperature of 85 °C [25]. The induction period is determined graphically from the peroxide number change curves.

For the planning of the experiment and data processing, mathematical methods have been applied using the software packages Misrosoft Offset 2003 (USA) and Stat Soft Statistica v6.0 (USA). In order to calculate the relationship between oil seeds in the base, simplex-lattice Sheffe plans have been used.

6. Research results

Flax seeds, because of the content of ω-3 PUFA, are prone to rapid oxidation, and this may affect the shelf life of the final product. In order to determine the optimum content of oilseed seeds to reduce the degree of oxidation of the protein-fat basis, the method of mathematical experiment planning (the plan of the three-factor experiment) has been used on the basis of 10 experiments.

Oxidative stability of triacylglycerols in ground oil seeds and their mixtures is determined by the method of «active oxygen» at a temperature of 85 °C. The experiment has been carried out in a bubbling type reactor with a constant rate of supply of oxygen of air with mixing and free access of light. The experiments have been carried out in accordance with the «composition – property» plan (Table 1). The factors were the content of selected oil seeds (c_s, c_{ss}, c_f) in samples of their mixtures. The response function is the induction period (*IP*) of the samples.

Table 1

The period of induction of oxidation of selected seeds and their mixtures

Sample No	The content of seeds in the mixture, mass fractions			Period of induction, *IP*, minutes
	sunflower, c_s	sesame, c_{ss}	flax, c_f	
1	1	0	0	136
2	0	1	0	473
3	0	0	1	64
4	0.66	0.33	0	248
5	0.33	0.66	0	361
6	0	0.66	0.33	274
7	0	0.33	0.66	148
8	0.66	0	0.33	82
9	0.33	0	0.66	76
10	0.33	0.33	0.33	267

The regression equations, which are the dependence of the induction oxidation period on the content of selected oil seeds, have the form:

$$IP = 123.9714 \cdot c_s + 462.2571 \cdot c_{ss} + 58.6857 \cdot c_f + \\ + 114.4286 \cdot c_s \cdot c_{ss} + 7.7143 \cdot c_s \cdot c_f - 159.4286 \cdot c_{ss} \cdot c_f, \quad (1)$$

where c_s – content of sunflower seeds in the mixture, % of the mass; c_{ss} – content of sesame seeds in the mixture, % of the mass; c_f – content of flax seeds in the mixture, % of the mass; *IP* – period of induction, minutes.

The verification of the coefficients significance, which has been carried out by the Student's test using three parallel experiments, has showed the significance of the coefficients presented in the polynomial (1). Based on the conducted experiments, the regression equation was calculated and tested for adequacy by the Fisher criterion (at significance level $\alpha = 0.05$).

Fig. 1 shows the dependence of the induction period for oxidation of the mixture on the mass fractions of seeds, namely flax seeds, sunflower seeds and sesame seeds.

It can be seen from Fig. 1 that with the increase in the content of sesame seeds in the mixture, its induction oxidation period increases. This can be explained by the action of sesamol, which is a potent plant antioxidant.

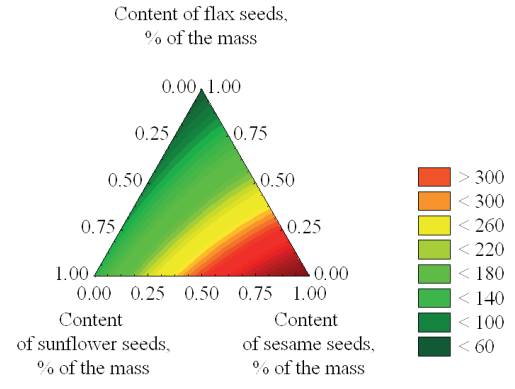

Fig. 1. Dependence of the induction period for oxidation on the content of oil seeds in the mixture

On the basis of the analysis of equation (1) and the graphical dependence for the purpose of reducing the degree of oxidation processes, the optimum content for each oil seed species was established: sunflower seed – 20 ± 5 %, flax seed – 50 ± 5 % and sesame seed – 30 ± 5 %. The period for oxidation induction of this mixture is within the range of 175–195 minutes, which exceeds the period of induction of sunflower seeds by approximately 1.3–1.4 times and the induction period of flax seed is approximately 2.7–3.0 times.

7. SWOT analysis of research results

Strengths. Among the strengths of this study, it is necessary to note a well-founded calculation of the optimal content of components in the protein-fat basis for athletes' nutrition in order to improve its shelf life. According to the analysis of modern scientific literature, today such data are not available. The obtained mixture of oil seeds for the protein-fat base has a high content of essential amino acids BCAA and a balanced composition for essential PUFA. In addition, this mixture has a large induction period of oxidation, and as a result – increased shelf life. The nutritional value of the final product is also enhanced by the fact that in the manufacture of the seed mixture, its components are not subjected to prolonged temperature treatment. The use of such basis in food technology, in particular confectionery industry, opens up wide opportunities for expanding the range of specialized products for athletes, because at present such a kind of domestic products on the Ukrainian market is almost absent.

Weaknesses. The weak side of this development can be considered a choice for the protein-fat basis of such expensive component as sesame seeds, which contain sesamol and sesamin. These antioxidants slow oxidative processes of triacylglycerols of oil seeds. This component of the mixture of oil seeds can be replaced by a cheaper one, for example, pumpkin seeds. But then in order to prevent oxidative processes in the mixture it is necessary to additionally introduce an antioxidant of natural origin.

Opportunities. In the future, it will be expedient to conduct more detailed studies on the development of formulations of sugar confectionery for athletes. In addition, it is necessary to consider other variants of protein-fat bases in the future, including using pumpkin seeds or walnuts. Such a replacement will further expand the range of products for athletes.

The introduction of this product into the production at the enterprises of the food industry in Ukraine will help to reduce the import of similar goods and the growth of domestic production.

Threats. Difficulties in implementing the results can be associated with the reorientation of enterprises from products for mass consumption to specialized products for a single layer of the population, in particular athletes. In addition, manufacturers, involving medical experts, must prove that the designed protein-fat basis has a positive effect on the athlete's body. This will entail additional costs for businesses.

Thus, SWOT analysis of research results allows to determine the main directions for achieving the aim of research, namely:

– to develop scientifically grounded recommendations on the selection of ingredients for the creation of enriched foods for athletes not only of high biological value, caloricity, but also an extended shelf life;
– to evaluate the effectiveness of the use of new food products and develop a diet for athletes, including using the developed products;
– to develop technical documentation for the enriched protein-fat basis;
– to develop technological solutions for obtaining an enriched protein-fat basis for athletes.

8. Conclusions

1. The oxidative stability of crushed sunflower seeds, sesame seeds and flax has been studied. It has been established that sesame seeds are the least susceptible to oxidation, and flax seeds are the most unstable to oxidative damage.

2. The oxidative stability of crushed seeds mixtures has been studied at different component ratios. It has been established that the mixture with the seeds of flax and sunflower is the most prone to oxidation. When adding sesame seeds to the mixture, the oxidative stability increases sharply.

3. The influence of the components ratio in the mixture on its oxidation induction period has been determined mathematically. The optimal content for each type of oil seeds is established, namely sunflower – 20 ± 5 %, flax – 50 ± 5 % and sesame – 30 ± 5 % of the mixture weight. The period of induction of oxidation of this mixture is in the range of 175–195 minutes, which exceeds the period of induction of sunflower seeds by approximately 1.3–1.4 times and about 2.7–3.0 times of flaxseed.

References

1. Naumova, N. L. Funktsional'nye produkty pitaniia kak osnova dlia sozdaniia sistemy profilakticheskoi meditsiny [Text] / N. L. Naumova. – Cheliabinsk: Tsitsero, 2013. – 126 p.
2. Binkovskaia, O. V. Lechebno-profilakticheskoe pitanie [Text] / O. V. Binkovskaia, N. I. Miachikova. – Belgorod: BelGU, 2012. – 100 p.
3. Verhagen, H. Status of nutrition and health claims in Europe [Text] / H. Verhagen, E. Vos, S. Francl, M. Heinonen, H. van Loveren // Archives of Biochemistry and Biophysics. – 2010. – Vol. 501, № 1. – P. 6–15. doi:10.1016/j.abb.2010.04.012
4. Topchii, N. V. Ratsional'noe pitanie kak istochnik zdorov'ia [Text] / N. V. Topchii // Meditsinskaia sestra. – 2002. – № 2. – P. 31–35.

ISSN 2226-3780

5. Holway, F. E. Sport-specific nutrition: Practical strategies for team sports [Text] / F. E. Holway, L. L. Spriet // Journal of Sports Sciences. – 2011. – Vol. 29, № sup1. – P. S115–S125. doi:10.1080/02640414.2011.605459
6. Gas'kova, N. P. Biologically active supplements food patterns of athlete [Text] / N. P. Gas'kova, A. M. Sadovnikova // Theory and Practice of Physical Culture. – 2011. – № 6. – P. 59–61.
7. Paquot, N. Sports nutrition [Text] / N. Paquot // Revue Medicale de Liege. – 2001. – Vol. 56, № 4. – P. 200–203.
8. Maughan, R. The athlete's diet: nutritional goals and dietary strategies [Text] / R. Maughan // Proceedings of the Nutrition Society. – 2002. – Vol. 61, № 1. – P 87–96. doi:10.1079/pns2001132
9. Correia-Oliveira, C. R. Strategies of Dietary Carbohydrate Manipulation and Their Effects on Performance in Cycling Time Trials [Text] / C. R. Correia-Oliveira, R. Bertuzzi, M. A. P. Dal'Molin Kiss, A. E. Lima-Silva // Sports Medicine. – 2013. – Vol. 43, № 8. – P. 707–719. doi:10.1007/s40279-013-0054-9
10. Zollner, N. Fatty acid composition of the diet: impact on serum lipids and atherosclerosis [Text] / N. Zollner, F. Tato // The Clinical Investigator. – 1992. – Vol. 70, № 11. – P. 968–1009. doi:10.1007/bf00180309
11. Krichkovskaya, L. V. The vitamin enrichment of fatty products [Text] / L. V. Krichkovskaya, A. P. Belinskaya, E. T. Zhilyakova // Belgorod State University Scientific Bulletin. Series «Medicine. Pharmacy». – 2010. – Vol. 9, № 4 (75). – P. 70–75.
12. Bochkarev, S. Development of the protein-fatty base of the sugar confectionery for nutrition of the sportsmen [Text] / S. Bochkarev, V. Papchenko, T. Matveeva, A. Belinska, V. Rudniev // Technology Audit And Production Reserves. – 2016. – № 5/3 (31). – P. 58–64. doi:10.15587/2312-8372.2016.81142
13. Lemon, P. W. R. Effect of exercise on protein requirements [Text] / P. W. R. Lemon // Journal of Sports Sciences. – 1991. – Vol. 9, № sup1. – P. 53–70. doi:10.1080/02640419108729866
14. Lytvynenko, O. A. Vyrobnytstvo kharchovykh form bilkiv iz nasinnia oliinykh kultur [Text] / O. A. Lytvynenko, F. F. Hladkyi, Z. P. Fediakina. – Kyiv: Ahrarna nauka, 2016. – 52 p.
15. Borisova, O. O. Pitanie sportsmenov: zarubezhnyi opyt i prakticheskie rekomendatsii [Text] / O. O. Borisova. – Moscow: Sovetskii sport, 2007. – 132 p.
16. Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine [Text] // Journal of the American Dietetic Association. – 2000. – Vol. 100, № 12. – P. 1543–1556. doi:10.1016/s0002-8223(00)00428-4
17. Rogozkin, V. A. Pitanie sportsmenov [Text] / V. A. Rogozkin, A. I. Pshendin, N. N. Shishina. – Moscow: Fizkul'tura i sport, 1989. – 115 p.
18. Steen, S. N. Precontest Strategies of a Male Bodybuilder [Text] / S. N. Steen // International Journal of Sport Nutrition. – 1991. – Vol. 1, № 1. – P. 69–78. doi:10.1123/ijsn.1.1.69
19. Kompozitsiia dlia proizvodstva fitnes-batonchikov [Electronic resource]: Patent RU 2583083, MPK[8] A23G 3/00, A23L 7/10, A23L 33/00 / Tarasenko N. A., Arhipov V. Yu.; assignee: Kuban State Technological University. – № 2015119726/13; filed 25.05.2015; published 10.05.2016, Bull. № 13. – Available at: \www/URL: http://www.findpatent.ru/patent/258/2583083.html
20. Sposob proizvodstva fruktovyh batonchikov dlia funktsional'nogo pitaniia s ovoshchnymi, zlakovymi i orehovymi dobavkami [Electronic resource]: Patent RU 2493720, MPK[8] A23G 3/48, A23L 1/29 / Vinnitskaia V. V., Popova E. I., Korshunov A. Yu., Komarov S. S.; assignee: Michurinsk State Agrarian University. – № 2012112690/13; filed 02.04.2012; published 27.09.2013, Bull. № 27. – Available at: \www/URL: http://www.findpatent.ru/patent/249/2493720.html
21. Grain bar containing amino-acid vitamin-and-mineral complex and bar production method [Electronic resource]: Patent RU 2468606, MPK[8] A23L 1/10, A23L 1/164, A23G 3/00 / Pervushin V. V., Edelev D. A., Kaplin L. A., Doronin A. F., Bakumenko O. E.; assignee: Moscow State University of Food Production. – № 2010122252/13; filed 01.06.2010; published 10.12.2012, Bull. № 34. – Available at: \www/URL: https://patents.google.com/patent/RU2468606C2/en
22. Kompozitsiia dlia proizvodstva sportivnyh batonchikov [Electronic resource]: Patent RU 2599821, MPK[8] A23G 3/00, A23L 33/00, A23L 11/00 / Levchenko M. A., Tarasenko N. A.; assignee: Kuban State Technological University. – № 2015130934/13; filed 24.07.2015; published 20.10.2016, Bull. № 29. – Available at: \www/URL: http://www.findpatent.ru/patent/259/2599821.html
23. Gandhi, A. P. Organoleptic and nutritiona l assessment of sesame (*Sesame indicum*, L.) biscuits [Text] / A. P. Gandhi, V. Taimini // Asian Journal of Food and Agro-Industry. – 2009. – Vol. 2, № 2. – P. 87–92.
24. Zubtsov, V. A. L'nianoe semia, ego sostav i svoistva [Text] / V. A. Zubtsov, L. L. Osipova, T. I. Lebedeva // Zhurnal Rossiiskogo himicheskogo obshchestva im. D. I. Mendeleeva. – 2002. – № 2. – P. 14–16.
25. Belinska, A. Tekhnolohiia kupazhovanoi olii pidvyshchenoi biolohichnoi tsinnosti [Text]: Dissertation of PhD: 05.18.06 / A. Belinska. – Kharkiv, 2011. – 230 p.

ИССЛЕДОВАНИЕ ВЛИЯНИЯ СООТНОШЕНИЯ МАСЛИЧНЫХ СЕМЯН НА ОКИСЛИТЕЛЬНУЮ СТАБИЛЬНОСТЬ БЕЛКОВО-ЖИРОВОЙ ОСНОВЫ ДЛЯ ПИТАНИЯ СПОРТСМЕНОВ

Исследована окислительная стабильность выбранных масличных семян и их смесей при различных соотношениях компонентов. Проведен расчет с использованием метода математического планирования эксперимента оптимального содержания масличных семян в белково-жировой основе с целью замедления окислительных процессов. Использование такой основы в технологиях пищевой, в частности кондитерской, промышленности, открывает широкие возможности для расширения ассортимента продукции специализированного назначения для спортсменов.

Ключевые слова: масличные семена, незаменимые аминокислоты, полиненасыщенные жирные кислоты, стойкость к окислению, питание спортсменов.

Bochkarev Sergiy, *Senior Lecturer, Department of Physical Education, National Technical University «Kharkiv Polytechnic Institute», Ukraine, e-mail: bochkarev.s.v@gmail.com, ORCID: http://orcid.org/0000-0003-4399-7907*

Matveeva Tatiana, *PhD, Associate Professor, Scientific Secretary, Ukrainian Scientific Research Institute of Oils and Fats of the National Academy of Agricultural Sciences of Ukraine, Kharkiv, Ukraine, e-mail: matveeva_73@mail.ru, ORCID: http://orcid.org/0000-0002-3867-8146*

Krichkovska Lidiya, *Doctor of Biological Sciences, Professor, Head of Department of Organic Synthesis and Nanotechnology, National Technical University «Kharkiv Polytechnic Institute», Ukraine, ORCID: http://orcid.org/0000-0001-8197-9801*

Petrova Iryna, *PhD, Doctor of Juridical Science, Professor, Department of Information Security, Kharkiv National University of Internal Affairs, Ukraine, e-mail: ekobezpeka.ira@gmail.com, ORCID: http://orcid.org/0000-0002-1652-6715*

Petrov Sergey, *PhD, Associate Professor, Department of Organic Synthesis and Nanotechnology, National Technical University «Kharkiv Polytechnic Institute», Ukraine, e-mail: petrowsa@gmail.com, ORCID: http://orcid.org/0000-0001-6500-5310*

Belinska Anna, *PhD, Associate Professor, Department of Organic Synthesis and Nanotechnology, National Technical University «Kharkiv Polytechnic Institute», Ukraine, e-mail: belinskaja.a.p@gmail.com, ORCID: http://orcid.org/0000-0001-5795-2799*