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MODELING OF FATTY ACID COMPOSITION OF COMBINED FOOD PRODUCTS

The object of research is the fatty acid composition of the milk-fat base for combined food products of a healthy diet. The biological effectiveness of fats is determined by the ratio of saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids, including the ratio of omega-3 PUFA:omega-6 PUFA. Not all foods have a balanced fatty acid composition, in particular, dairy products contain excessive amounts of SFAs, the excessive consumption of which leads to an increase in blood cholesterol levels, which increases the risk of cardiovascular disease. The amount of mono- and polyunsaturated fatty acids, essential in nutrition, in milk fat (and, accordingly, in dairy products) is insufficient. Therefore, this study is aimed at developing the composition of the milk-fat base with a balanced fatty acid composition using natural vegetable oils.

The work substantiates the expediency of using vegetable oils, namely pumpkin seed as a source of monounsaturated fatty acids, rice bran oil as a source of polyunsaturated fatty acids, to optimize the ratio of SFA:MUFA:PUFA when combined with milk fat in multicomponent food products. The fatty acid composition of the milk-fat base has been optimized using a three-component mixture of fats – milk fat, pumpkin seed oil and refined rice bran oil. The ratio of fatty acids in the milk-fat base for the production of food products with a balanced fatty acid composition (SFA:MUFA:PUFA – 0.442:0.403:0.155) has been determined, which is achieved with the optimal ratio of milk fat: rice bran oil: pumpkin seed oil – 20.2:70.5:9.3. Recommendations are given on the use of the developed milk-fat base with a balanced fatty acid composition in the production of combined dairy-vegetable food products. Since today dairy products with a balanced fatty acid composition are presented in limited quantities in the global consumer market, the implementation of research will expand the niche of «healthy food». And correctly conducted marketing activities, which are proposed in this work, will allow to gain a foothold in the market of healthy food products with a balanced chemical composition and an affordable price.

Keywords: *milk-fat base, balanced fatty acid composition, milk fat, pumpkin oil, rice bran oil.*

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1. Introduction

Healthy diet is not only good health and getting rid of many ailments, a strong nervous system and normalization of weight, but also love and respect for oneself, it is the desire for a healthy and long life. More and more people in the world strive to consume healthy food: they carefully study information about the composition of foods, limiting the use of unhealthy ingredients, in particular, salt, sugar and excessive amounts of fat [1].

Unsaturated fatty acids (unsaturated fatty acids) are fatty acids that contain at least one double bond in the fatty acid chain. Depending on the saturation, they are divided into two groups:

1) monounsaturated fatty acids (MUFA), which contain one double bond;

2) polyunsaturated fatty acids (PUFA), which contain more than one double bond [2].

Both types of unsaturated fatty acids are predominantly found in plant foods. These acids are considered healthier than saturated fatty acids. Indeed, some of them have the ability to lower cholesterol and blood pressure, thereby reducing the risk of cardiovascular disease. Linoleic, linolenic and arachidonic (PUFA), oleic, myristoleic, palmitoleic (MUFA) acids are some of them.

Important: the fats that a person consumes must be fresh. The fact is that fats are easily oxidized. In stale or overheated fats, harmful substances accumulate, which serve as irritants for the gastrointestinal tract, kidneys, and disrupt metabolism. In dietetic food, such fats are strictly prohibited. The daily requirement of a healthy person for fats is 80–100 g [3].

With dietary nutrition, the qualitative and quantitative composition of fats can change. A reduced amount of fat is recommended for pancreatitis, atherosclerosis, hepatitis, diabetes, exacerbation of enterocolitis, obesity. With the depletion of the body and during the recovery period after long-term illnesses, on the contrary, it is recommended to increase the daily rate of fat to 100–120 g.

The biological effectiveness of fats is determined by the ratio of saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids [4].

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Saturated fatty acids are used by the human body mainly as an energy material, but their excessive consumption leads to an increase in blood cholesterol levels, which increases the risk of cardiovascular diseases [5].

Monounsaturated fatty acids help lower blood pressure and blood cholesterol. Oleic acid (ω–9) helps maintain a healthy weight, strengthens the body's protective functions, which is necessary for vascular health, hormone synthesis, normal metabolism and many other processes that ensure health and longevity [5, 6].

Linoleic (ω–6) and linolenic (ω–3) fatty acids are irreplaceable (essential) and must be supplied with food. The quality of dietary fats and the ratio of ω–6 and ω–3 fatty acids in them affect the function of cell biomembranes, stimulate the functions of internal organs, normalize blood circulation and oxygen exchange, strengthen the immune system, and reduce cholesterol. They have the unique ability to reduce the risk of diseases such as arrhythmia, atherosclerosis, hypertension, diabetes, thrombophlebitis, rheumatoid arthritis, psoriasis, benign and malignant tumors, obesity, etc. [6, 7].

The minimum content of PUFA in the daily diet of an adult should be 2–6 g (4–6 % of the energy value of the diet), the recommended daily intake of PUFA is 5–10 g, and the ratio of PUFA ω–6 PUFA ω–3 should be 10:1, and in violation of lipid metabolism – 5:1 (and even 3:1) [8]. In the structure of modern human nutrition, the real ratio of ω–6 PUFAs ω–3 PUFAs ranges from 10:1 to 30:1, that is, there is a deficiency of ω–3 fatty acids [9].

None of the existing natural fats (excluding olive oil), including dairy, meets the requirements of nutritional science. Therefore, one of the tasks of developing healthy food products, including products with a balanced chemical composition, is the correct assessment of the fatty acid composition of raw materials in order to subsequently adjust it and ensure the optimal fatty acid composition of the finished product.

Cow's milk fat contains an insignificant amount of PUFA (especially in the autumn-winter period), an insufficient amount of MUFA, and an excessive amount of SFA. The ratio between SFA:MUFA:PUFA in cow's milk fat averages 0.63:0.31:0.06 [10], which does not meet the requirements of nutritional science. Various physiological and nutritional scientists recommend different levels and ratios of fatty acids in the reference fat. According to various literature data, the following ratios of SFAs are optimal in the diet of a healthy adult: SFA:MUFA:PUFA – 1.0:1.0:1.0 [3]; 0.3:0.6:0.1 [7]; 0.45:0.45:0.10 [9].

In this regard, it is of interest to modify the fatty component in healthy food products with a balanced fatty acid composition. The simplest and safest technically, economically and environmentally friendly way to obtain fats with an optimal fatty acid composition is their mixing, or blending.

Therefore, the development of the composition of the milk-fat base with a balanced fatty acid composition using natural vegetable oils is an urgent task today.

2. The object of research and its technological audit

The object of research is the fatty acid composition of the milk-fat base for combined food products of a healthy diet.

The following fats were used to model the fatty component of healthy food products:

– milk fat;
– pumpkin seed oil;
– refined rice bran oil.

The choice of oils for modeling and optimization of the fatty acid composition of combined food products of a healthy diet based on dairy raw materials was carried out taking into account the content of MUFA and PUFA. Unrefined pumpkin seed oil was a source of PUFA, and refined rice bran oil was a source of MUFA.

The calculation of the optimal ratio of milk fat, refined pumpkin oil and refined rice bran oil was performed by mathematical modeling using the simplex-centroid method of plans in the Design Expert software package [11, 12].

The problem was solved by mathematical modeling using the simplex-centroid method of plans. This method is most suitable for describing the factor space of the properties of fat mixtures and provides a uniform arrangement of experimental points with $(q-1)$-dimensional simplices, where q is the number of components [11, 12]. The designs contain a point in the center of the simplex and the centroids of all low-dimensional simplexes that store it [11, 12]. Basically, the existing recipe optimization models are reduced to:

– the problem of linear programming, in which the target function is the requirements for the maximum value of the organoleptic assessment;
– the maximum yield of any one component;
– the need for the content of a component not less than the planned value or some additive criterion – a complex indicator that takes into account the combined effect of several criteria with different weight coefficients [13, 14].

In the work, the target functions were the ratio of SF:MUF:PUFA and the ratio of PUFA ω–6:PUFA ω–3.

3. The aim and objectives of research

The aim of research is to optimize the fatty acid composition of the milk-fat base for the production of food products with a balanced ratio of SFA:MUFA:PUFA and PUFA ω–6:PUFA ω–3.

To achieve this aim, the following objectives were solved:

1. Determine the content of fatty acids in the milk-fat base for the production of food products with an optimal fatty acid composition.
2. Provide recommendations on the use of the developed milk and fat base with an optimal fatty acid composition in the production of combined dairy and vegetable food products.

4. Research of existing solutions to the problem

Many people mistakenly believe that milk fat substitutes (MFS) are harmful and even dangerous to human health. In fact, vegetable fats themselves are not dangerous at all. Their harm or benefit is determined by the quality of vegetable fats (as, by the way, and milk fat), and not by their very presence in the finished product. MFSs are high quality special fats. They are used for partial replacement of milk fat in the industrial production of spreads and milk-containing products – cream, sour milk, cottage cheese, sour cream, condensed products, curd cheeses, combined ice cream, as well as in the bakery and confectionery industry.

It is important to note that modern milk-containing products are very similar to their natural samples in terms of organoleptic characteristics and physicochemical properties. For example, milk fat substitutes obtained by the method of transesterification of vegetable fats have high plasticity and the ability to crystallize into a stable fine-crystalline polymorphic modification (β'-form) [11]. This makes it possible to bring the structural and rheological properties of the milk fat substitute as close as possible to milk fat (compatibility with milk fat up to 90 %), which is of decisive importance for improving the quality of products with a complex raw material composition.

Modern MFS not only guarantee high safety and quality indicators, but also contribute to lengthening the shelf life of the final products manufactured with their use.

It is important to note that the use of natural vegetable oils or MFS obtained by transesterification or fractionation of vegetable oils or oils in the production of dairy products is fully consistent with the trends of healthy nutrition. Replacing milk fat in the production of milk-containing products with these fats reduces the risk of cardiovascular diseases, providing the consumer with not only high-quality, but also healthy products with a balanced fatty acid composition, which are easily absorbed by the body [7].

MFS obtained by hydrogenation of vegetable oils containing a significant amount (up to 30 %) of trans fatty acids [15]. As shown by the results of fundamental research [16], an increase in the content of trans isomers of fatty acids in food contributes to the development of oncological pathology, diabetes mellitus, obesity, atherosclerosis, impaired reproductive function and some other equally serious diseases.

Therefore, it is necessary to look for natural substitutes for milk fat – plant oils, which are sources of MUFA and/or PUFA.

There are several health benefits of unsaturated fatty acids. Foods containing monounsaturated or polyunsaturated fats are considered healthier than those containing saturated fatty acids. The fact is that molecules of saturated fatty acids, getting into the blood, tend to bind to each one, which leads to the formation of plaques in the arteries. In turn, unsaturated fats are composed of large molecules that do not form compounds in the blood. This facilitates smooth passage through the arteries. The main benefit of unsaturated fats is the ability to lower bad cholesterol and triglycerides, thereby reducing the likelihood of heart disease such as strokes and heart attacks. Of course, it is almost impossible to eliminate all saturated fat from the diet, but many of them can be replaced with unsaturated fat. For example, switching to olive oil for cooking can significantly reduce your intake of saturated fat. Diet fats contain fat-soluble vitamins A, D and E, which are essential for maintaining good health [3]. Vitamins E and A are antioxidants and help support the immune system so that we stay healthy. They also aid in blood circulation and prevent plaque build-up in arteries. Vitamin D is essential for the growth and development of bones and muscles [17]. Other benefits of unsaturated fatty acids:

- have an antioxidant effect;
- have an anti-inflammatory effect;
- lower blood pressure;
- reduce the risk of certain cancers;
- improve the condition of hair and skin;
- improve blood flow (prevention of blood clots).

Omega-3s are fatty acids that lack two protons, they are «unsaturated» with hydrogen [18]. There are two main classes of unsaturated fatty acids – omega-3 and omega-6. They differ in the arrangement of the double bond in the molecule.

Omega-3 is the collective name for fatty acids. The main omega-3s include alpha-linolenic, eicosapentaenoic and docosahexaenoic acids [19]. Omega-3s are necessary for the formation of membranes around neurons, the synthesis of eicosanoids – one of the types of molecules through which the cells of the immune system communicate with each other. It is also necessary omega-3s to adjust the processes of inflammation in the body, vasoconstriction, sperm production, brain health and development [18]. Older publications have counted up to 27 cases where omega-3s have been beneficial. However, correctly conducted studies did not live up to expectations.

Omega-6 unsaturated fatty acids belong to the family of unsaturated fatty acids that have a carbon-carbon double bond located at the end of the sixth carbon atom. Linoleic acid is the main representative of long-chain fatty acids of the omega-6 (ω–6) family [20].

Fatty acids ω–6 and ω–3 compete for metabolism by enzyme systems and can replace each other. The ratio of ω–6/ω–3 polyunsaturated fatty acids, recommended by the Institute of Nutrition of the Russian Academy of Medical Sciences, should be 10:1 in the diet of a healthy person, and from 3:1 to 5:1 for medical nutrition. Based on clinical and experimental studies foreign scientists the ratio of acids ω–6 and ω–3 Recommended ranges from 4:1 to 2:1 [4].

Research by scientists has established that a living organism does not synthesize linoleic and linolenic acids, they can only come from food. Depending on the original fatty acid, the synthesized eicosanoids have a different structure and biological effect on the body, often directly proportional. Eicosanoids, formed from ω–3 fats, namely eicosapentaenoic acid, have anti-inflammatory, anti-allergic effects, thin blood and prevent blood clots, improve blood circulation, dilate blood vessels and lower blood pressure. On the contrary, eicosanoids, synthesized from arachidonic acid (ω–6), promote the development of inflammation, allergies, platelet adhesion and blood clots, and constrict blood vessels. The exception is prostaglandin E1, which is formed from γ-linolenic acid (ω–6) and has an anti-inflammatory effect, slows down the release of histamine, reducing the allergic component of inflammation. Clinical studies have shown that a deficiency in the cells of essential polyunsaturated fatty acids (especially ω–3) forms a high potential for inflammation.

Drinking «balanced omega-3/omega-6» is not worth it – we consume enough omega-6 fatty acids in vegetable oils. The main determinant of balance is the absolute amount of all types of omega-3, not their ratio to omega-6 [4].

No matter how useful unsaturated fatty acids are, it is also not worth overusing foods that contain them in large quantities. These substances are not toxic or poisonous. However, with an increased content of omega-3 acids in the body, blood thinning occurs, which can lead to bleeding.

Symptoms of excess vitamin F in the body can be stomach pain, heartburn, skin-allergic rashes, etc. It is also important to know that unsaturated acids should be consumed in certain proportions. For example, with an excess of omega-6, omega-3 acid production is impaired, which can lead to the development of asthma and arthritis.

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Pumpkin seed oil (a source of PUFA) contains large quantities of unsaturated fatty acids (mainly linoleic), vitamins A, E, F, C, B1, B2, B6, proteins, pectins, sterols, chlorophyll, flavonoids, phytosterols. As well as unique plant phospholipids and a whole complex of 53 useful minerals and trace elements, including magnesium, zinc, selenium, iron. Pumpkin seed oil is one of the richest natural sources of zinc. The oil is especially famous for the quantitative content of vitamin A, which is rightfully called the «vitamin of youth». Nature has endowed pumpkin seed oil with vitamin E, which not only performs essential functions in itself, but also protects against the destructive oxidation of vitamin A.

Rice bran oil (a source of MUFA) is rich in vitamins A, E, PP and B vitamins. Most of it is vitamin E, known as the vitamin of youth. Like many other natural oils, rice bran oil contains a lot of fatty acids. It contains about 46 % oleic (omega-9), about 36 % linoleic (omega-6) and about 1 % linolenic (omega-3) acids. Among the saturated fatty acids in rice oil are palmitic and stearic acids. Rice oil also contains tocotrienols, gamma orizonol, tocopherol and squalene. These substances are powerful bioantioxidants. Rice oil also contains phytosterols, which remove carcinogens from the body.

5. Methods of research

5.1. Investigated materials used in the study, and the methodology of the experiment. For experimental studies, the following materials were used as raw materials:

- milk fat – ghee «Yahotynske», produced by the Company with additional liability «Yahotyn Butter Plant», Ukraine;
- unrefined pumpkin oil produced by Agroselprom Limited Liability Company, Ukraine;
- refined rice bran oil produced by Kasisuri Co, LTD, Thailand.

At the first stage of experimental-statistical studies, the fatty acid composition of selected vegetable oils was determined (the fatty acid composition of milk fat was taken from the literature).

The second stage of the work consisted in the implementation of the optimization of the fatty acid composition of the three-component milk-vegetable mixture. The problem of optimizing the fatty acid composition of a three-component milk-vegetable mixture was solved by mathematical modeling by the method of simplex-centroid plans.

When carrying out the modeling, the following recommendations of physiologists were used regarding the ratio of fatty acids in food products: SFA:MUFA:PUFA – 0.45:0.45:0.10 [21]; PUFA ω–6 (C18:2): PUFA ω–3 (C18:3) – 5–10 [9].

The third stage of experimental statistical studies was to determine the content of fatty acids in the milk-fat base for the production of food products with an optimal fatty acid composition.

On the basis of the studies carried out, recommendations were provided on the use of the developed milk-fat base with an optimal fatty acid composition in the production of combined dairy-vegetable food products.

5.2. Experimental research methods used in the research. When performing experimental studies, the fatty acid composition of vegetable oils was determined by capillary gas chromatography. The preparation of a sample of oils was carried out according to DSTU ISO 5509. An oil sample of 0.2 g was dissolved in 4 cm^3 of isooctane, then 0.4 cm^3 was added to the methylation agent KOH in methanol with a concentration of 0.5 mol/dm^3, the tube was shaken for 30 s. After that, the sample was purified by adding 3 g of sodium sulfate monohydrate and filtered on a paper filter. The determination of methyl esters of fatty acids was carried out according to DSTU ISO 5508.

Chromatographic separation was carried out on a Clarus 500 gas chromatograph manufactured by Perkin Elmer (USA), equipped with a flame ionization detector and a Supelko SP-2380 quartz capillary column 30 m long, 0.32 mm in diameter and an active layer thickness of 0.20 μm. The carrier gas was helium, the detector temperature was 250 °C, the column was heated at a gradient from 50 to 230 °C, the injection mode with a flow distribution from 1 to 100, the injection mode was manual, the injection volume was $1\cdot10^{-6}$ dm^3. The Supelko®37 FAME Mix standard was used as the identification mixture.

6. Research results

The fatty acid composition of selected oils was studied by gas chromatography. The research results are shown in Table 1.

Table 1

Fatty acid composition of vegetable oils and milk fat

Fatty acid	Fatty acid content (%) in		
	pumpkin seed oil	rice bran oils	milk fat [22]
C8:0 Caprylic acid	–	0.01	0.12
C12:0 Lauric acid	–	0.02	0.57
C14:0 Myristic acid	0.09	0.39	2.62
C15:0 Pentadecanoic acid	–	0.02	0.22
C16:0 Palmitic acid	8.59	18.45	4.48
C16:1 Palmitooleic acid	0.12	0.18	1.02
C17:0 Heptadecanoic acid	0.06	0.04	–
C18:0 Stearic acid	4.37	2.18	5.97
Tr18:1 Elaidic	0.01	0.12	–
C18:1 Oleic acid	*31.31*	*41.93*	*12.30*
Tr18:2 Linoleic acid (trans isomer)	–	0.19	0.4
C18:2 Linoleic acid	*53.89*	*32.66*	*1.24*
C20:0+C18:3 n6	0.33	0.93	
C18:3 Linolenic acid	*0.14*	*1.10*	*0.63*
C20:1 Eicosanoic acid	0.17	0.62	0.13
C21:0 Heicosanoic	–	0.01	–
C20:2 Eicosadienic	–	0.02	0.12
C22:0 Behenic acid	0.45	0.37	–
C20:4 n6 Arachidonic acid	–	0.04	0.25
C22:1 n9 Erucic acid	–	0.07	–
C22:2 Docosahexaenoic	–	0.03	0.12
C24:0 Lignoceric acid	0.19	0.58	–
C24:1	–	0.02	–
C22:6 Docosahexaenoic	–	0.09	0.22

The objects of modeling were milk fat (as a source of SFA and MUFA [22]), rice oil (as a source of MUFA and PUFA), and pumpkin oil (as a source of PUFA). The summary fatty acid composition of the objects of modeling is given in Table 2.

Table 2

Consolidated fatty acid composition of objects of modeling

Modeling object name	SFA content	MUFA content	PUFA content	C18:2/C18:3 ratio
Object A – milk fat (MF)	0.63	0.31	0.06	2.80
Object B – rice bran oil (RBO)	0.22	0.43	0.35	29.69
Object C – pumpkin seed oil (PO)	0.14	0.32	0.54	384.9

As the response functions, the ratio of fatty acids was used, which, in accordance with the recommendations of physiologists selected for modeling, should be: SFA/MUFA – 0.9–1.1; MUFA/PUFA – 2.0–4.5; SFA/PUFA – 2.0–4.5; C18:2/C18:3 – 5.0–10.0.

In a graphical form, the dependence of the response functions on the ratio of modeling objects (ternary graphs) are shown in Fig. 1–4.

Analysis of the data shown in Fig. 1 shows that the optimal ratio of SFA/MUFA (0.9–1.1) is observed in three areas with a predominance of one of the used fats in the milk-fat base, due to the presence of SFA and MUFA in all three raw ingredients.

The optimal ratio of EFA/PUFA (2.0–4.5) is obtained in the central part of the study area (in the center of the triangle) when the content of vegetable oils in the milk-fat base is 72.0–83.0 % (Fig. 2), and MUFA/PUFA (2.0–4.5) – with the predominance of one of the three objects of modeling (Fig. 3).

The ratio C18:2/C18:3 (Fig. 4) does not correspond to the value specified in the modeling, it is explained by the insignificant amount of linolenic acid in the used fats, therefore, this ratio was subsequently excluded for optimization.

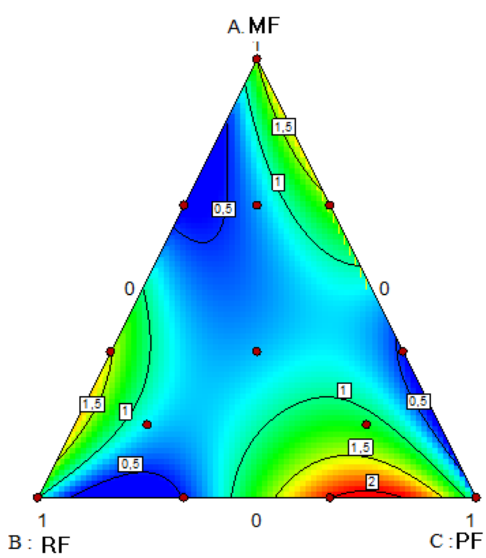

Fig. 1. Ternary graph of the SFA/MUFA ratio when combining milk, rice and pumpkin fats

To determine the area of the optimal fatty acid composition of the milk-fat base of products obtained by combining milk fat, rice bran oil and pumpkin seed oil, a software overlay of simulated response functions was performed the ratios of SFA/MUFA, MUFA/PUFA, SFA/PUFA. The results are shown in Fig. 5.

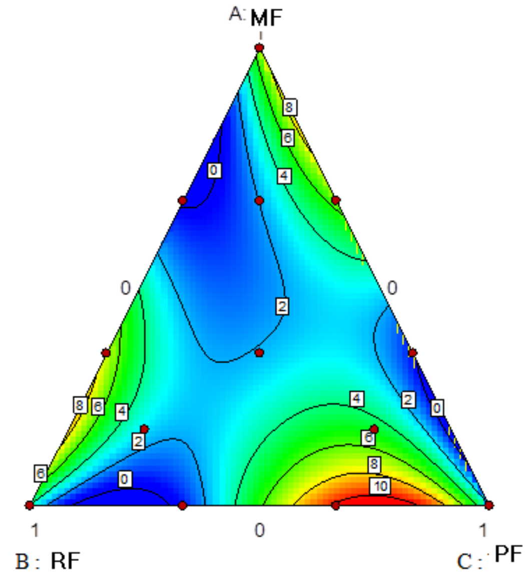

Fig. 2. Ternary graph of the SFA/PUFA ratio when combining milk, rice and pumpkin fats

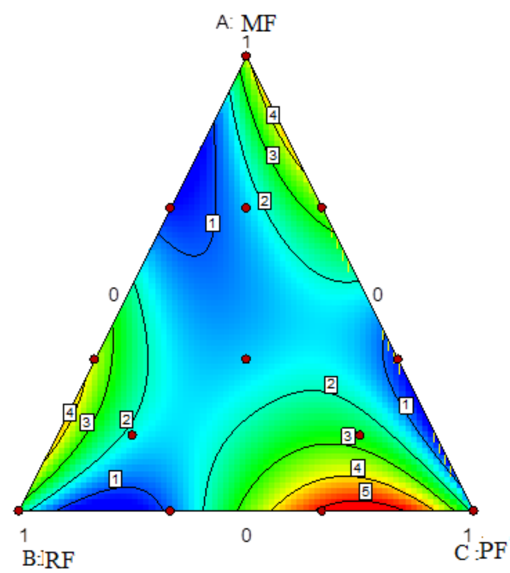

Fig. 3. Ternary graph of the PUFA/MUFA ratio when combining milk, rice and pumpkin fats

The analysis of the results obtained (Fig. 5) shows that for the production of combined food products with the optimal ratio of SFA:MUFA:PUFA, one of them should prevail in the mixture of the selected objects of modeling. The task has 68 solutions. Rice bran oil contains the maximum amount of MUFA, which are the most physiological for the human body, and also contains tocotrienols, which is recognized as a powerful antioxidant that helps to improve the functioning of the cardiovascular system. Therefore, solution 38 was chosen, in which the ratio of milk fat: rice bran oil: pumpkin seed oil is 20.2:70.5:9.3.

With this solution, the content of rice bran oil in the fat mixture is maximized. In this case, the ratio of

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SFA/MUFA is 1.098; MUFA/PUFA – 2.585; SFA/PUFA – 4.472 (SFA:MUFA:PUFA – 0.442:0.403:0.155) C18:2/C18:3 – 154.695.

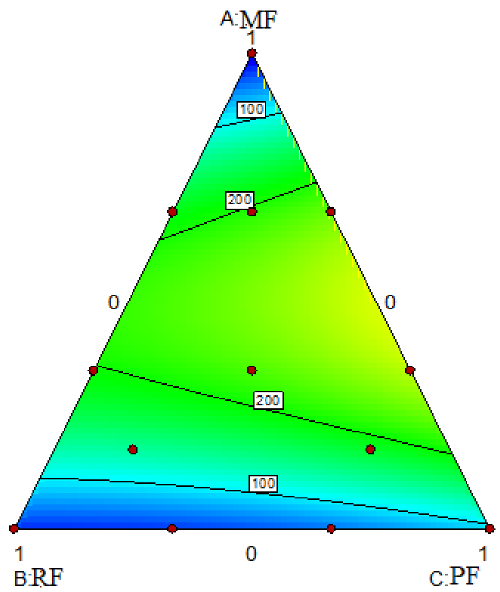

Fig. 4. Ternary graph of the C18:2/C18:3 ratio when combining milk, rice and pumpkin fats

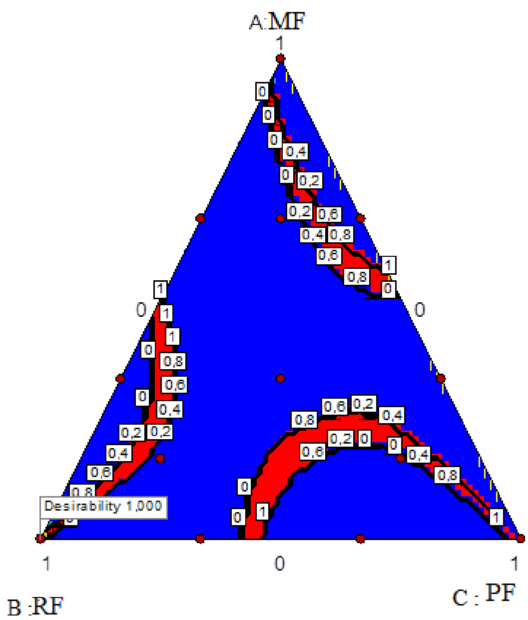

Fig. 5. The area of optimal fatty acid composition (red) of a milk-fat base with a balanced fatty acid composition, obtained by combining milk, rice and pumpkin fats

Recommendations have been developed for the ratio of milk fat: rice bran oil: pumpkin oil in the composition of the milk-fat base can be used in the production of combined dairy-vegetable products with a balanced fatty acid composition. In particular, the developed milk-fat base can be introduced into drinking and fermented beverages, fermented protein products, sour cream products, desserts on yoghurt, protein, sour cream and combined bases for various categories of the adult healthy population.

To date, a milk-fat base with a balanced fatty acid composition has already been used in the formulations of combined milk-rice yoghurts with a balanced chemical composition for the nutrition of a healthy population [23, 24]. Currently, the development of recipes and technologies for yoghurt and protein desserts with a balanced chemical composition for the nutrition of military personnel is underway. The developed milk-fat base is one of the ingredients in the formulations of these products.

7. SWOT analysis of research results

Strengths. The strengths of the developed milk-fat base with a balanced fatty acid composition include:
- natural ingredients;
- optimized component composition;
- balanced fatty acid composition (SFA:MUFA:PUFA and PUFA ω–6:PUFA ω–3);
- high biological efficiency;
- functional properties.

Weaknesses. The weaknesses of the study include:
- poor consumer awareness of the benefits of products with a balanced fatty acid composition;
- high price compared to similar products.

Opportunities. The capabilities of the developed milk-fat base with a balanced fatty acid composition include:
- increased demand for healthy hoarse mooing;
- presence of undeveloped sales markets;
- customer loyalty to products;
- growing popularity for products with an optimal fatty acid composition.

Threats. The threats of research include:
- low prevalence of information on the benefits of combined fatty foods with a balanced fatty acid composition;
- emergence of new competitors on the market;
- decrease in the purchasing power of the population;
- unstable economic and political situation in the country;
- increase in sales of substitute goods, change in tastes and needs of consumers.

Based on the SWOT analysis, the following strategic solutions were proposed:

1. First of all, it is entering new sales markets and developing advertising campaigns with the aim of promoting combined dairy and vegetable products with a balanced fatty acid composition for healthy nutrition. When promoting products, it is necessary to focus on the balanced and rational fatty acid composition of combined dairy and rice products with a balanced fatty acid composition based on natural ingredients with high biological effectiveness.

2. The first weakness, namely the high price compared to similar products on the market, let's propose to solve by reducing the price of combined dairy and vegetable products with a balanced fatty acid composition by increasing their production and sales. Also, an increase in demand for new products will occur due to the high biological effectiveness of the developed combined dairy and vegetable products. Since the developed products will have an optimal fatty acid composition and high functional properties, a steady demand for these products is predicted. Due to the «poor awareness of consumers about the benefits of products with a balanced fatty acid composition», it is necessary to conduct a set of information and advertising activities among potential consumers/producers in order to widen the use of the milk-fat base in the production of combined food products.

3. To reduce the influence of such factors as «the emergence of new competitors» and «low prevalence of combined dairy and vegetable products with a balanced fatty acid composition», let's suggest:

– flexible pricing policy;
– use of effective channels of commodity circulation and marketing communications;
– development of new sales markets.

As for the factor of «decreasing purchasing power», it is envisaged to attract investments for the implementation of the project, as well as the production and sale of combined dairy and vegetable products to potential consumers (for example, military personnel on terms of direct contractual deliveries).

4. To reduce the influence of such factors as «a decrease in the purchasing power of the population» and «a high price compared to analogue products», let's suggest maintaining price stability due to the absence of dependence on foreign raw materials. Also, product promotion in various ways of marketing communications in order to popularize combined dairy and vegetable products with a balanced fatty acid composition of products. Special attention was paid to informing about new combined products at specialized professional forums, exhibitions, etc. among potential producers and consumers of combined dairy and vegetable products.

8. Conclusions

1. The ratio of fatty acids in the milk-fat base for the production of food products with a balanced fatty acid composition (SFA:MUFA:PUFA – 0.442:0.403:0.155) is determined, which is achieved with the optimal ratio of milk fat: rice bran oil: pumpkin oil – 20.2:70.5:9.3.

2. Recommendations on the ratio of milk fat: rice bran oil: pumpkin oil in the composition of the combined fat are developed. These recommendations can be used in the production of combined dairy and vegetable products with a balanced fatty acid composition:

– drinking and fermented beverages;
– fermented protein products;
– sour cream products;
– desserts on yoghurt, protein, sour cream and combined bases for various categories of the adult healthy population.

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