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PROBIOTIC EMULSIFIED PRODUCTS WITH BIOLOGICALLY ACTIVE COLORFUL ATTRACTANTS

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Abstract

The possibility of increasing the biological and consumer properties of traditional emulsified products by using a complex of biologically active compounds of plant raw materials is considered and scientific developments of emulsified products, in particular probiotic direction, are analyzed. Taking into account modern food trends, the fatty acid composition of lipid component of mayonnaise sauce has been adjusted. The analysis of fatty acid composition of different oils and mathematical modeling for their selection by the optimal ratio of polyunsaturated fatty acids (PUFA) ω-6:ω-3 was carried out. It was found that to achieve the recommended nutritional ratio of PUFA ω-6:ω-3 at 10:1, it is necessary to add to sunflower oil a smaller amount of linseed oil than soybean oil, which improves the economic performance of products while increasing the biological value. The list of expedient ingredients - extract of *Taraxacum officinale* roots and colorful attractants represented by plant pigments of heterocyclic and polyene nature - was substantiated. Based on sensory indicators, the amount of aqueous extract of *Taraxacum officinale* roots - 30.0 % to mayonnaise sauces - was established, as well as the concentration of polyene pigment (carotene dye) at 3.0 % and heterocyclic compounds (chlorophylls) at 3.5 %. Prebiotic bifidogenic ingredients retained a higher number of bifidobacteria in the developed mayonnaise sauces by a factor of 6.8 for chlorophyll sauce and 8.5 for carotene colorant sauce. Mayonnaise sauces with *Taraxacum officinale* extract and carotene or chlorophyll colorants show a significant increase in antioxidant activity by 4.9 and 6.0 times compared to the control sample, respectively. The given technological scheme of production of probiotic mayonnaise sauces in vector and machinery representation shows the possibility of their manufacturing on the existing technological lines.

Keywords: emulsified products; polyunsaturated fatty acids; extract of *Taraxacum officinale*; bifidobacteria; color attractants of heterocyclic and polyene nature; chlorophylls; carotenoids; biosafety.

ПРОБІОТИЧНІ ЕМУЛЬСІЙНІ ПРОДУКТИ З БІОЛОГІЧНО АКТИВНИМИ КОЛЬОРОВИМИ АТРАКТАНТАМИ

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Анотація

Розглянуто можливість підвищення біологічних і споживчих властивостей традиційних емульсійних продуктів шляхом використання комплексу біологічно активних сполук рослинної сировини для емульсійної продукції пробіотичного напрямку. Проведено аналіз жирнокислотного складу різних видів олій та математичне моделювання для їх вибору за оптимальним співвідношенням поліненасичених жирних кислот (ПНЖК) ω-6:ω-3. Встановлено, що для досягнення рекомендованого нутриціологічного співвідношення ПНЖК ω-6:ω-3 = 10:1 необхідно додавання до соняшникової олії меншої кількості лляної в порівнянні з соєвою олією, що покращує економічні показники продукції при підвищенні біологічної цінності. Обґрунтовано перелік доцільних інгредієнтів – екстрактів кульбаби лікарської *Taraxacum officinale* і кольорових атрактантів – рослинних пігментів гетероциклічної і полієнової природи. На основі сенсорних показників встановлено кількість водного екстракту кульбаби лікарської – 30.0 % до майонезних соусів, а також концентрацію полієнового пігменту – каротинового барвника – 3.0 % та гетерециклічних сполук – хлорофілів – 3.5 %. Пребіотичні біфідогенні інгредієнти дали змогу зберегти більшу кількість біфідобактерій у розроблених майонезних соусах в 6,8 разів для соусу з хлорофільним та у 8,5 разів – з каротиновим барвником. Майонезні соуси з екстрактом кульбаби лікарської та каротиновим або хлорофільним барвниками показують значне підвищення антиоксидантної активності у порівнянні з контрольним зразком у 4.9 та 6.0 рази, відповідно. Наведені векторна та апаратурна технологічні схеми виробництва пробіотичних майонезних соусів для їх випуску на існуючих технологічних лініях.

Ключові слова: емульсійні продукти; поліненасичені жирні кислоти; *Taraxacum officinale*; біфідобактерії; кольорові атрактанти гетероциклічної і полієнової структур; хлорофіли; каротиноїди; біобезпека.

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Introduction

In the diet of modern man there are risks of undesirable contaminants of chemical and biological nature in the composition of food raw materials and processed products. Emulsion products, namely the line of mayonnaise products, are in wide demand among the range of food products of vegetable and animal origin. Special attention is paid to the establishment of their safety and quality as the main nutritional factor. Innovative technologies of emulsion products production are aimed at improving sensory characteristics, rheological properties, increasing nutritional and biological value. The multicomponent composition of this segment of food products provides an opportunity to introduce non-traditional raw materials into the formulations of mayonnaise and mayonnaise sauces [1; 2].

A recipe for mayonnaise sauce with chia seeds, raspberry puree, smoked paprika and herbs, with vinegar acid substituted for citric acid, is known. To give stability to this emulsion, a stabilization system "Stabilex" was used, which includes a mixture of guar gum and xanthan [3].

The use of natural preservatives, namely phenolic extracts of fenugreek seeds and leaves as a natural preservative, as indicated by the authors [4], improve the qualitative properties of the mayonnaise product during storage. The introduction of kalina juice into the recipe of mayonnaise sauce, in addition to providing an original flavor, con-serving effect, enriches it with vitamins and increases its nutritional value [5]. Vitamin D enrichment of mayonnaise based on whey and soy proteins provides a stable and bio-available vitamin D in the diet [6].

Lipid oxidation is the main chemical process affecting the spoilage of mayonnaise products. Plant ingredients that are qualified as natural antioxidants have been investigated and proposed as potential substitutes for synthetic antioxidants in mayonnaise and mayonnaise sauce formulations [7]. The essential oil of dill and basil with the addition of *Lactobacillus plantarum* [8], and the essential oil of oregano fine [9] have been proposed as antioxidants.

Chlorophyll, anthocyanin, xanthophyll, carotenoid coloring substances have been described as food quality enhancers, for which priority methods of isolation and technologies of obtaining from secondary plant raw materials have been developed and tested [10; 11].

The analytical review showed that it is expedient from the position of nutritionology to adjust the composition to increase the biological activity of traditional emulsion products. This requires the search for ingredients of different chemical nature. Along with adjusting the composition of emulsion products, it is promising to determine the spectrum of their biological activity together with sensory and general characteristics of product safety. That is why the actual scientific and practical problem is to determine the possibility of using various plant ingredients as potential initiators of increasing the biological activity and probiotic properties of emulsion products with ensuring its quality and safety.

The aim of the work is to develop probiotic mayonnaise sauces enriched with biologically active plant color attractants of different chemical structure.

The goal requires the solution of the following tasks:

- substantiation of fatty acid composition of the lipid component of mayonnaise sauce;
- substantiation of modification of the aqueous phase of mayonnaise sauce;
- establishment of the appropriate amount of colored attractants for sensory characteristics and biological activity;
- substantiation of the components of the formulation of probiotic mayonnaise sauce with prebiotic ingredients;
- determination of biosafety according to the results of sensory, physicochemical and microbiological studies of samples of developed mayonnaise sauces.

Materials and Methods.

Mayonnaise sauce of the following composition was chosen as a control sample for experimental studies: refined deodorized sunflower and soybean oils, whey protein concentrate, concentrate of Jerusalem artichoke "NOTEO", stabilization system "Hamulsion QNA", egg powder, fructose, table salt, lactic acid, cheese whey with activated bifidobacterium *LIOBAC 3BIFIDI*, drinking water [12–14].

As new ingredients for the composition of innovative mayonnaise sauce we used: refined deodorized linseed oil TM "Vita Doro" (Ukraine), dandelion extract *Taraxacum officinale* (manufacturer "Medagroprom", Ukraine) and biologically active dyes of carotene and chlorophyll nature [15].

Fatty acid composition of oils was determined by gas chromatography using chromatograph "Clarus 500" by Perkin Elmer with flame

Journal of Chemistry and Technologies, 2025, *33*(2), 418-426

ionization detector and quartz capillary column Supelko SP – 2380 with a length of 30 m, diameter 0. 32 mm and active layer thickness 0.20 µm, carrier gas – helium, injector temperature 250 °C, detector temperature 250 °C, thermostat temperature from 50 °C to 250 °C for 25 min, volume of injected sample $1.0 \cdot 10^{-3}$ cm^3. Chromatograms were recorded and processed using Total Chrom program from Perkin Elmer [16; 17].

An aliquot of the extract intended for carotenoid studies was fractionated for carotenes and xanthophylls on sucrose columns under low light with the addition of an antioxidant to the extracts. The extract after evaporation on a rotary evaporator (Buchi Rotavapor R-124 Rotary Evaporator with B-481 Bath, USA) was applied to chromatographic plates for thin-layer chromatography (TLC) L5/40, silica gel with gypsum (Czech Republic). The solvent petroleum ether-acetone (98:2) or hexane-acetone (96:4) was used to isolate carotenoids (oxygen-free derivatives). Carotenoids were also identified by comparing the chromatographic mobility of the studied samples with carotenoid preparations (Fluka, Switzerland), as well as the maximum absorption of pigments in the region of 200…700 nm. The amount of each pigment was determined spectrophotometrically on the basis of individual extinction coefficients [10; 15].

For the separation and quantification of chlorophylls, an aliquot of the extract was used after preliminary purification from associated impurities by column chromatography on silica gel L100/160. The separation of chlorophylls and their structural analogs, as well as the quantification of their individual species and forms were performed according to [15; 18].

The main physicochemical parameters of the samples: emulsion stability, viscosity, mass fraction of fat, acidity (in terms of lactic acid), active acidity, peroxide number were determined by classical biochemical methods [19–21].

Antioxidant activity was determined by volumetric method, the total concentration of antioxidants was estimated by the period of induction of isopropylbenzene oxidation [18; 22]. The test was carried out at the initiation rate $W_i = 6.8 \cdot 10^{-5}$ mol/dm^3, the initiator was azoisobutyronitrile. The concentration of antioxidants was determined by the expression:

$$[\ln H] = t \cdot W_i,$$

where [ln H] is the inhibitor concentration obtained experimentally;

t is the duration of the induction period, s.

Microbiological parameters were determined by classical and accelerated PCR methods and using Compact Dry microbiological media (manufacturer Nissui Pharmaceutical CO. LTD, Japan) [23; 24].

The number of bifidobacteria was determined by sowing into thioglycol medium poured into tubes in a high column and thermostating at 37 °C without access to oxygen for 48...72 h [24].

The results of the studies were processed using methods of mathematical statistics.

Results and discussion

Modern scientific developments provide for the production of mayonnaise products with a variety of consumer properties and increased nutritional value by adjusting the composition of products, which allows to significantly expand the range of their positive effects on the human body. The conducted studies of fatty acid composition of oils substantiated the expediency of the ratio of PUFAs of the ω-6 family: PUFAs of the ω-3 family to replace soybean oil with linseed oil in the fat base of mayonnaise sauce (Table 1).

Table 1

Fatty acid composition of the investigated refined deodorized vegetable oils

Fatty acids	Fatty acid content, %		
	sunflower oil	linseed oil	soybean oil
C 8:0 Caprylic	0.03	0.01	–
C 14:0 Myristic	0.11	0.08	0.08
C 14:1 Myristoleic	0.02	–	–
C 15:0 Pentadecanoic	–	0.02	0.02
C 16:0 Palmitic	6.64	6.27	10.67
C 16:1 Palmitoleic	0.08	0.22	0.10
C 17:0 Heptadecanoic	0.04	0.06	0.09
C 18:0 Stearic	2.83	3.77	4.39
C 18:2 Lenoleic	58.1	15.64	51.55
C 20:0 + C 18:3n6	0.19	3.25	0.41
C 18:3 Lenolenic	0.12	48.37	6.83
C 21:0 Heneicosanoic	0.02	0.06	0.03
C 20:2 Eicosapentaenoic	0.02	0.03	0.04
C 22:0 Behenic	0.61	0.17	0.37

Journal of Chemistry and Technologies, 2025, *33*(2), 418-426

Continuation of Table 1

C 22:1n9 Erucic	–	–	0.01
C 20:3n6 Eicosatrienoic	–	0.03	-
C 23:0 Tricosylic	0.01	0.02	0.04
C 22:2 Docosadienoic	0.03	0.01	–
C 20:5n3 Eicosapentaenoic	0.01	0.02	0.01
C 24:0 Lignoceric	0.21	0.10	0.16
C 24:1 Nervonic	0.01	0.02	0.02

According to the recommendations of the Institute of Nutrition the ratio of PUFAs of the ω-6 family: PUFAs of the ω-3 family should be 10:1. Based on the results of the analysis of fatty acid composition and cost of soybean and flaxseed oils, it is reasonable to replace soybean oil with flaxseed oil. The optimal ratio of the selected oils was established by mathematical modeling (Table 2).

Table 2

Results of mathematical modeling on the ratio of PUFA ω-6:ω-3 of sunflower and linseed refined deodorized vegetable oils

Mass fraction sunflower oil	Mass fraction linseed oil	PUFA content ω-6	PUFA content ω-3	Ratio ω-6: ω-3
0.96	0.04	59.644	2.0472	29.13443
0.95	0.05	59.605	2.529	23.5686
0.94	0.06	59.566	3.0108	19.78411
0.93	0.07	59.527	3.4926	17.04375
0.92	0.08	59.488	3.9744	14.96779
0.91	0.09	59.449	4.4562	13.34074
0.9	0.1	59.41	4.938	12.03119
0.89	0.11	59.371	5.4198	10.95446
0.88	0.12	59.332	5.9016	10.05354
0.87	0.13	59.293	6.3834	9.288624
0.86	0.14	59.254	6.8652	8.631067
0.85	0.15	59.215	7.347	8.059752
0.84	0.16	59.176	7.8288	7.558757
0.83	0.17	59.137	8.3106	7.115852

Analysis of the results of Table 2 showed that with increasing mass fraction of linseed oil the content of PUFA ω-3 increases, which allows to correct the ratio of PUFA ω-6 : ω-3. The optimum value of the index (10.05:1) is achieved at the ratio of sunflower and linseed oils 22:3, respectively.

To improve the vitality of bifidobacteria as a probiotic component in mayonnaise sauce, the extract of *Taraxacum officinale* was additionally used. As is known, the extract contains inulin, fructose, fatty acids, sitosterol, triterpene compounds, taraxacin, sterols, flavanoids, mucilages, ascorbic acid, etc., which additionally increases the biological activity of the product [24].

In the mayonnaise sauce, the aqueous phase consisting of drinking water and curd whey was partially replaced with an aqueous extract of the root of the *Taraxacum officinale* in an amount of 10...50 %. The results of the sensory evaluation of the samples are given in Table 3.

Table 3

Sensory indicators of the produced samples of mayonnaise sauces with an aqueous extract of *Taraxacum officinale*

Name Indicator	Replacement of part of the aqueous phase with an extract of *Taraxacum officinale*, %				
	10	20	30	40	50
Appearance and consistency	Homogeneous, creamy product with single air bubbles				
Taste and smell	According to the technical description of mayonnaise sauce, without dye, with a characteristic smell of mayonnaise sauce and a slight aftertaste of Noteo		According to the technical description of mayonnaise sauce, without dye, with a characteristic smell of mayonnaise sauce and a pleasant oily aftertaste of Noteo, which is enhanced by the extract of *Taraxacum officinale*	According to the technical description of mayonnaise sauce, without dye, with a characteristic smell of mayonnaise sauce with a burning sensation and a bitter aftertaste	
Color	Light cream, uniform throughout the mass, with a gray tint				

The results presented in Table 3 show that replacing different amounts of the aqueous phase with dandelion extract does not affect the appearance, consistency, and color of the mayonnaise sauce. When adding 40...50 % of the extract, a feeling of pungency and a bitter taste appears. Considering the increased amount of inulin due to the added extract and the presence of other biologically active substances in it, it is advisable to replace 30 % of the aqueous phase of the mayonnaise sauce with extract of *Taraxacum officinale*.

Natural dyes of various chemical natures are included in a number of modern biologically active substances (BAS) and are considered as potential initiators of increasing the biological activity of food products [10; 11]. According to the results of preliminary comprehensive studies of leafy vegetables, a wide range of their biological activity was shown, in particular, significant antioxidant, antimutagenic and antitoxic effects. Antioxidant activity has been confirmed in models of initiated oxidation; demutagenic properties have been determined in models of induced mutagenesis by different mechanisms; antitoxic properties have been established for toxic agents acting on target organ tissues based on certain biological mechanisms of action [18; 25; 26].

Along with biological activities, dyes used in the developed recipes of mayonnaise sauces are considered, they have important technological properties. The main ones are heat resistance, absence of indicator properties (i.e. color change at different pH values of the medium), resistance to substances that cause osmotic pressure (sugar, salt, etc.). This is especially important for the food industry, where dyes are usually affected by the whole complex of the above-mentioned factors.

Color attractants from secondary plant raw materials, namely heterocyclic pigments (chlorophylls) and pigments of polyene nature (carotenes), are presented in the form of syrup-like extracts, without taste, extraneous flavors, odor and have green and yellow colors, respectively. According to microbiological indicators, the selected dyes meet the requirements of industrial sterility and do not contain pathogenic microorganisms and/or their toxins. At pH in the range of 4.5...6.5, the degree of destruction of carotene and chlorophyll dyes at a temperature of 100 °C for 20 minutes is 17...22 % [10], which is acceptable for use in mayonnaise sauces.

Carotenoid and chlorophyll attractants were added to mayonnaise sauce recipes in amounts from 2.0 to 5.0 %. The results of sensory, physicochemical and microbiological studies of samples with these natural dyes are presented in Table 4 and Table 5.

For further study of physicochemical and microbiological indicators based on the results of sensory analysis (Tables 4; 5), samples with the addition of 3.0 % carotene and 3.5 % chlorophyll dyes were selected. Recipes for new types of probiotic colored mayonnaise sauces have been developed, which include: sunflower and linseed refined deodorized oils, concentrate of Jerusalem artichoke "Noteo", whey protein concentrate, egg powder, fructose, table salt, classic stabilization system, lactic acid, curd whey with probiotic culture, carotene or chlorophyll dye.

The technological scheme of mayonnaise sauce production by hot method using batch equipment in a vector image is shown in Fig. 1, and the equipment diagram is in Fig. 2.

Table 4

Organoleptic characteristics of mayonnaise sauce samples with carotenoid attractant

Indicators	**Mayonnaise sauce without dye (control)**	**Mayonnaise sauce with dye (amount of carotenoid attractant, %)**		
		2.0	**3.0**	**5.0**
Appearance and consistency	Homogeneous, creamy product with single air bubbles	Homogeneous, creamy product with single air bubbles	Homogeneous, creamy product with single air bubbles	Homogeneous, creamy product with single air bubbles
Taste and smell	According to the technical description of mayonnaise, without dye, with a characteristic smell of mayonnaise and a slight aftertaste of Noteo	According to the technical description of mayonnaise with a characteristic smell and a pleasant oily aftertaste of Noteo, enhanced by extract of *Taraxacum officinale*	According to the technical description of mayonnaise with a characteristic smell and a pleasant oily aftertaste of Noteo, enhanced by extract of *Taraxacum officinale*	According to the technical description of mayonnaise with a characteristic smell and a pleasant oily aftertaste of Noteo, enhanced by extract of *Taraxacum officinale*
Colour	Light cream, uniform throughout the mass, with a grey tint	Uniform throughout the mass, with a yellow-grey tint	Uniform throughout the mass, with a pleasant rich yellow tint	Uniform throughout the mass, of a rich orange colour

Journal of Chemistry and Technologies, 2025, *33*(2), 418-426

Table 5

Organoleptic characteristics of mayonnaise sauce samples with chlorophyll attractant

Indicators	Mayonnaise sauce without dye (control)	Mayonnaise sauce with dye (quantity of chlorophyll attractant, %)		
		2.0	3.5	5.0
Appearance and consistency	Homogeneous, sour cream-like product with single air bubbles	Homogeneous, sour cream-like product with single air bubbles	Homogeneous, sour cream-like product with single air bubbles	Homogeneous, sour cream-like product with single air bubbles
Taste and smell	According to the technical description of mayonnaise, without dye, with a characteristic smell of mayonnaise and a slight taste of Noteo	According to the technical description of mayonnaise with a characteristic smell and oily taste due to Noteo and enhanced by extract of *Taraxacum officinale*	According to the technical description with a weak characteristic smell and oily taste due to Noteo and enhanced by extract of *Taraxacum officinale*	According to the technical description of mayonnaise with a barely noticeable smell and oily taste due to Noteo and enhanced by extract of *Taraxacum officinale*
Colour	Light cream, uniform throughout, with a grey tint	Uniform throughout with a weakly defined greenish-grey tint	Uniform throughout, with a pleasant fresh green colour	Uniform throughout, dark green

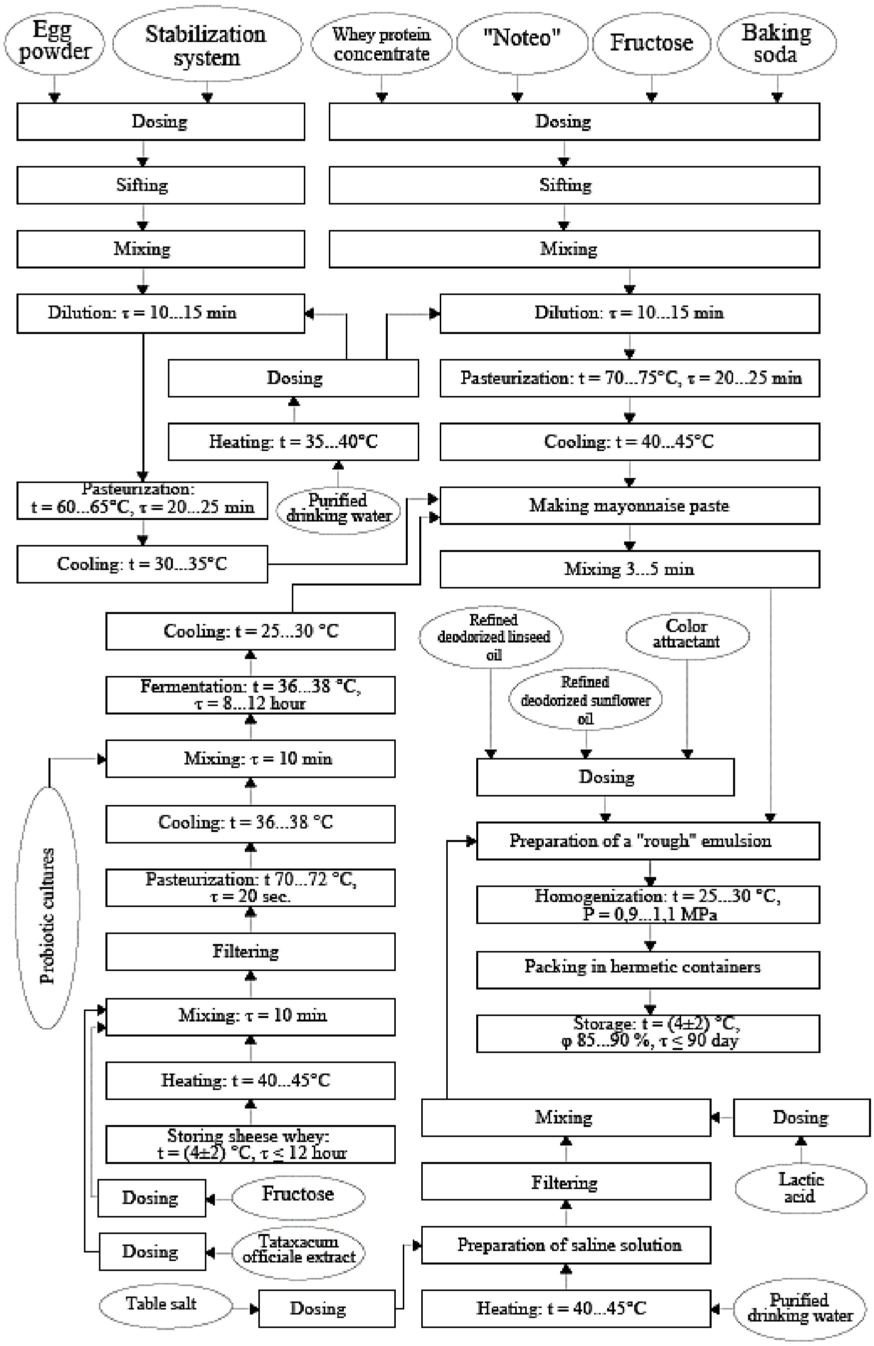

Fig. 1. Technological scheme of production of probiotic mayonnaise product with colored attractants

Journal of Chemistry and Technologies, 2025, *33*(2), 418-426

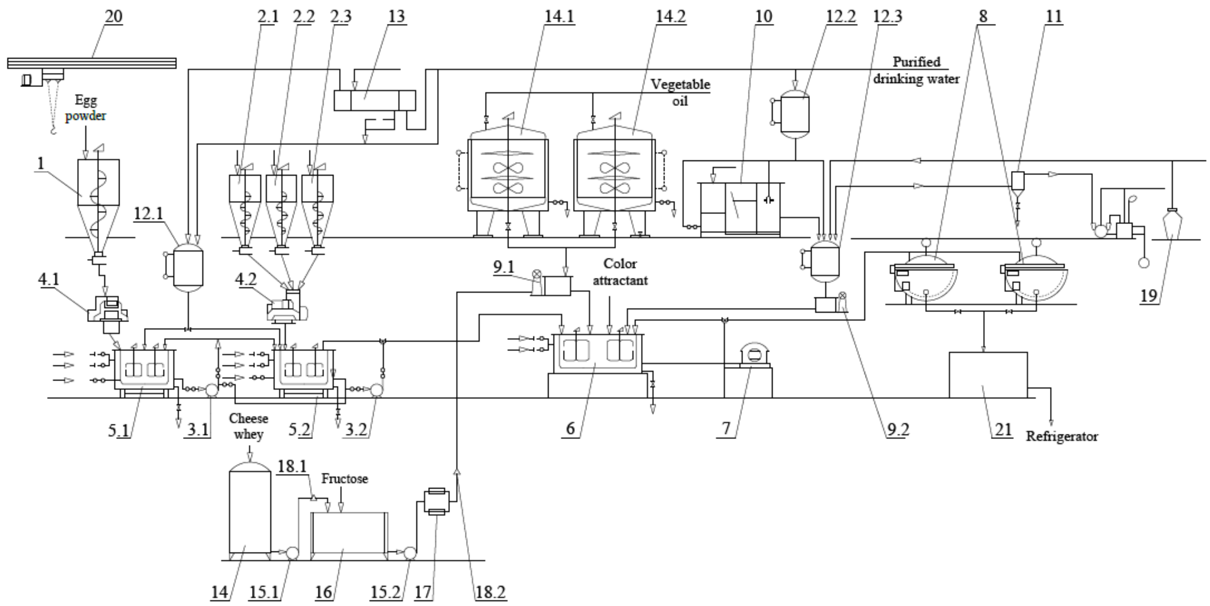

Fig. 2. Machinary representation of the production of a probiotic mayonnaise product with color attractants
1 – bin for egg powder; 2 – bins for bulk components; 3 – emulsifier pump; 4 – scales; 5 – small mixers; 6 – large mixer; 7 – homogenizer; 8 – container for the finished product; 9 – scales for liquid components; 10 – salt dissolver; 11 – catcher; 12 – tank for lactic acid solution; 13 – boiler for preparing warm water; 14 – container for curd whey; 15 – centrifugal pump; 16 – pasteurization bath; 17 – filter; 18 – counter, 19 – container with concentrated lactic acid, 20 – hoist; 21 – packaging machine.

The developed mayonnaise sauces with a fat mass fraction of 30...49 % do not require the introduction of additional equipment and make it possible to produce emulsion products on existing production lines.

A set of quality, stability and safety indicators for the developed mayonnaise sauces was determined (Table 6).

Table 6

Quality, stability and safety indicators for mayonnaise sauces with carotenoid and chlorophyll attractants (n=3; p≤0.05)

Indicators	**Mayonnaise sauce without dye (control)**	**Mayonnaise sauce**	
		with carotene dye	**with chlorophyll dye**
Physicochemical and biochemical indicators			
Mass fraction of fat, %	30.0…49.0	30.0…49.0	30.0…49.0
Sedimentation stability of emulsion, %	98.0 ± 0.72	99.8 ± 0.38	99.5 ± 0.45
Viscosity, kPa*s	2438.5 ± 13.08	2538.4 ± 10.55	2500.3 ± 9.53
Acidity, %	0.83 ± 0.02	0.79 ± 0.01	0.78 ± 0.03
Active acidity, pH	4.61 ± 0.02	4.57 ± 0.01	4.56 ± 0.02
Carotenes, 10^{-3}% including:	0.1 ± 0.01	18.8 ± 0.72	0.4 ± 0.01
β-carotene, 10^{-3}%	0.1 ± 0.01	16.5 ± 0.28	0.2 ± 0.01
α-carotene, 10^{-3}%	not defined	1.3 ± 0.02	0.1 ± 0.01
Chlorophylls, 10^{-3}%	not defined	not defined	69.0 ± 3.82
Stability and safety indicators			
Peroxide value, mgO_2/g	0.21 ± 0.03	0.11 ± 0.02	0.13 ± 0.01
Oxidation induction period, s	67.1 ± 1.0	329.0 ± 3.0	405.0 ± 5.0
Concentration of antioxidants [In H], mol/kg	$0.46 \cdot 10^{-5}$	$2.24 \cdot 10^{-5}$	$2.75 \cdot 10^{-5}$
Content of bifidobacteria, CFU/g	$(1.3 \pm 0.2) \cdot 10^{7}$	$(1.1 \pm 0.4) \cdot 10^{8}$	$(8.9 \pm 0.3) \cdot 10^{7}$
Mold fungi, CFU/g	6.0 ± 1.0	3.0 ± 1.0	2.0 ± 2.0
Yeast, CFU/g	$(4.2 \pm 0.1) \cdot 10^{2}$	$(3.5 \pm 0.1) \cdot 10^{2}$	$(2.5 \pm 0.2) \cdot 10^{2}$
Coliform bacteria, including Shiga toxin-producing bacteria. coli (STEC), CFU/g	Absent	Absent	Absent

Journal of Chemistry and Technologies, 2025, *33*(2), 418-426

Continuation of Table 6

Pathogenic microorganisms, including bacteria of the genus *Salmonella*, in 25 g	Absent	Absent	Absent
Bacillus cereus, CFU/g	Absent	Absent	Absent
Clostridium perfringens, CFU/g	Absent	Absent	Absent
Staphylococcus aureus, CFU/g	Absent	Absent	Absent
Listeria monocytogenes, in 25 g	Absent	Absent	Absent

It should be noted that in addition to the α-carotene and β-carotene specified in Table 6, the carotene dye contains minor amounts of γ-carotene, δ-carotene, lycopene, etc., which give the mayonnaise sauce an attractive yellow color.

The chlorophyll dye contains 12 individual pigments: chlorophylls, pheophytins, chlorophyllides, ethylchlorophyllides, pheophorbides, and ethylpheophorbides in forms *a* and *b*. The chlorophyll dye colors the developed mayonnaise sauce a pleasant, fresh green color.

The introduction of the proposed color attractants, *Taraxacum officinale* extract, and the replacement of soybean oil with linseed oil make it possible to obtain a stable, safe, and high-quality product according to the set of indicators given in Table 6. The addition of prebiotic components, namely the extract of *Taraxacum officinale*, increased the survival rate of bifidobacteria compared to the control at the final shelf life of 90 days at a temperature of 4...6 °C in an amount that provides probiotic properties of the developed products.

Conclusions

Taking into account the current trends in the food industry to increase the biological activity of popular emulsified products, the fatty acid composition of the lipid composition of mayonnaise sauces with the addition of biologically active plant extracts was adjusted. The fatty acid composition of various types of refined deodorized oils - sunflower, soybean and linseed – was analyzed. Mathematical modeling showed that in order to achieve the recommended nutritional ratio of PUFA ω-6:ω-3 at 10:1 it is necessary to add to sunflower oil a smaller amount of linseed oil than soybean oil, which improves the economic performance of products while increasing biological value.

A new direction in the creation of emulsified sauce products is to give them probiotic properties with the help of probiotic bifidobacteria, included in the *LIOBAC 3BIFIDI* bacterial concentrate. The expediency of increasing the prebiotic component in such mayonnaise sauces by replacing 30 % of the aqueous phase with the extract of *Taraxacum officinale* has been substantiated. The addition of prebiotic components increased the survival rate of bifidobacteria compared to the control at the end of shelf life (90 days) at a temperature of 4...6 °C in an amount providing the probiotic properties of the developed products.

The recommended amount of polyene (carotenes) and heterocyclic (chlorophylls) color attractants not only provided the coloration of the product, but also gave them antioxidant properties. The oxidation induction period was established using a model of initiated oxidation of isopropylbenzene by azoisobutyronitrile, which increased the antioxidant activity compared to the control sample by 4.9 and 6.0 times for the carotene and chlorophyll dye samples, respectively. The appropriate concentration of carotene dye was established – 3.0 % and chlorophyll – 3.5 %.

The composition of probiotic mayonnaise sauce with the addition of prebiotic and colorant ingredients was substantiated, and thea process flow diagram in processing and machinery representation was proposed, showing the possibility of their manufacturing on the existing technological lines.

The biosafety of all mayonnaise sauce samples was determined based on the results of sensory, physicochemical and extended microbiological studies. The developed products are less contaminated and do not contain food poisoning agents, which positively characterizes the new products.

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