Оптимізовано рецептурний склад низькокалорійних емульсійних жирових систем з використанням стабілізаційної системи «Хамульсіон QNA» і концентрату топінамбура «Нотео» як джерела пребіотика інуліну та харчових волокон. Наведено рекомендації щодо розробки технологій двох груп низькокалорійних майонезів, соусів, дресингів, збагачених харчовими волокнами і пребіотиками (або комплексами синбіотиків), на основі розроблених емульсійних жирових систем

Ключові слова: низькокалорійна емульсійна система, топінамбур, в'язкість, органолептичні показники, оптимізація, поверхня відклику

Оптимизирован рецептурный состав низкокалорийных эмульсионных жировых систем с использованием стабилизационной системы «Хамульсион QNA» и концентрата топинамбура «Нотео» как источника пребиотика инулина и пищевых волокон. Приведены рекомендации по разработке технологий двух групп низкокалорийных майонезов, соусов, дрессингов, обогащенных пищевыми волокнами и пребиотиками (или комплексами синбиотиков), на основе разработанных эмульсионных жировых систем

Ключевые слова: низкокалорийная эмульсионная система, топинамбур, вязкость, органолептические показатели, оптимизация, поверхность отклика

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OPTIMIZATION OF FORMULATION COMPOSITION OF THE LOW-CALORIE EMULSION FAT SYSTEMS

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1. Introduction

Food is one of the most important environmental factors that influence health, performance, mental and physical development, as well as duration of human life. However, the structure of food of a modern human is characterized by negative trends. This is due to active invasion of new technologies into vital activity, automation and computerizing of main production processes, huge information flows and also due to pollution [1]. The concept of a healthy diet, the nutritiology requirements – the science of nutrition, imply the need for a new approach towards improving the structure, properties, technology of food products, which should not meet the needs of human body in major nutrients and energy only, but also contribute to disease prevention, maintaining health and ensuring longevity [2].

Among the promising food products in the oil and fat industry, special role is given to emulsion fat products, in which vegetable oil is in dispersed state that improves its digestibility and nutritional value. Food water-fat emulsions are promising systems based on which it is possible to create mayonnaises, mayonnaise sauces, dressings, oil pastes, spreads and other foodstuffs with a balanced composition of physiologically functional food ingredients. Emulsion fat systems are characteristic of high taste and nutritional properties, due to the specificity of their structure [3].

Marketing analysis of mayonnaises and sauces market in Ukraine, the status of their production, consumer motivations and benefits when choosing emulsion products, attitude of the respondents towards designing of new products of emulsion nature, enriched with natural additives, demonstrate the need to improve the quality and expand the range of these products. This can be achieved by introducing new low-calorie emulsion fat products to the market – mayonnaises and mayonnaise sauces enriched with natural supplements with predetermined special, healthy or medicinal properties [4].

2. Analysis of scientific literature and the problem statement

The main objective to improve the structure of the nutrition of the population is expanding the range of products of mass consumption with high nutritive and biological value, as well as foods rich in dietary fibers, polyunsaturated fatty acids, valuable proteins, vitamins, mineral substances, probiotic bacteria, etc. [2]. The consequences of insufficient quantity or lack of certain essential biologically active substances are a breach of biochemical reactions and functional processes occurring in human body, resulting over time in changes that cause various diseases and disorders [3].

Creation of emulsion products for a healthy diet is based on reducing the content of fatty phase and a decrease in the energy value of a product, on excluding or replacing cholesterol-containing raw materials with non-traditional components [5]. The most significant functional impact on human body is produced by emulsion products that have increased food and/or biological value due to the addition of vitamins, proteins, prebiotics, phospholipids, probiotic bacteria and other biologically valuable substances [6]. To prevent oxidative and microbiological damage to a food product, natural antioxidants and preservatives, which possess high physiological activity, are used as formulation components of emulsion products [7]. These directions can be implemented based on the search for efficient compositions of emulsifiers and stabilizers that allow producing high-quality products of given consistency against the reduction of content of fatty phase [8].

Now much attention is paid to the development of new technologies and organization of production of food for a healthy diet, in particular those which contain dietary fibers that have predetermined physical and chemical properties: water-retaining ability, solubility in water, obtaining solutions varying in viscosity, ability to gelling, sorption, ion-exchange and radioprotecting properties, because at present the inhabitants of large Ukrainian cities receive in their diet about 10 grams of dietary fibers per day on average, while the recommended dose is 25–38 g, including 10 g of inulin [9].

Emulsion fat systems based on natural vegetable oils are products, during the manufacturing of which all of the useful properties of dietary fibers can be used to the fullest, both those health improving and technological [8].

In the food industry as dietary fibers they use starch, gum, pectins, inulins, mucilage, oligofructose, cellulose, hemicellulose, etc. [8]. As the gastrointestinal tract of humans lacks the enzymes that split the fibers, the latter reach the colon unchanged. Bacteria in large intestine produce enzymes that are able to metabolise certain fibers, primarily soluble ones. The most important health function of soluble dietary fibers are due to their prebiotic properties that are associated with participation in the formation of nutrient medium for developing normal intestinal microflora, especially, bifidobacteria [10]. Prebiotics are food ingredients that selectively stimulate growth and biological activity of microorganisms in human's intestines, positively affecting the composition of the microbiocenosis [11].

For low calorie emulsion products, in the formulation of which only dietary fibers are used, characteristic are such drawbacks as non-distinctive taste, too liquid consistency and others [8]. One of the ways to improve organoleptic properties of the low calorie healthy emulsion products is using stabilizers in their production [12].

When modeling emulsion products it is necessary to create stable low fat emulsions with high organoleptic properties and predetermined viscous characteristics while reducing caloric value. These tasks may be solved by the introduction of hydrocolloids of polysaccharide nature (in particular, inulin, which is a fat imitator and a prebiotic), which in conjunction with stabilizers are able to provide the required texture of the product [8].

Today there are designs of mayonnaise sauces enriched with pro- and prebiotics [3]. Creation of low fat mayonnaise emulsions enriched in dietary fibers is under way [13]. Oil and fat industry produces low fat mayonnaises and sauces by using stabilizers and stabilizing systems [12]. However, there are no scientific guidelines for the comprehensive application of soluble dietary fibers (such as inulin) and stabilizers in order to obtain low calorie emulsion fat systems of high quality that could be used as a basis for the production of low fat mayonnaises, sauces, dressings, oil pastes, etc.

3. The purpose and objectives of the study

The conducted studies set out to optimize the component composition of low calorie fat systems using the concentrate of Jerusalem artichoke "Noteo" as a source of inulin and insoluble dietary fibers, as well as the stabilizing system "Hamulsion QNA".

To achieve the set goal, the following tasks were solved:

– to optimize the component composition of low calorie fat systems with the concentrate of Jerusalem artichoke "Noteo" and the stabilizing system "Hamulsion QNA" in formulations;

– to define the parameters of quality of low calorie fat systems manufactured using raw components in optimum ratio;

– to provide recommendations on the scientific substantiation of technologies of low calorie mayonnaises and sauces enriched with dietary fibers and prebiotics (or synbiotics complexes) on the basis of low calorie fat systems composed of raw components in optimum ratio.

4. Materials and methods for optimization of formulation composition of low calorie fat systems

4. 1. Researched materials used in carrying out the study, and the methodology of the experiment

For conducting experimental research, we used refined deodorized sunflower and soybean oils, whey protein concentrate derived by ultrafiltration (KSB–UF), the concentrate of Jerusalem artichoke "Noteo", the stabilizer "Hamulsion QNA", egg powder, fructose, edible salt, lactic acid and drinking water as raw materials.

The concentrate of Jerusalem artichoke "Noteo" ("New Dewatering Technology" LLC, Odessa, Ukraine) is made of ecologically clean raw materials and is a product of processing tubers of Jerusalem artichoke with preservation of biologically active components of the original raw material. Chemical composition of the concentrate of Jerusalem artichoke "Noteo" is listed in Table 1.

The main component of the stabilizing system "Hamulsion QNA" by G. K. HAHN and Co. (Germany) used for the research is gelatin, with modified starch, carob tree gum and guar gum included in small amounts, too. More detailed information about the raw component, including the technology of its production, is not provided by the manufacturer.

For optimization of formulation composition of low calorie fat systems we used the response surface methodology [14].

The simulation and experimental data processing were performed by using the *Statistica 10* (*StatSoft, Inc.*) package.

Table 1

Chemical composition of the concentrate of Jerusalem artichoke "Noteo"

Name of the indicator	Value of the indicator
Mass fraction of proteins, %	up to 7
Mass fraction of fats, %	0.4–0.7
Mass fraction of pectins,%	up to 10
Mass fraction of polysaccharides of inulin nature, %	up to 75
Mass fraction of fiber, %	up to 5
Mass fraction of water, %	up to 6

When carrying out experimental research, mass fractions of refined deodorized oils (sunflower and soybean), KSB-UF, lactic acid, edible salt, egg powder and fructose in the formulation of low calorie fat systems with a mass fraction of fat of 30 % were defined in accordance with the recommendations developed by the authors of [15]. In the formulations of low calorie fat systems, the mass fractions of the concentrate of Jerusalem artichoke "Noteo", the stabilizing system "Hamulsion QNA" and drinking water were varied. All the dry formulation components were mixed in necessary quantities, restored in warmed-up drinking water, and the resulting paste was pasteurized at temperature of 60–65 °C, after the preparation of coarse emulsion (by adding vegetable oils) it was homogenized at temperature of 25–30 °C and pressure of 0.9–1.0 MPa, packed into containers and cooled to temperature of (4±2) °C [15].

In one day, organoleptic indicators, effective viscosity and stability of emulsion were determined in the experimental samples of low calorie fat systems.

Substantiation of the optimum ratio of components in low calorie fat systems was carried out by using integrated quality metric IQM, which takes into account cumulative impact of effective viscosity, organoleptic indicators, stability of emulsion and weight coefficients of these individual indicators.

In a low calorie fat emulsion made of raw components in optimal ratios, we determined the chemical composition and the main indicators of quality, by the results of which we made conclusions about the feasibility of production on its basis of the assortment of mayonnaises and sauces with prebiotic or synbiotic properties.

4. 2. Methods of experimental research, used during the study

While performing research, organoleptic indicators of low calorie fat systems were defined by a 20-point assessment scale according to the method of sensory analysis, described in [16]; rheological properties – by the rotary viscometer "Reotest-2" (Medingen, Germany) according to [17]; stability of emulsion – by [16].

5. Results of the optimization of formulation composition of low calorie emulsion fat systems and their discussion

The criteria of the optimization of formulation composition of low calorie fat systems were set by their effective viscosity (EV, Pa·s), organoleptic assessment (OA, points) and an integrated quality metric (IQM is the indicator, which takes into account the cumulative impact of effective viscosity (EV, Pa·s), organoleptic assessment (OA, points), stability of emulsion (SE, %) and the weight coefficients (M_i) specified by individual indicators). Independent factors that varied were selected in the experiment: mass fraction of the concentrate of Jerusalem artichoke "Noteo" ($C_{КТ}$, %) and mass fraction of the stabilizing system "Hamulsion QNA" (C_{CC}, %).

For modeling the effective viscosity (EV, Pa·s), organoleptic assessment (OA, points) and the integrated quality metric (IQM), we selected the response function, which has the form of a polynomial of the second degree:

$$EV = b_0 + b_1 \cdot C_{ca} + b_{11} \cdot C_{ca}^2 + \\ + b_2 \cdot C_{ss} + b_{22} \cdot C_{ss}^2 + b_{12} \cdot C_{ca} \cdot C_{ss}, \quad (1)$$

$$OA = b_0 + b_1 \cdot C_{ca} + b_{11} \cdot C_{ca}^2 + \\ + b_2 \cdot C_{ss} + b_{22} \cdot C_{ss}^2 + b_{12} \cdot C_{ca} \cdot C_{ss}, \quad (2)$$

$$IQM = b_0 + b_1 \cdot C_{ca} + b_{11} \cdot C_{ca}^2 + \\ + b_2 \cdot C_{ss} + b_{22} \cdot C_{ss}^2 + b_{12} \cdot C_{ca} \cdot C_{ss}, \quad (3)$$

where EV is the effective viscosity, Pa·s; OA is the organoleptic assessment, points; IQM is the integrated quality metric; b_0 is the constant; C_{ca} is the mass fraction of the concentrate of Jerusalem artichoke "Noteo", %; C_{ss} is the mass fraction of the stabilizing system "Hamulsion QNA", %; b_1, b_{11}, b_2, b_{22}, b_{12} are the coefficients for each element of a polynomial.

In the studies we used a central composite rotatable design, that is best suited for the chosen method of optimization [14]. The choice of levels and intervals of variation of factors was carried out according to the results of previous experiments [15] and analysis of the scientific literature [9]; mass fraction of the stabilizing system "Hamulsion QNA" was varied within 0.1–0.5 %; mass fraction of the concentrate of Jerusalem artichoke "Noteo" – within 6.67–13.34 %, with a mass fraction of inulin of 5–10 % (this satisfies the need of human body in inulin for 10–30 %, when consuming 20–30 g of emulsion fat product per day, according to the nutritiology recommendations [8]).

Design matrix and experimental values of the response function are presented in Table 2. To reduce the effect of systematic errors, caused by external conditions, the sequence of experiments conducting was randomized.

To check the significance of regressions factors (1) and (2) we built Pareto charts, presented in Fig. 1 (L is the linear effect, Q is the quadratic effect).

Attached Pareto charts (Fig. 1) present standardized coefficients, which are sorted by absolute values. Analysis of data of Fig. 1a indicates that the mass fraction of the concentrate of Jerusalem artichoke "Noteo" (C_{ca}), quadratic for regression (1), is insignificant because the column of points of the indicated effect does not cross the vertical line that is a 95 % confidence probability. With this in mind, the specified member of the regression was eliminated from the model (1). For the regression (2), according to the data shown in Fig. 1b, all of the coefficients are significant. The received equations with calculated coefficients have the form:

$$EV = 241.1 + 30.7 \cdot C_{ca} - 10237.6 \cdot C_{ss} + 17372.2 \cdot C_{ss}^{2} + 761.1 \cdot C_{ca} \cdot C_{ss}, \quad (4)$$

$$OA = -11.92 + 5.93 \cdot C_{ca} - 0.38 \cdot C_{ca}^{2} + 25.97 \cdot C_{ss} - 82.34 \cdot C_{ss}^{2} + 3.08 \cdot C_{ca} \cdot C_{ss}. \quad (5)$$

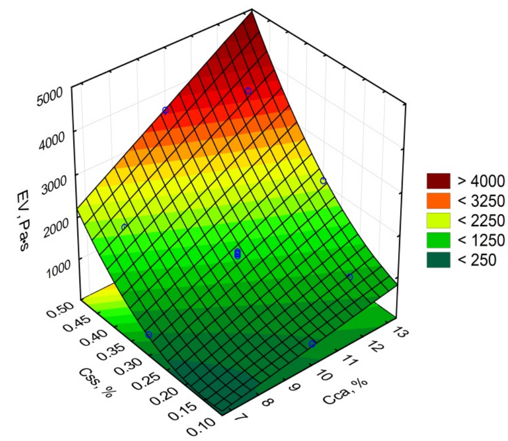
Table 2

Design matrix and response function

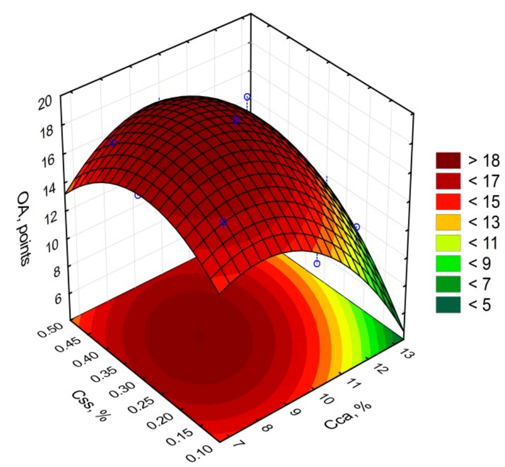
No. of experiment	Mass fraction of the concentrate of Jerusalem artichoke «Noteo», C_{ca}		Mass fraction of stabilisation systems «Hamulsion QNA», C_{ss}		Effective viscosity (*EV*), Pa·s	Stability of emulsion (*SE*), %	Organoleptic assessment (*OA*), points
	Coded level	%	Coded level	%			
1	–1	7.64	–1	0.16	102.0	40	17
2	0	10.00	0	0.30	1340.0	100	19
3	0	10.00	–√2	0.10	522.5	60	13
4	+√2	13.34	0	0.30	2074.5	100	10
5	–√2	6.67	0	0.30	512.3	65	17
6	+1	12.36	+1	0.44	3684.4	100	17
7	0	10.00	0	0.30	1300.0	100	18
8	0	10.00	0	0.30	1360.0	100	18
9	0	10.00	0	0.30	1400.0	100	19
10	+1	12.36	–1	0.16	935.4	80	12
11	0	10.00	+√2	0.50	3556.8	100	16
12	–1	7.64	+1	0.44	1842.2	100	17

The adequacy of the developed models (4) and (5) was checked by the analysis of variance (ANOVA). Its results, in particular, the values of the coefficients of determination (for the model (4) R^2=0.997 and R^2_{adj}=0.994; for the model (5) R^2=0.922 and R^2_{adj}=0.857) and the non-significant lack of fit (for both models, the level of significance of this indicator p>0,05) prove that the models adequately describe the experiment.

The aggregate impact of mass fraction of the concentrate of Jerusalem artichoke "Noteo (*Cca*, %) and mass fraction of the stabilisation system (*Css*, %) on the effective viscosity (EV, Pa·s) and organoleptic assessment (OA, points) of the low calorie emulsion fat systems, described by the polynomials (4) and (5), is graphically represented in Fig. 2, *a*, *b*, respectively.

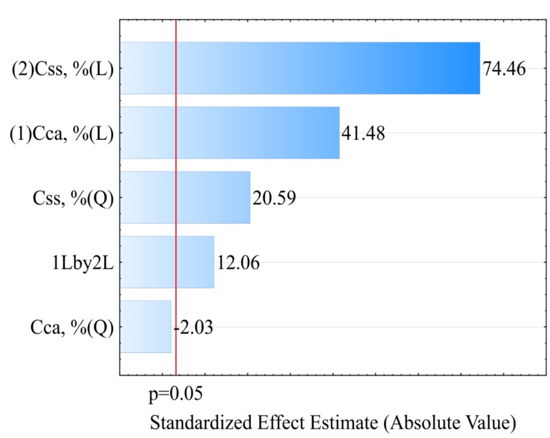


a

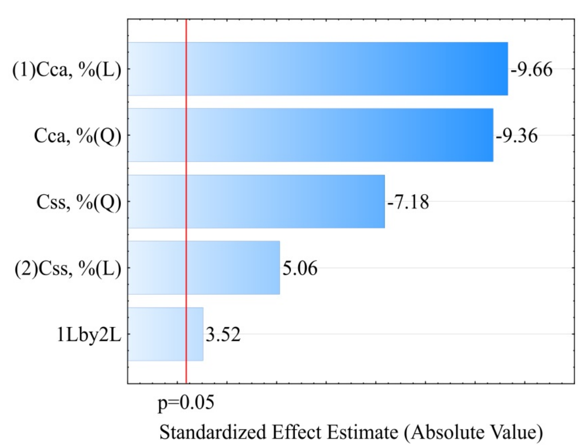


b

Fig. 2. Dependence of effective viscosity: *a* – EV, Pa·s; *b* – organoleptic assessment (OA, points), on the mass fraction of the concentrate of Jerusalem artichoke "Noteo (%) and mass fraction of the stabilizing system "Hamulsion QNA" (%)



a



b

Fig. 1. Pareto charts for checking the significance of factors: a is the regression (1); b is the regression (2)

The increase of mass fraction of hydrocolloids in the formulation of low calorie emulsion systems in the concentrate of Jerusalem artichoke "Noteo and the stabilizing system "Hamulsion QNA" helps increase effective viscosity (Fig. 2, *a*). However, increasing the mass fraction of the stabilization system from 0.1 to 0.5 % has a more significant impact on the value of the indicator of effective viscosity than increasing the mass fraction of the concentrate of Jerusalem artichoke. The maximum value of effective viscosity – 4951.4 Pa·s is displayed by the low calorie fat system, which contains 0.5 % of the stabilizing system "Hamulsion QNA" and 13.34 % of the concentrate of Jerusalem artichoke "Noteo", which corresponds to the mass fraction of inulin of 10.0 %.

The highest organoleptic assessment of 19.42 points (Fig. 2, *b*) is displayed by the low calorie emulsion fat system which contains 9.01 % of the concentrate of Jerusalem artichoke "Noteo" (which corresponds to the mass fraction of inulin of 6.76 %) and 0.33 % of the stabilizing system "Hamulsion QNA".

The obtained results do not make it possible to determine the optimal mass fraction of raw ingredients, that is why a integrated quality metric (IQM) was used for the optimization of formulation composition of low calorie fat systems, which is defined as the function of evaluations of individual quality indicators – effective viscosity (EV, Pa·s), organoleptic assessment (OA, points) and stability of emulsions (SE, %) (Table 2), transferred into the scaled values, taking into account the weight coefficients of individual indicators (W_i) [18]:

$$IQM = W_1 \cdot EV_{sv} + W_2 \cdot OA_{sv} + W_3 \cdot SE_{sv}, \quad (6)$$

where EV_{sv}, OA_{sv}, SE_{sv} are the effective viscosity, organoleptic assessment, stability of emulsion, respectively, transferred into the scaled values; W_1, W_2, W_3 are the weight coefficients of individual indicators – effective viscosity, organoleptic assessment and the stability of emulsion, accordingly. In this case

$$\sum_{i=1}^{n} W_i = 1{,}0. \quad (7)$$

For the transfer of individual indicators into the range of [1; 10], the source data given in Table 2, were scaled by the expression (8)

$$y = \frac{(y_{max} - y_{min}) \cdot (x - x_{min})}{x_{max} - x_{min}} + y_{min}, \quad (8)$$

where y are the scaled data; x are the source data given in Table 2; x_{min} and x_{max} are the minimum and maximum value of the source data (for effective viscosity, x_{min} та x_{max} were calculated by the model (4); for organoleptic assessment, of x_{min}=4 points, x_{max}=20 points (according to a 20-point score), for the stability of emulsion x_{min}=40 %, x_{max}=100 % according to the data of experimental research); x_{min} and x_{max} are the minimum and maximum value of the new range (1 and 10, respectively).

Scaled values of the individual indicators and the values of integrated quality metric (IQM), calculated by the expression (6), are in Table 3 (when calculating the IQM, we adopted the following weight coefficients – in accordance with the recommendations of the expert committee: W_1=0,2; W_2=0,7; W_3=0,1).

Table 3

Scaled values of the individual indicators and the calculated values of the integrated quality metric

No. of experiment	Effective viscosity, scaled (EV_{sv})	Stability of emulsion, scaled (SE_{sv})	Organoleptic assessment, scaled (OA_{sv})	Integrated quality metric (IQM)
1	1.00	1.00	8.31	6.12
2	3.30	10.00	9.44	8.27
3	1.78	4.00	6.06	5.00
4	4.66	10.00	4.38	4.99
5	1.76	4.75	8.31	6.65
6	7.65	10.00	8.31	8.35
7	3.22	10.00	8.88	7.86
8	3.33	10.00	8.88	7.88
9	3.41	10.00	9.44	8.29
10	2.54	7.00	5.50	5.06
11	7.41	10.00	7.75	7.91
12	4.23	10.00	8.31	7.66

To check the significance of the regression coefficients (3), we built Pareto charts, which is presented in Fig. 3 (L is the linear effect, Q is the quadratic effect).

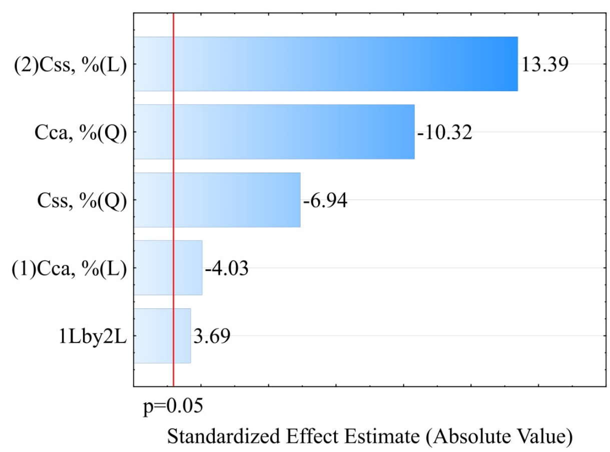


Fig. 3. Pareto chart for checking the significance of regression coefficients (3)

Analysis of the data shown in Fig. 3 prove that all researched parameters are significant, because the columns of the ratings of all effects cross the vertical line that is a 95 % confidence probability.

Resulting equation with calculated regression coefficients has the form:

$$IQM = -9.20 + 2.93 \cdot C_{ca} - 0.17 \cdot C_{ca}^2 + +14.29 \cdot C_{ss} - 32.57 \cdot C_{ss}^2 + 1.32 \cdot C_{ca} \cdot C_{ss}. \quad (9)$$

The adequacy of the developed model (9) was verified by ANOVA, the results of which are presented in Table 4.

The data given in Table 4, in particular, the non-significant lack of fit (level of significance p>0.05) and the values of the coefficients of determination (R^2 and R^2_{adj}), close to 1, allow making a conclusion about the obtained model (9) adequately describing the response.

Cumulative effect of mass fraction of the concentrate of Jerusalem artichoke "Noteo" (Cca, %) and mass fraction of the stabilizing system (Css, %) on the integrated quality metric (IQM) of low calorie emulsion fat systems, described by a polynomial (9), is graphically represented in Fig. 4.

Table 4

ANOVA for the model (9)

Factor	Sum of squares, SS	Degrees of freedom, df	Mean square, MS	F-value	The level of significance, p-value
(1) Cca, %, (L)	0.90720	1	0.90720	16.2526	0.027440
Cca, %, (Q)	5.94861	1	5.94861	106.5695	0.001939
(2) Css, % (L)	10.00274	1	10.00274	179.1994	0.000901
Css, % (Q)	2.68875	1	2.68875	48.1690	0.006134
1L by 2L	0.75992	1	0.75992	13.6140	0.034523
Lack of fit	1.38879	3	0.46293	8.2934	0.057949
Pure Error	0.16746	3	0.05582		
The total sum of squares	20.54714	11			
Coefficient of determination R^2=0.924 Adjusted coefficient of determination R^2_{adj}=0.861					

The increase of mass fraction of "Hamulsion QNA" in the formulation of low calorie emulsion systems from 0.10 to 0.42 % causes the increase in IQM, while further increasing the content of the stabilizing system in the emulsion reduces the IQM (Fig. 4). When increasing the mass fraction of the concentrate of Jerusalem artichoke "Noteo" from 6.67 to 10.06 %, we note the increase of the IQM, and with further increase of the *Cca,* we observe decrease in this indicator (Fig. 4).

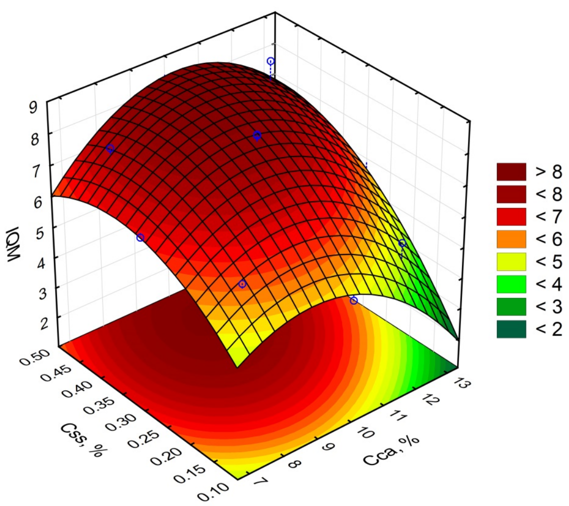


Fig. 4. Dependence of the integrated quality metric (IQM) on the mass fraction of the concentrate of Jerusalem artichoke "Noteo" (%) and the mass fraction of the stabilizing system "Hamulsion QNA" (%)

Processing a polynomial (9) in the medium of the *Statistica 10* allowed setting the optimum values of the mass fractions of the stabilizing system "Hamulsion QNA" and of the concentrate of Jerusalem artichoke "Noteo" – 0.42 and 10.06 %, at which the maximum value IQM (8.905) is achieved. Under these conditions, the content of inulin in the emulsion fat systems is 7.55 %. When consuming 20–30 g of the product, produced on the basis of such an emulsion fat system, human body would receive 15.1–22.6 % of the daily requirement of inulin.

Chemical composition and the main indicators of the quality of the low calorie emulsion fat system, obtained with the use of raw material components in optimal ratios are given in Table 5.

Table 5

Organoleptic, physical-chemical and microbiological parameters of the quality of the low calorie emulsion fat system (n=3, p≤0.05)

Indicator	Characteristic of indicator for low calorie emulsion fat system
Organoleptic indicators	
Taste and smell	Characteristic for low calorie mayonnaise, with a slight touch of taste and smell of Jerusalem artichoke
Consistency and physical appearance	Consistency is homogeneous, viscous, with barely visible air bubbles
Colour	Light mustard, homogeneous for all mass
Physical-chemical indicators	
Active acidity, units pH	4.62±0.02
Stability of emulsion, %	99.5±0.5
Effective viscosity, Pa·s	2530.45±0.05
Microbiological indicators	
Bacteria of the E. coli group in 1 g of emulsion, CFU	absent
Pathogenic bacteria, including *Salmonella*, in 25 g of emulsion, CFU	absent

The studied low calorie emulsion fat system with optimal ratios of raw ingredients possesses normalized physical-chemical and microbiological indicators, good organoleptic characteristics, including nice colour, taste and smell (Table 5), which is predetermined by adding the concentrate of Jerusalem artichoke "Noteo", a stabilizing system, fructose, egg powder, lactic acid and KSB – UF into its composition.

Designed low calorie emulsion fat system may become the basis for the production of low calorie mayonnaises, mayonnaise sauces, dressings for healthy nutrition. It is possible to produce two groups of low calorie mayonnaises, sauces and dressings on the basis of the developed low calorie emulsion fat systems with optimum composition:

– first group are the foods with prebiotic properties, the technology of which involves introduction of the stabilizing systems and inulin, contained in the concentrate of Jerusalem artichoke, into their composition;

– second group are the products with synbiotic properties, the technology of which, in addition to the stabilizers and prebiotic components, involves using activated cultures of probiotic bacteria (such as bifidobacterium activated in cheese whey [19]).

It is also possible to include spicy-aromatic raw materials, greens, etc. in the technologies of sauces and dressings.

With the scientific substantiations of the technologies for low calorie mayonnaises, mayonnaise sauces, dressings with synbiotic properties, based on the recommended low calorie emulsion fat system with optimal composition, it is necessary to take into account the fact that the application of probiotic cultures of lactobacilli and/or bifidobacteria in their technologies make it possible not only to prolong the term of their storage, but to give probiotic and hepatoprotective properties to the products.

The prospects for further research are: scientific–practical justification of formulations and technological parameters of the production of low calorie mayonnaises, mayonnaise sauces, dressings for healthy food; development of normative documentation for their production; carrying out industrial approbation of the designed technologies.

7. Conclusions

1. Optimum mass fractions of the concentrate of Jerusalem artichoke "Noteo" and the stabilizing system "Hamulsion QNA" were substantiated – 10.06 and 0.42 % respectively, as components of low calorie emulsion fat basis for the production of low calorie oil-fat products.

2. It was shown that low calorie emulsion fat system, produced by using raw components in the optimal ratio, had normalized physical-chemical and microbiological indicators, good organoleptic characteristics, including nice color, taste and smell, and could be used as the raw material for the production of low fat mayonnaises, sauces and dressings for healthy nutrition.

3. It was proposed to use designed low calorie emulsion fat system as the basis for the production of two groups of low calorie mayonnaises, sauces and dressings: the first included products with prebiotic properties; the second – products with synbiotic properties, additionally enriched with activated cultures of probiotic bacteria.

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TECHNOLOGY OF SPECIALTY FATS BASED ON PALM STEARIN

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Розроблена нова технологія модифікування жирів, яка дозволяє шляхом ферментативного етанолізу одержати жири спеціального призначення (кулінарні, хлібопекарські та для молочної промисловості). Такі жири за показниками якості відповідають вимогам нормативних документів і, крім того, збагаченіфізіологічно-активнимиінгредієнтами – етиловим ефірами жирних кислот, які краще засвоюються організмом людини і зменшують ресинтез жиру

Ключові слова: алкоголіз, пальмовий стеарин, етиловий спирт, фермент, етилові ефіри, жир спеціального призначення

Разработана новая технология модифицирования жиров, которая позволяет путем ферментативного этанолиза получить жиры специального назначения (кулинарные, хлебопекарные и для молочной промышленности). Такие жиры по показателям качества соответствуют требованиям нормативных документов и, кроме того, обогащены физиологически-активными ингредиентами – этиловыми эфирами жирных кислот, которые лучше усваиваются организмом человека и уменьшают ресинтез жира

Ключевые слова: алкоголиз, пальмовый стеарин, этиловый спирт, фермент, етиловые эфиры, жир специального назначения

1. Introduction

To date, there is imbalance in the nutritional needs of the population of Ukraine and in the world as a whole, the essence of which is that the diet is dominated by high calorie products that enter the body when eating the food with high content of fat and simple carbohydrates. This way of consuming food leads to the deterioration in the population health, occurrence of diseases of the cardiovascular system and premature aging.

The relevance of the work in this direction is linked to the fact that, since the products of oil and fat industry refer to the goods of mass demand, creating new domestic technologies and designs with respect to dietary fats with healthcare and prophylactic and functional properties can be an efficient solution to this problem.

2. Analysis of scientific literature and the problem statement

Oil and fat industry of Ukraine produces wide range of specialty fats, but there is a significant amount of fats among them that contain spatial isomers of natural unsaturated fatty acids (trans-isomers). They are formed in large volumes during hydrogenation of vegetable oils for obtaining solid and half-solid fat product. Reducing the content of trans-isomers in oil and fat products is a worldwide trend, linked to