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ВЛИЯНИЕ УСЛОВИЙ ПОЛУЧЕНИЯ ВОДЫ ИЗ ВОЗДУХА НА МИКРОБИОЦЕНОЗ КОНДЕНСАТА

Представлены результаты теоретических и экспериментальных исследований влияния различных факторов на микробиоценоз воды из воздуха. Установлены закономерности между загрязненностью атмосферного воздуха различными примесями, а также особенностями эксплуатации настенных кондиционеров сплит-систем и рядом показателей микробиологического загрязнения воды. Показано, что вода, полученная из воздуха с помощью бытовых кондиционеров, характеризуется значительным микробиологическим загрязнением и без специальной очистки использовать ее для питьевых нужд опасно.

Ключевые слова: атмосферный воздух, бытовой кондиционер, качество воды, микробиоценоз воды из воздуха.

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UDC 665.1
DOI: 10.15587/2312-8372.2017.119481

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CALCULATION OF PHYSICAL PROPERTIES OF FATS ON THEIR TRIACYLGYCLEROLE COMPOSITION

Проведено дослідження по отриманню жирових сумішей з заданими властивостями. Визначено залежність між фізико-хімічними показниками і концентрацією компонентів (триацилгліцеролів) суміші. Також визначено тріацілгліцерольний (ТАГ) склад переетеріфіцірованих жирів і отриманих в ході експерименту жирових сумішей. Доведено, що існує функціональна залежність між ТАГ складом і фізико-хімічними показниками.

Ключові слова: *тріацілгліцерольний склад, температура плавлення, температура застигання, рослинне масло.*

1. Introduction

The main component of fats (usually more than 95 %) is triacylglycerols. Triacylglycerol, and, consequently, fatty acid composition of fats is of great importance for the properties of food products containing fats [1, 2].

To obtain fatty products with specified physical-chemical and organoleptic properties, it is necessary to take into account the ratio of solid and liquid fats in the formulations of fatty foods. Physicochemical properties of fats affect the structure, stability, organoleptic characteristics and presentation of finished fat-containing products.

The composition of fatty foods for various food industries depends on many factors. The composition may be different, depending on the field of application, the process, the used equipment and many other features, and also depending on the requirements of the customer. At present, the formulation of fats for a certain product is being developed, to ensure the necessary quality characteristics of the finished product. However, the development of fats of general purpose involves the creation of fatty mixtures with a large range of physicochemical parameters [3]. This is not always possible, because fats due to polymorphism can exist in different crystalline forms, of which α, β and β′ are the main ones, depending on the phase transition temperatures [4]. The melting profile of fat crystals plays a key role in determining the structural and organoleptic properties. Therefore, work on obtaining fats with specified properties has been carried out for a long time and is a priority in the fat industry. In general, efforts are aimed at creating recipes for various fats, such as culinary, confectionery, fat bases of margarines, etc. But since the market for raw materials is limited and constantly changing, the old recipes lose their importance and there is a need to develop new ones [5].

2. The object of research and its technological audit

The object of research is the fat bases of margarines with given properties, for the creation of which it is necessary to have initial data on three interrelated sets. These data primarily become a set of raw components from which it is possible to create fat bases or the original components of the mixture. The second source of data is the physicochemical parameters of this raw material or fat bases. The third source is a triacylglycerol (TAG) composition of raw materials or mixtures. This is, in fact, a list of all TAGs that exist in nature. Since the number of species of fatty material for creating fatty bases is limited, all subsequent data is also finite.

When creating a specific fat basis for a specific type of fat products, it is necessary to know the physical and chemical parameters of the original fats. This makes it possible to guess from which fats it is possible to obtain a fat basis for a specific type of fatty foods. TAG composition of these fats varies within rather narrow limits depending on the manufacturer, as well as on the features of the manufacturing process.

TAG composition of fatty bases is not well understood. The main thing is that the patterns that bind TAG are not revealed. Revealing of such regularities will allow to accelerate the process of correction of the composition of fat bases for margarine with the use of new fat raw materials and new (calculated) methods.

3. The aim and objectives of research

The aim of research is development of methods for calculating the raw composition of fatty formulations for various types of fat products.

To achieve this aim it is necessary to:

1. Determine the TAG composition of fats and obtained mixtures.
2. Establish a relationship between the TAG composition and the physical and chemical properties of mixtures using a Scheffe third-order simplex-lattice plan for a three-component mixture.
3. Experimentally show the possibility of creating fatty products with specified properties by using data on the TAG composition of fatty raw materials.

4. Research of existing solutions of the problem

Studies conducted in Europe show that the composition of the components of fatty compositions has changed significantly over the past two decades due to the removal of hydrogenated vegetable oils that contain trans fats obtained by industrial hydrogenation [6, 7]. Reduction of trans fats in food products in Europe has been largely achieved through sectoral initiatives. In America, significant changes in the composition of fatty foods over the past 10 years have been accelerated by initiatives aimed at limiting the content of trans fats, indicating their amount when labeling food, and prohibiting the use of these trans fats in the restaurant business [8, 9]. Despite attention to trans fats in food, reliable data on the fat composition of products in the US market is limited [10, 11].

A stable fat composition is a suspension of a crystallization-coagulation structure in which the liquid fat fraction is a continuous medium. The phase of liquid fat in the solid structure ensures high plasticity of the compositions. Therefore, in work [12], the complexity of the structure of fatty compositions is considered and the structural and mechanical properties are determined.

In Ukraine, studies are conducted [13] on the composition of fat bases with specified properties for the incomplete fatty acid composition of interesterified fats, for this purpose only 6–7 essential fatty acids of the initial fats are used. At the same time, calculation algorithms are obtained for the melting temperature and Kaminsky hardness.

In [14], the composition-property diagrams are obtained for the content of the components in the mixture and it is suggested to combine fatty acids with the same physical properties. Based on this, fat bases with predetermined properties for interesterified fats are obtained.

Also, studies [15] are conducted to determine the basic TAG in pure fats and oils. It has been established that in the studied fats, the amount of TAG, which is more than 80 % of their total fat content, does not exceed 6÷8 depending on oil or fat.

Proceeding from the fact that fatty mixtures can be formulated according to the LC composition, one can expect that it is possible to do this based on the TAG composition, but whether or not the interesterification mixture is irrespective of whether it is. Since the TAG composition is uniquely related to the properties of the fat mixture, this development methodology should give more accurate results.

It should be noted that there is no functional relationship between raw materials and physical and chemical indicators of fat bases. Since the batch composition of the mixture may differ from batch to batch, even if they meet the requirements of regulatory documentation. In order to formulate the fatty product, it is necessary to know the physical and chemical parameters that characterize this fatty product and the raw fat components.

5. Methods of research

To date, methods of mathematical experiment planning for systems that are mixtures of various components have been successfully applied. This design of the experiment excludes blind search and significantly reduces the number of experiments, hence the costs and timing of the experiment, makes it possible to obtain quantitative estimates of the influence of factors in the form of mathematical models.

For the first time the problem of constructing a mathematical model of the composition-property that includes all components of the system was solved by Scheffe who introduced the canonical form of a polynomial of degree *n*:

$$\hat{y}=\sum_{i=1}^{n}\beta_i\cdot\chi_i+\sum_{\substack{i=1\\ i\prec j}}\beta_{ij}\cdot\chi_i\cdot\chi_j,$$

$$y=\sum_{i}^{n}\beta_i\cdot\chi_i+\sum_{i\prec j}^{n}\beta_{ij}\cdot\chi_i\cdot\chi_j+$$

$$+\sum_{i\prec j}^{n}\gamma_{ij}\chi_i\chi_j\left(\chi_i-\chi_j\right)+\sum_{i\prec j\prec l}\beta_{ijl}\chi_i\chi_j\chi_l, \tag{1}$$

where $\chi_i\chi_j\chi_l$ – concentration of the corresponding components; β and γ – calculated regression coefficients.

Polynomials of this kind (the so-called reduced polynomials) are obtained from ordinary polynomials of appropriate degree for q variables by introducing relation (2) and contain C_{q+n-1}^{n} coefficients. In addition, the independent variables in (1) must satisfy the normalization condition:

$$\sum_{1\le i\le q}x_i=1. \tag{2}$$

To estimate the coefficients of the reduced polynomial, plans are proposed that ensure a uniform spread of the experimental points along the $(q-1)$-dimensional simplex. The points of such plans are nodes of $\{q,\ n\}$-simplex lattices. In the $\{q,\ n\}$-lattice, $n=1$ equal-level levels in the interval from 0 to 1 ($x_i=0.1/n,\ 2/n,...,1$) are used for each factor (component) and all possible combinations thereof are taken [16].

Therefore, to study the physicochemical parameters of the mixture, Scheffe third order simplex-lattice plan for a three-component mixture is chosen. The experiment used such fats as palm olein (refined, deodorized according to DSTU 4438:2005), palm stearin (refined, deodorized – DSTU 4439:2005) and hydrogenated fat MZ (refined, deodorized – DSTU 5040:2008).

The interesterification process is carried out under the following conditions:

- temperature – 105–115 °C;
- residual pressure – (0.4–0.9) kPa;
- duration – 1.5 hours;
- catalyst dosing – 0.1 % in terms of metal.

The catalyst residues are removed by adsorption purification using Tonsil Standard 310 FF adsorbent at a temperature of 90 °C, the dosage of the adsorbent is 2 % of the weight of the three-component mixture [17].

As parameters of the system response, the following parameters are chosen: the melting temperature determined by the open capillary method in accordance with DSTU ISO 6321:2003 and the temperature set by Zhukov device – DSTU 4463:2005.

TAG determinations are performed on an HP-6890 gas chromatograph from Agilent Technologies (USA) with a flame ionization detector and autosampler [18].

6. Research results

A functional relationship between the TAG composition and the physical and chemical properties of the fat mixture is demonstrated below in a specific example.

To study the physical and chemical parameters, mixtures are prepared according to the Scheffe third order simplex-lattice plan for the three-component mixture. The mixtures consisted of palm olein (hereinafter PO), palm stearin (hereinafter referred to as PS) and hydrogenated fat M3 (hereinafter HF), the mass content of which in the mixtures are respectively denoted x_1, x_2 and x_3. In accordance with the simplex-plan, they are determined by standard methods, melting temperature T_m, °C and pour point T_k, °C, which are designated y_1 and y_2, respectively, for components and fat mixtures composed of them, which are presented in Table 1. All the mixtures underwent interesterification, as well as adsorptive purification. A description of the technique can be found in [17].

According to the results of the research, the mathematical processing of data is carried out using the program Statistica 8 (StatSoft, Inc., USA) [19]. As the analysis of the obtained experimental results shows, the linear model most reliably corresponds to the data of the study. Using this model, regression equations (3), (4) are written that relate the melting point and the pour point with the concentration of the components in the mixture [19]:

$$y_1=30.44\cdot x_1+50.66\cdot x_2+33.98\cdot x_3, \tag{3}$$

$$y_2=20.61\cdot x_1+36.85\cdot x_2+28.49\cdot x_3. \tag{4}$$

To check the adequacy of models, an analysis of variance was used. In it, statistically significant effects (*p*-test) are checked, which did not exceed 0.05. Similarly, the quality of the regression model is estimated using the coefficient of determination R_2. For a model with a melting point response, this criterion is 0.94, and for the pour point it is 0.87. All the coefficients in the regression equation are significant, which is confirmed by the Pareto diagram and the pseudo-component estimate. To avoid the influence of different measurement scales, the components of the mixture are usually recoded into so-called pseudo-components. If the plan is a standard simplex-vertex or simplex-centroid, then this transformation simply leads to another scale of factor measurement.

Table 1

Scheffe simplex-lattice plan of the third order for a three-component mixture

No. of experiment		1	2	3	4	5	6	7	8	9	10	11
PO	x_1	1	0	0	0.33	0.33	0	0.67	0.67	0	1/3	0.15
PS	x_2	0	1	0	0.67	0	0.33	0.33	0	0.67	1/3	0.08
HF	x_3	0	0	1	0	0.67	0.67	0	0.33	0.33	1/3	0.77
T_m, °C	y_1	28.5	50	35.5	44.4	31.2	38.8	40	31.3	43.6	40.3	36.5
T_k, °C	y_2	19	36.6	30.5	32	22	30.8	27	26	33.3	29.3	27.4

For additional verification of the model, a control point is taken for adequacy, the composition of which is given in Table 1 in the line under No. 11 (concentration of PO – 15 %, PS – 8 %, HF – 77 %). For this mixture, a melting point of 36.5 °C and a pour point of 27.4 °C are obtained by experiment. By the regression equation for the melting temperature with a probability of 95 %, a confidence interval of prediction (32.5–37.1) °C is obtained, as well as the boundary for the forecast – (29.9–39.7) °C. For this mixture, the predicted melting point is 34.8 °C. The predicted pour point is 28.0 °C, the confidence interval of forecasting (25.3–30.6) °C, the boundary for the forecast (22.3–33.7) °C. This also confirms the adequacy of the chosen model.

The TAG composition of the PO, PS, and HF is determined by gas-liquid chromatography. Fig 1 shows an example of a chromatogram for palm stearin.

From the results of the TAG determination of the composition, it follows that for components the number of TAGs in their composition varies from 13 to 20.

To demonstrate the functional relationship between the TAG composition and the physical and chemical properties of the fat mixture, depending on its composition in the initial mixture, one of the components is replaced by another with a different TAG composition. As a model component, palm stearin (hereinafter referred to as PS*) with a different TAG composition is used.

In Table 2 in columns 1 to 3 is the percentage of TAG in the composition of the starting components of the mixture and mixture in the column 4. Columns 5 and 6 show TAG compositions of PS* and a model mixture.

The ratio of the components of the model mixture is calculated from the condition that the TAG composition should coincide with the TAG composition of the initial mixture of components given in line 10 (Table 1). Since the system of equations for the calculation consists of three in number of components, and the TAG composition of these components contains in total 22 names of TAGs, in the end, the system is redefined and in the sum of 210 equations. To solve the system in Mathcad 14, an algorithm is compiled that, in the iterative process, allows to find a solution that satisfies the posed problem [20].

Table 2

The results of measuring the triacylglycerol (TAG) composition of the components and the calculated TAG compositions of ternary mixtures

No.	TAG	Experimental data				Model mixture	
		PO, %	PS, %	HF, %	1/3PO+ +1/3PS+ +1/3HF	PS*, %	PO0.469+ +0.255PS*+ +0.276HF
		1	2	3	4	5	6
1	MPP	0.534	2.733	0	1.089	2.501	0.888
2	MOM	0.302	0.652	0	0.318	0.120	0.172
3	PPP	3.733	29.613	0.135	11.160	28.198	8.979
4	MOP	2.579	1.662	0	1.414	1.459	1.582
5	MLP	0.762	0.114	0	0.292	0.269	0.426
6	MSS	0	0	0.408	0.136	0	0.113
7	PPS	0.967	6.206	2.760	3.311	3.211	2.034
8	POP	36.670	30.165	0	22.278	33.783	25.813
9	MOO	0.714	0.381	0	0.365	0	0.335
10	PLP	8.870	5.758	0	4.876	5.758	5.628
11	MLO	0.178	0.117	0	0.098	0.092	0.107
12	PSS	0	0.631	0.325	0.319	2.056	0.614
13	POS	5.417	4.236	5.632	5.095	2.311	4.684
14	POO	24.544	10.559	15.884	16.996	10.939	18.685
15	PLS	0	0.931	3.968	1.633	0.622	1.254
16	PLO	7.651	3.555	0	3.735	3.358	4.445
17	PLLn	1.222	0	0	0.407	0	0.573
18	PLL	0	0	0	0.000	0.396	0.101
19	SOS	0.454	0.408	3.237	1.366	0.275	1.176
20	SOO	1.692	0.846	19.151	7.230	0.947	6.321
21	OOO	2.590	1.034	37.287	13.637	1.612	11.917
22	*	0	0	11.818	3.737	0	5.258
23	SLO	0	0.399	0	0.133	0.529	0.146
24	OLO	0	0	0	0.000	0.494	0.136
25	SLL	1.121	0	0	0.374	0	0.286
Total		100	100	100	100.000	98.93	99.705

Note: * – unidentified TAG.

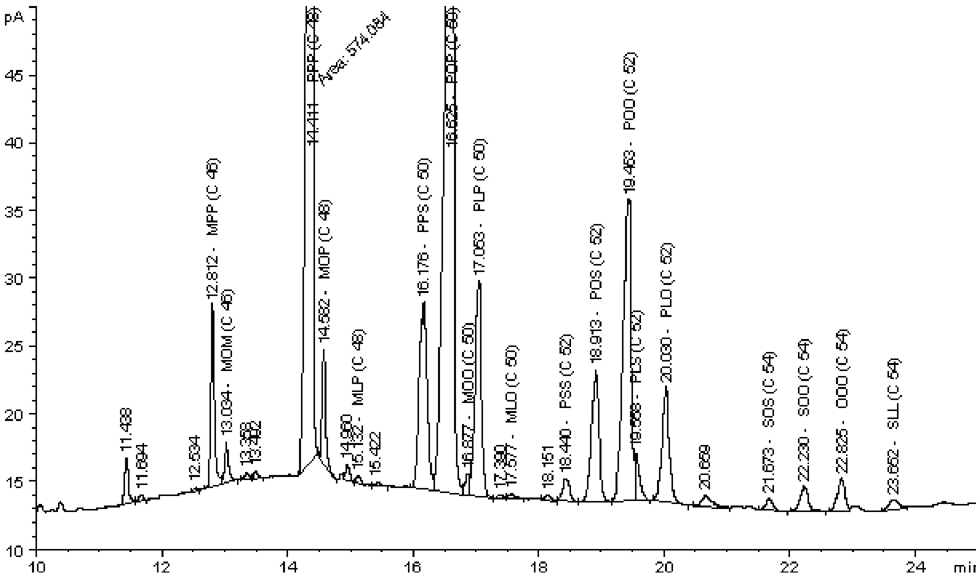


Fig. 1. Chromatogram of triacylglycerol (TAG) composition of palm stearin

Fig. 2 is a graph showing the convergence of the iterative process of solving a system of equations for calculating the content of components in a mixture in the form of a polygon. Fig. 3 is comparison of TAG compositions of the initial and model mixtures.

From the iterative process in Fig. 2 that, starting from the number of iterations over 150, the ratio of the components in the model mixture does not undergo significant changes. For further estimates, the following final result is obtained for calculating the ratio of the components of the model mixture: palm olein (PO) $x_1=0.469$, palm stearin (PS*) $x_2=0.255$, hydrogenated fat M3 (HF) $x_3=0.276$. The curves in Fig. 3 are TAG compositions of the experimental and model mixtures quite well coincide and the greatest absolute difference the TAG content does not exceed 2 %.

Since the content of the components in the mixture and the TAG content in each of the components, as well as the mixtures, satisfy the normalization condition (2), then there is a linear relationship between them, which allows to change the variables x_i in the relations (3), (4) (the content of the components in the mixture) to the pseudo-variable t_j (the content of TAG in the mixture). As shown by numerical calculations, it is sufficient to use the recommendations given in [15] to perform this procedure. It is also possible to limit the basic TAG, which make up more than 80 % of the total TAG in each component, which is 5–6 TAG in each of the components. In this case, it is necessary to perform the renormalization procedure of the basic TAGs without fail. As a result, for the mixtures listed in Table 1, data are generated that accept pseudo-components in their composition. Values of the pseudo-component are given in Table 3.

The system of linear equations for determining the coefficients in the regression equation for the melting and solidification temperatures has the form:

$$\sum_{i=1}^{11} t_{ij}\cdot a_i = y_{kj}, \qquad (5)$$

where i – the TAG number in Table 3; j – the number of the experiment in Table 3; k – the index corresponding to the temperature in Table 1.

As a result of solving the systems of equations (5), regression relations (6) and (7) are obtained to determine the melting and solidification temperatures of the mixtures.

$$y_1=-3.7\cdot x_1+2.1\cdot x_2+9.3\cdot x_3-1.9\cdot x_4-1.6\cdot x_5-11.5\cdot x_6+$$
$$+0.9\cdot x_7+5\cdot x_8+2321.7\cdot x_9-1187.2\cdot x_{10}+0.4\cdot x_{11}, \qquad (6)$$

$$y_2=-2\cdot x_1+1.3\cdot x_2+5.5\cdot x_3-0.7\cdot x_4-1\cdot x_5-7.1\cdot x_6+$$
$$+0.7\cdot x_7+3.5\cdot x_8-942\cdot x_9+487.6\cdot x_{10}-0.7\cdot x_{11}. \qquad (7)$$

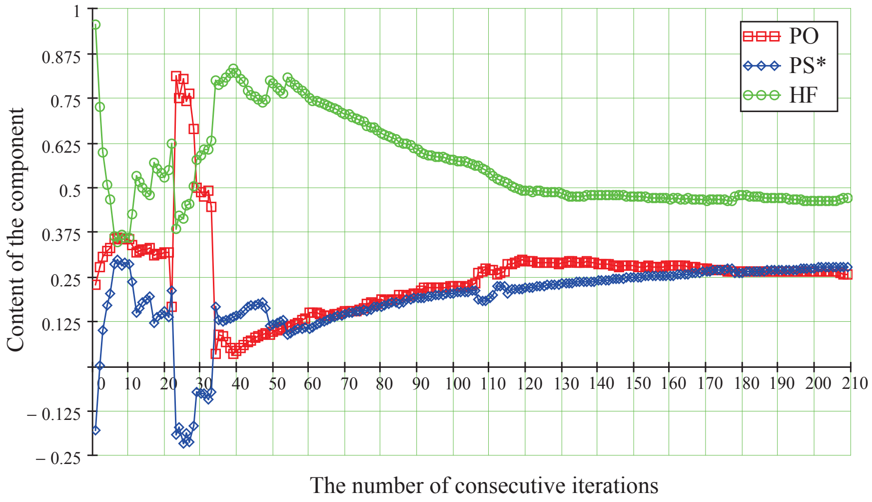


Fig. 2. The iterative process of calculating the model triacylglycerol composition

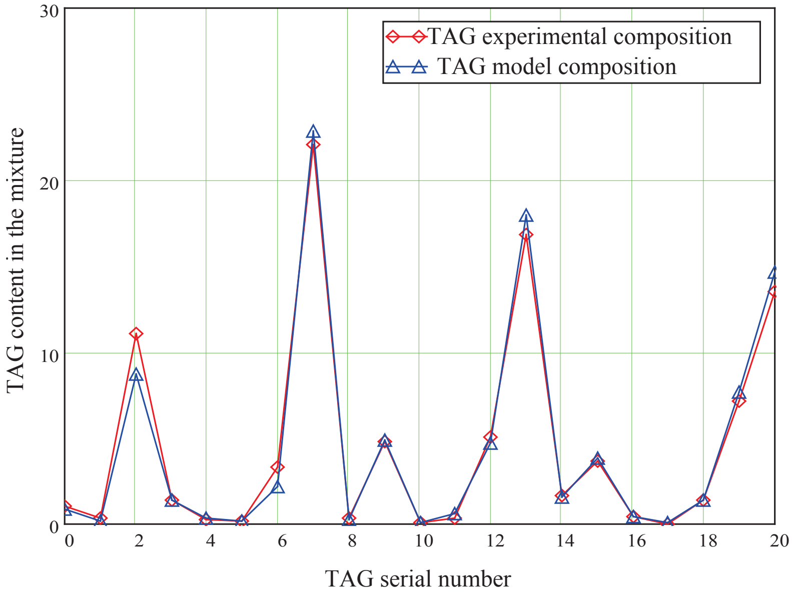


Fig. 3. Comparison of the triacylglycerol formulations with the model

Table 3

Values of pseudo-variables for mixtures from the Scheffe third order simplex-lattice plan

Pseudo-variable	TAG	No. of experiment										
		1	2	3	4	5	6	7	8	9	10	11
t_1	PPP	4.296	34.22	–	27.886	–	13.129	16.604	–	26.728	15.354	–
t_2	PPS	–	7.171	–	–	–	–	–	–	–	–	–
t_3	POP	42.205	34.858	–	42.91	15.738	13.373	46.254	32.781	27.228	30.719	10.203
t_4	PLP	10.209	6.654	–	9.016	–	–	10.499	7.929	–	–	–
t_5	POS	6.235	4.895	6.047	–	6.835	–	–	7.191	6.185	6.847	6.694
t_6	POO	28.249	12.202	17.055	20.187	23.254	17.767	26.643	28.565	16.192	22.923	20.526
t_7	PLO	8.806	–	–	–	–	–	–	–	–	–	–
t_8	PLS	–	–	4.26	–	–	–	–	–	–	–	–
t_9	SOO	–	–	20.564	–	15.337	15.778	–	7.986	8.032	8.198	17.716
t_{10}	OOO	–	–	40.035	–	29.859	30.718	–	15.548	15.635	15.959	34.491
t_{11}	*	–	–	12.038	–	8.978	9.236	–	–	–	–	10.371
Total		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note: * – unidentified TAG.

By substituting in these TAG equations the composition of any mixture that is in the Scheffe third order simplex-lattice plan, let's obtain the calculated values for the melting and solidification temperature. This allows to conclude that the introduction of pseudo-variables according to the above procedure retains the functional relationship between the TAG composition and the physical and chemical parameters of fats.

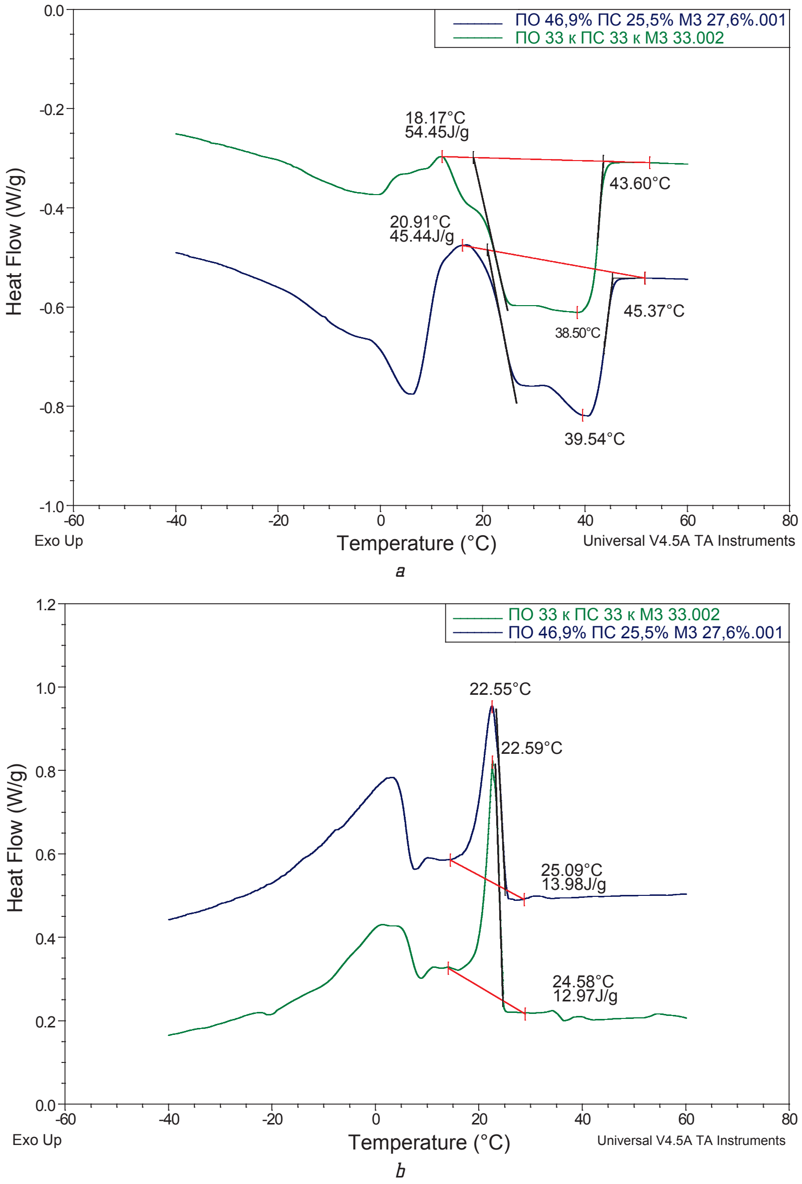
In accordance with the column 6 in the Table 2, the fat mixture is made up by the ratio of the components and the melting temperature is determined for it which is equal to 40.3 °C and the hardening is 28.7 °C.

In addition, the melting and crystallization of the initial and model mixtures by differential scanning calorimetry (DSC) is investigated. Fig. 4 shows DSC diagrams of melting and crystallization of mixtures.

As can be seen in Fig. 4, *a*, the melting peak in the new mixture is visually different from the original mixture.

The main endothermic peak in the main mixture starts at a temperature of 18.17 °C, and in the model mixture it starts at 20.91 °C.

There is a temperature coincidence of peak peaks, which differ only in 1 °C. In this case, the endothermic peak of the maximum differs in its form. This is due to the concentration of certain TAGs that melt at these temperatures. The presence in the model mix of a large number of such TAGs and influenced the changes in the endothermic peak. The end of the melting process also differs by 2 °C. However, the melting points obtained by standard methods coincide.



a

b

Fig. 4. DSC-grams: *a* – melting process; *b* – crystallization process

During crystallization, which is shown in Fig. 4, *b*, it is clear that the origin and the peaks of the first peaks coincide. The pour points obtained with the help of Zhukov apparatus differ insignificantly.

On the basis of these studies, it can be concluded that fat mixtures with a given melting point can be obtained by mathematical calculation of the composition of the mixture.

7. SWOT analysis of research results

Strengths. Among the noteworthy aspects of this study, it should be noted that the relationship between the TAG composition and the physicochemical parameters of the mixtures is linear. This makes it possible to obtain for each point of the Scheffe simplex-lattice plan not only the dependence of the content of the mixture components on the parameters, but also the TAG composition at this point. This leads to the possibility of using TAG composition or basic TAG for the development of fat products with a given melting point, including the fat bases of margarine products.

Using the DSC method to compare the mixtures, one can see the differences and coincidences of the melting and crystallization processes. This makes it possible to observe not only the specific temperature, but also the process in dynamics, which makes it possible to more accurately compare the fat bases and processes that are observed in them.

Weaknesses. The weak side of research is that changing the composition of the initial mixture will lead to a change in the parameters and the found dependencies. Therefore, it is necessary to know the TAG composition of fats that are included in the previous fat base and TAG fat composition, which will replace one of them.

Opportunities. Additional opportunities in this work are in the fact that the selection of fat products by this method will reduce the time and reagents' expenses for the experimental correction of the composition of raw mixtures. This will lead to the formation of a fat base with given physical and chemical and organoleptic indicators. The use of such mathematical calculations at enterprises will allow to quickly respond to changes in fatty materials and to make appropriate adjustments in the ratio of components in the fat mixture.

Threats. The cost of the enterprise when implementing the methodology for the synthesis of the composition of the fatty product, which will be based on the results of this study, consists of one-off costs for the development of the calculation algorithm and the costs of performing an experimental verification of the calculation results for each of the calculated fat blends.

8. Conclusions

1. The composition of fats and mixtures obtained during the TAG studies varies from 13 to 20.

2. The dependence between the concentration of the components and the physical and chemical properties of the mixture (melting point and solidification temperature) is established according to the Scheffe third order simplex-lattice plan. The equations connecting the TAG composition with the given physical and chemical properties of the mixtures are obtained. The mathematical algorithm for calculating the concentrations of the components of the model mixture is calculated using these equations: palm olein (PO) $x_1=0.469$, palm stearin (PS*) $x_2=0.255$, hydrogenated fat M3 (HF) $x_3=0.276$.

3. It is shown experimentally that the obtained model mixture has a melting point equal to 40.3 °C, and solidification is 28.7 °C, which coincides with a mixture of the Scheffe third order simplex-lattice plan. To confirm the coincidence of the physical and chemical properties of the interesterified mixture and the model mixture, the DSC method is used to see the dynamics and the differences in the melting and crystallization process.

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РАСЧЕТ ФИЗИЧЕСКИХ СВОЙСТВ ЖИРОВ ПО ИХ ТРИАЦИЛГЛИЦЕРОЛЬНОМУ СОСТАВУ

Проведены исследования по получению жировых смесей с заданными свойствами. Определена зависимость между физико-химическими показателями и концентрацией компонентов (триацилглицеролов) смеси. Также определен триацилглицерольный (ТАГ) состав переетерифицированых жиров и полученных в ходе эксперимента жировых смесей. Доказано, что существует функциональная зависимость между ТАГ составом и физико-химическими показателями.

Ключевые слова: триацилглицерольный состав, температура плавления, температура застывания, растительное масло.

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UDC 664.849:613.292
DOI: 10.15587/2312-8372.2017.119482

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INVESTIGATION OF HYDRATION AND FORMATION OF STRUCTURAL-MECHANICAL PROPERTIES OF VEGETABLE PASTE WITH IODINE-CONTAINING RAW MATERIAL

Експериментально обґрунтовано технологічні властивості та структурно-механічні характеристики овочевих паст при різних гідромодулях обводнення порошків гідробіонтів та ламінарії. Досліджено вплив тривалості набрякання порошків гідробіонтів та ламінарії на властивості паст. Обґрунтовано вплив концентрації гідратованих порошків ламінарії та гідробіонтів на структурно-механічні показники овочевих паст. Визначено раціональний вміст гідратованих порошків з ламінарії та гідробіонтів.

Ключові слова: *структурно-механічні характеристики, овочеві пасти, порошки гідробіонтів та ламінарії, йодовмісна сировина.*

1. Introduction

To date, the population's nutritional structure has significant deviations from the formula for balanced nutrition, primarily on the level of consumption of vitamins and minerals, including iodine. This causes the formation of risk factors for the development of alimentary and alimentary-dependent diseases.

To prevent diseases caused by iodine deficiency, it is promising to increase its content in food products. This can be done through the integrated use of dietary supplements, food raw materials and functional ingredients in which iodine is in an organically bound state and in conjunction with its synergists. Hydrobionts are a valuable raw material, a reserve of iodine and synergist nutrients, in which iodine is in an organically bound state. An additional source of vitamins of group B, for effective assimilation of iodine, is inactivated yeast, and for tyrosine and calcium – cheese products – bryndza and cottage cheese. Vegetable raw material balances the taste, improves the nutritional and biological value of the product. So, the complex use of this raw material in the food composition will create a food product with sufficient iodine content in the form associated with organic compounds and other iodine synergists with functional and technological properties.