

IRSTI 65.35.03

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<https://doi.org/10.55956/BYMR9511>

IMPROVEMENT OF THE RECIPE FOR A DECORATIVE CREAM USING OLEOGEL AS A SUBSTITUTE FOR SOLID FAT

Abstract. The use of vegetable oils allows to manufacture products of the improved structure, with the extended shelf life. At present, Ukraine has organized the manufacture of specialized fats, which are used mainly for making dough. Also, fat components are widely used for combination with raw milk – these are milk fat substitutes. The advantages of their use are the ability to adjust the melting point of the fat phase, high antioxidant stability and the ability to long-term storage. Disadvantages include unequal substitution of milk fat with fat-containing raw materials and products of its processing in terms of nutritional value, content of trans-isomers and refractory fats. Thus, the replacement of fat mixtures with liquid oils is impossible without changing the quality of food products, as it involves a change in manufacturing technology. Therefore, in this aspect it is important to use oils without trans-isomers of fatty acids, without solid fats or with their reduced content, provided that cream retains its shape when forming various shaped decoration, meet the requirements of organoleptic, physicochemical and safety indicators. The expediency of using a fatty semi-finished product based on refined sunflower oil in the form of oleo gel in the recipe composition of cream for surface decoration of flour confectionery is proved. The influence of food ingredients on technological properties of cream for surface decoration of flour confectionery is analyzed. The influence of sugar-containing raw materials (white sugar, powdered sugar, sugar syrup) is determined. The foaming ability and stability of the foam of cream for decorating the surface of the confectionery products depending on the type and content of food ingredients is studied. Determination of these technological factors allows to improve the recipe composition of cream for surface decoration of flour confectionery, to replace butter in the recipe composition with sunflower oil without reducing technological properties.

Keywords: flour confectionery, oleogels, creams finishing, foaming ability, foam resistance.



Omelchenko S., Pyvovarov P. Improvement of the recipe for a decorative cream using oleogel as a substitute for solid fat //Mechanics and Technology / Scientific journal. – 2025. – No.2(88). – P.101-110. <https://doi.org/10.55956/BYMR9511>

Introduction. For decorating flour-based confectionery products, creams are used that must maintain their shape, structure, and pattern [1]. The range of confectionery products is extensive and includes soft waffles, muffins, cupcakes, stollen, scones, macarons, brownies, cannoli, and more. To achieve the stability of

shape, structure, and pattern of the cream, a significant amount of solid fats is used. For butter creams, butter is used, and for creams based on vegetable oils, palm, palm kernel, coconut, and other hydrogenated fats are used. Since the consumption of confectionery products is increasing, it is necessary to enhance their safety by reducing the content of solid and hydrogenated fats in their composition.

In the production of flour confectionery products (pastries, cakes, muffins, cupcakes), a significant amount of various decorative semi-finished products for spreading, filling, and decorating is used [2]. Cream for decorating low-calorie confectionery products is a whipped mass made by whipping butter, chicken eggs, cream with sugar, and other PowerPoint products. Such creams are characterized by high nutritional value. Buttercream for decorating the surface of confectionery products is plastic, allowing for the creation of decorations in various shapes. However, along with its advantages, buttercream for decorating confectionery products has certain drawbacks, namely, it spoils quickly and is very sensitive to bacterial contamination, has low foaming ability, and foam stability under technological factors. To increase the shelf life and microbiological stability in the formulation of decorative creams, hydrogenated oils are used, which contain trans isomers of fatty acids that negatively affect the human body.

The use of such oils allows for the production of products with improved structure and extended shelf life. Today, specialized fats production has been organized in Ukraine, which are primarily used for dough preparation. Fat components are also widely used for combining with dairy raw materials – milk fat substitutes. The advantages of their use lie in the ability to adjust the melting temperature of the fat phase, high oxidative stability, and the capacity for long-term storage. The disadvantages include the unequal replacement of milk fat with fat-containing raw materials and their processed products in terms of nutritional value, trans isomer content, and hard fats.

Thus, replacing fat mixtures with liquid oils is impossible without changing the quality indicators of food products, as this involves altering the manufacturing technology. Therefore, the application of oils without trans isomers of fatty acids, without solid fats, or with reduced content of solid fats is relevant in this aspect, provided that the cream can maintain its shape during the formation of various figurative decorations, and meets the requirements of organoleptic, physicochemical indicators, and safety standards. One of the promising ways to address the issue of using solid fats and hydrogenated oils is the use of oleogels. Oleogels are obtained from liquid oils by introducing a gelling agent, which transforms the liquid oil into a gel-like state.

The above-mentioned defines the necessity of conducting research aimed at substantiating the formulation of a decorative cream based on oleogels to replace the solid fat used for decorating flour confectionery products (pastries, cakes, muffins, cupcakes).

The production of flour confectionery products and decorative semi-finished products is primarily based on the use of solid fats with specific physical and mechanical properties. Solid fats provide the desired structure to these food products. However, the consumption of such fats increases the risk of certain diseases in humans.

Scientists A.B. Horalchuk, S.S. Andreeva, A.M. Dikhtiar, M.A. Chekanov, I.S. Romashko, I.M. Basarab [3,4] examined the issues of replacing trans fats and hard (solid) fats in food products, specifically the production of semi-solid and solid fats from oils. The most common practice is the use of natural tropical fats or the consumption of their individual fractions. However, the use of too many solid

fats in the diet has necessitated their replacement with liquid oils and the addition of supplementary raw materials.

The issue of transforming oil into structured oleogels with viscous, elastic properties is highlighted in the works [5,6]. A. Jang, W. Bae, H.-S. Hwang, H. Lee, S. Lee, J. Lim note that the production of oleogels is a technologically simple, economical, accessible, and inexpensive method that provides a texture close to that of natural solid fats, extended shelf life, and a pleasant aroma to the final product.

The issue of developing and improving the technology for producing decorative semi-finished products for flour confectionery is highlighted in the work [7]. As a rule, the research is aimed at ensuring the necessary texture of the cream, foaming ability, and foam stability by using gelling agents or raw materials that contain them. Some developments [8-10] concern the production of oleogels without the necessary technological principles for their use in food products. The potential of replacing 30% of solid fat with sunflower oil in the cream formulation has been established by creating a multiple emulsion and using a mixture of various fatty acid monoglycerides and Tween 80 [11]. In the work [12], it is proposed to completely replace solid fat with sunflower oil, using monoglycerides and a gelling agent to provide the desired textural properties. The obtained creams are recommended for the production of dessert products, rather than decorative creams.

Oleogels are a promising product for addressing the issue of using hydrogenated oils and solid fats. Oleogels are hydrophobic gels whose base is a non-polar liquid, such as oil, wax, or paraffin, to which a gelling agent is added to achieve the desired physical properties. Oleogels are classified by the dimensional characteristics of their gel-forming molecules as low-molecular-weight and high-molecular-weight. The qualitative composition of oleogels is formed by the following factors: the source of oil extraction, the fatty acid composition, the particle size, the ratio of oil to the gel-forming component, and the digestibility of the oil with a gel-like structure by the human body [13]. To obtain an oleogel, it is necessary to introduce a gelling agent of a certain concentration into the fat system, which forms the gel structure. The transformation of liquid oil into solid occurs due to van der Waals forces. Similar to triacylglycerols, the particles contained in liquid oil capture a portion of the liquid phase, forming a colloidal network. Thus, the mechanism of forming oil with a gel-like structure involves the introduction of a gelling agent into the fat system, which forms the gel structure. During heating, the molecules of the gellant disperse in the oily phase, and after cooling, a three-dimensional network is formed, creating the gel structure. The formation of oil with a strong gel-like structure occurs due to the introduction of up to 30% monoglyceride of fatty acids into the system [12]. Another condition for the formation of an oleogel is the introduction of up to 5% beeswax into the system. However, it is noted that to obtain an oleogel that most closely matches the properties of the specified solid fat, it is necessary to use a mixture of various gelling agents and conduct experimental studies to determine their optimal content [3].

Based on analytical research, it has been established that the technological properties of cream for decorating flour confectionery products depend on the technological properties of the fat component (butter or other solid fat), which affects the structural-mechanical and physicochemical properties of the finished cream. However, there is a lack of systematic data in the literature regarding the replacement of the fat component with liquid oils in creams for decorating the

surface of flour confectionery products and its impact on the patterns of formation of the physicochemical properties of the finished product.

Thus, it is necessary to conduct experimental studies on the modification of the cream's fat base and to determine the influence of the formulation components on the foaming ability, foam stability of the finishing semi-finished product, its shape retention, and plasticity.

The aim of the article is to experimentally justify the formulation of decorative semi-finished products based on oleogels, which will allow for a reduction in the content of solid fats in creams for flour confectionery products without deteriorating their organoleptic, physicochemical, and safety indicators.

Materials and methods. In this study, components meeting the “food grade” standard were used. The following ingredients were employed: refined, deodorized, and frozen sunflower oil; white sugar; 60% sugar syrup; powdered sugar; vanilla powder; sweetened condensed milk with 8.5% fat content; distilled monoglycerides (E471) with an iodine value of (3.0 ± 0.1) g/100 g; and purified beeswax.

Foaming capacity (FC, %) was determined using the formula:

$$FC = \frac{V_f}{V_s} \times 100 \quad (1)$$

where: V_f – volume of foam, cm^3 ; V_s – volume of the solution before whipping, cm^3 .

Foam stability (FS, %) was calculated using the formula:

$$FS = \frac{V_f}{V_n} \times 100 \quad (2)$$

where: V_f – volume of foam after 3600 s, cm^3 ; V_n – initial foam volume, cm^3 .

To determine the mechanical strength of the cream, an OV-204 device (Labor, Hungary) was used. The principle of operation of this device is based on measuring the depth of cone penetration into the sample. During the tests, the mass of the cone remained constant, and the immersion time was 5 seconds. The consistency of the cream was calculated using the following formula:

$$\sigma = k \frac{mg}{h^2}, \quad (3)$$

where: h – immersion depth, m; g – gravitational acceleration, equal to 9.80665 m/s^2 ; k – dimensionless coefficient ($k = 0.356$), which depends on the cone angle (angle at the vertex 30°); m – the mass of the cone, which is equal to 0.11352 kg .

For the study, whipped cream of the brand “Na zdorovya” (Ukraine), Décor Up (Italy), and traditional butter cream were used.

Research results and discussion. The technological process of producing buttercream for decorating the surface of flour confectionery products involves two whipping stages: whipping butter with powdered sugar until a homogeneous mass is obtained; whipping the prepared butter-sugar mass with the remaining recipe ingredients.

The recipe for the buttercream used to decorate the surface of flour-based confectionery products includes: powdered sugar, butter, sweetened condensed

milk, and vanilla powder. The main recipe component that forms the structure of such cream is butter. However, butter is prone to rancidity due to fat oxidation and microbial spoilage. Therefore, it is necessary to completely replace butter to ensure longer and safer storage of the product.

Given the above, a fat-based semi-finished product for a specific purpose has been developed – an oleogel for decorative cream. This semi-finished product, in terms of the polarity of the dispersed phase and the dispersion medium, is a second-type emulsion, like butter. The fat semi-finished product is characterized by neutral organoleptic indicators. The mass fraction of fat is 72.5%, which allows it to be used as a base for the production of finishing creams without deteriorating technological properties. Thus, there is a need to conduct research on the impact of food ingredients on the FC, FS, and mechanical strength of the finishing semi-finished product.

At the first stage of the study, butter was completely replaced with a fat semi-finished product according to the recipe provided in Table 1.

Table 1

Project of the recipe composition for cream to decorate the surface of confectionery products using a fat semi-finished product

Names of the recipe ingredients	Mass fraction of dry matter, %	In nature	In dry substances
Fatty semi-finished product	84,00	523,0	439,0
Refined powder	99,85	279,0	277,2
Condensed milk with sugar	74,00	209,0	154,0
Vanilla powder	99,85	5,2	5,14
Cognac	0,00	1,7	0,00
Total	-	1017,65	876,04
Product release	86,00	1000,00	860,00

A technology for producing a decorative cream using oleogel has been developed. The cream for decorating the surface of confectionery products should be characterized by high foaming ability, foam stability, mechanical strength, and high organoleptic properties, which necessitates conducting research on the impact of food ingredients on the foaming ability, foam stability, and mechanical strength of this cream.

The foaming ability and stability of the decorative cream foam were studied depending on the type and content of sugar-containing raw materials (white sugar, powdered sugar, sugar syrup). The raw materials were selected based on their colloidal state and the content of substances capable of affecting the properties of the system.

It has been found that increasing the sugar powder content from 0 to 25% (Table 2) leads to an increase in foaming capacity from $(100 \pm 10)\%$ to $(320 \pm 20)\%$. Further increasing the amount of powdered sugar does not contribute to an increase in foaming capacity, which remains unchanged at $(320 \pm 20)\%$. The introduction of white sugar into the system in the same quantity leads to an increase in foaming capacity from $(100 \pm 10)\%$ to $(300 \pm 20)\%$. Further increasing the content of white sugar does not contribute to an increase in foaming capacity, which remains unchanged at $(300 \pm 20)\%$. The introduction of sugar syrup into the system leads to an increase in foaming capacity from $(80 \pm 10)\%$ to $(220 \pm 18)\%$ and contributes to the thinning of the ready cream system for decoration.

Table 2

The foaming ability of the cream for decorating the surface of confectionery products depending on the concentration of powdered sugar, white sugar, and sugar syrup

Content of powdered sugar, %	0	5	10	15	20	25	30
Foaming capacity, %	100±1	150±1	200±1	220±1	250±1	330±1	330±1
Foam stability, %	99±1	99±1	99±1	99±1	99±1	99±1	99±1
Content of white sugar, %	0	5	10	15	20	25	30
Foaming capacity, %	100±1	130±1	150±1	185±1	250±1	300±1	300±1
Foam stability, %	99±1	99±1	99±1	99±1	99±1	99±1	99±1
Content of sugar syrup, %	0	5	10	15	20	25	30
Foaming capacity, %	80±1	87±1	100±1	118±1	150±1	200±1	200±1
Foam stability, %	99±1	99±1	99±1	99±1	99±1	99±1	99±1

The results of the foam stability study confirmed that the foam stability is (99±1)% for all studied systems.

During the research, it was found that the introduction of sugar-containing raw materials, specifically powdered sugar, into the recipe increases the foaming capacity, with foam stability at (99±1)%. However, undesirable graininess during chewing appears, which worsens the organoleptic properties of the finished decorative cream.

The introduction of condensed milk into the system contributed to an increase in foaming capacity: with the increase in the content of condensed milk with sugar from 0 to 50%, the foaming capacity increased from (100±10)% to (320±20)% (Fig. 3). Further increasing the content of condensed milk did not significantly affect the increase in foaming capacity. The foam stability was (99±1)%.

Table 3

The foaming ability of the cream for decorating the surface of confectionery products depending on the concentration of condensed milk with sugar

Content of sweetened condensed milk, %	0	10	20	30	40	50
Foaming capacity, %	100±1	135±1	200±1	250±1	300±1	300±1
Foam stability, %	99±1	99±1	99±1	99±1	99±1	99±1

Thus, in the recipe for the cream used to decorate the surface of confectionery products, one component-powdered sugar completely disappears, and the concentration of another component-sweetened condensed milk increases, which eliminates the main drawback of the cream – graininess. The consistency, appearance, and taste meet the requirements of the regulatory documentation.

Based on the obtained data, a project for the cream recipe for decorating the surface of flour confectionery products has been developed (Table 4).

Table 4

Project of the cream formulation for decorating the surface of confectionery products using fat semi-finished product

Names of the recipe ingredients	Mass fraction of dry matter, %	In nature	In dry substances
1	2	3	4
Fatty semi-finished product	84,00	523,0	439,0
Condensed milk with sugar	74,00	488,0	431,0

Table 4 continued

1	2	3	4
Vanilla powder	99,85	5,15	5,14
Cognac	0,00	1,7	0,00
Total	–	1017,65	874,50
Product release	86,0	1000,00	860,00

Thus, the recipe for the developed decorative cream includes: fat semi-finished product, condensed milk with sugar, vanilla powder, and dessert wine.

During the analytical and experimental studies, a formulation for a finishing cream based on oleogel was developed without compromising its technological properties. Table 5 presents a comparative characterization of the indicators of the oil-based cream and the developed finishing cream based on oleogel. To compare the technological properties, butter cream and creams based on vegetable fats were used, the technological process of which involves the use of solid fats [14]. Creams made from vegetable cream are widely used for decorating confectionery products. It has been established that in terms of foaming ability and mechanical strength, all creams are similar. Since the butter cream was studied immediately after preparation, its mechanical strength is close to the indicators of creams based on vegetable fats. But after storing the cream at 4°C for 24 hours, its strength increases due to the crystallization of triglycerides in the butter oil.

Table 5

Comparative characteristics of the indicators of cream based on vegetable oils and the developed finishing cream based on oleogel

Name of the semi-finished product	Names of indicators			
	FC, %	FS, %	Mechanical strength, Pa	Type of oil
Developed cream based on oleogel	320±1	99±1	1830±100	Sunflower oil
Oil-based cream (Italy)	320±1	99±1	2055±100	Hydrogenated palm kernel oil
Pastry cream “Cheers” (Ukraine)	370±1	99±1	2217±100	Hydrogenated palm kernel oil
Buttercream	270±1	99±1	1880±100	Milk fat

It has been established that the developed finishing cream based on oleogel has good organoleptic properties, foaming ability, foam stability, and mechanical strength, even though it does not contain solid fat.

Conclusion. It has been determined that the foaming capacity, foam stability, and mechanical strength indicators of the finishing cream based on oleogel are close to the corresponding values of creams made with vegetable fats and butter cream. As a result of the research, the content of food ingredients for obtaining a decorative cream based on oleogel has been determined. The developed cream has good foaming ability, mechanical strength, stable structure, does not contain trans isomers of fatty acids, and can be used for decorating flour confectionery products. Further research is planned to study the impact of fillers on the developed cream with the aim of developing recommendations for forming the assortment of decorative semi-finished products.

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Received: 20 June 2025

Accepted: 27 June 2025

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ҚАТТЫ МАЙЛАРДЫҢ ОРНЫНА ОЛЕОГЕЛЬ ҚОЛДАНА ОТЫРЫП, ДЕКОРАТИВТІК КРЕМНІҢ РЕЦЕПТУРАСЫН ЖЕТІЛДІРУ

Аңдатпа. Өсімдік майларын қолдану өнім құрылымын жақсартуға және сақтау мерзімін ұзартуға мүмкіндік береді. Қазіргі уақытта Украинада негізінен қамыр дайындау үшін қолданылатын арнайы майлар өндірісі жолға қойылған. Сондай-ақ, май компоненттері шикі сүтпен біріктіріліп кеңінен қолданылады – бұл сүт майын алмастырғыштар. Оларды пайдаланудың артықшылығы – май фазасының балқу температурасын реттеу мүмкіндігі, жоғары антиоксиданттық тұрақтылық және ұзақ сақтау қабілеті. Кемшіліктеріне тағамдық құндылық, транс-изомерлер мен отқа төзімді майлардың құрамына байланысты сүт майының толыққанды алмастырылмауы жатады. Сондықтан май қоспаларын сұйық майлармен ауыстыру тағам өнімдерінің сапасына әсер етпей, өндіріс технологиясын өзгертусіз мүмкін емес. Осыған байланысты, кремнің түрлі пішінді сәндік элементтерді қалыптастыру кезінде пішінін сақтау қабілетін, органолептикалық, физика-химиялық және санитарлық талаптарға сәйкестігін қамтамасыз ете отырып, құрамында қатты майлар немесе олардың мөлшері төмен майлар, май қышқылдарының транс-изомерлері жоқ майларды пайдалану маңызды. Рафинирленген күнбағыс майы негізіндегі олеогель түріндегі майлы жартылай фабрикатты ұннан жасалған кондитерлік өнімдерді беткі безендіруге арналған крем рецептурасына енгізудің тиімділігі дәлелденді. Ұннан жасалған кондитерлік өнімдерді беткі безендіруге арналған кремнің технологиялық қасиеттеріне тағамдық ингредиенттердің әсері талданды. Құрамында қант бар шикізаттың (құмшекер, қант ұнтағы, қант шәрбаты) әсері анықталды. Кремнің пенообразуыштық қабілеті мен көбіктің тұрақтылығы тағамдық ингредиенттердің түрі мен мөлшеріне байланысты зерттелді. Осы технологиялық факторларды анықтау ұннан жасалған кондитерлік өнімдерді безендіруге арналған крем рецептурасын жетілдіруге, оның құрамындағы сары майды күнбағыс майымен алмастыруға мүмкіндік береді, бұл ретте технологиялық қасиеттер төмендемейді.

Тірек сөздер: ұннан жасалған кондитерлік өнімдер, олеогельдер, әрлеу кремдері, көбіктену қабілеті, көбіктің тұрақтылығы.

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СОВЕРШЕНСТВОВАНИЕ РЕЦЕПТУРЫ ДЕКОРАТИВНОГО КРЕМА С ИСПОЛЬЗОВАНИЕМ ОЛЕОГЕЛЯ В КАЧЕСТВЕ ЗАМЕНИТЕЛЯ ТВЕРДЫХ ЖИРОВ

Аннотация. Использование растительных масел позволяет получать продукты с улучшенной структурой и увеличенным сроком хранения. В настоящее время в Украине налажено производство специализированных жиров, которые в основном применяются для изготовления теста. Также жировые компоненты широко используются в сочетании с сырым молоком – это заменители молочного жира. К преимуществам их использования относятся возможность регулирования точки плавления жировой фазы, высокая антиоксидантная стабильность и способность к длительному хранению. К недостаткам относится неравноценная замена молочного жира сырьем, содержащим жир, и продуктами его переработки по пищевой ценности, содержанию транс-изомеров и тугоплавких жиров. Таким образом, замена жировых смесей на жидкие масла невозможна без изменения качества пищевых

продуктов, так как требует изменения технологии производства. В этом аспекте важно использовать масла без транс-изомеров жирных кислот, без твердых жиров или с их пониженным содержанием при сохранении способности крема держать форму при формировании различных декоративных элементов, а также при соответствии требованиям органолептических, физико-химических и санитарных показателей. Доказана целесообразность использования жирового полуфабриката на основе рафинированного подсолнечного масла в виде олеогеля в рецептуре крема для поверхностного оформления мучных кондитерских изделий. Проанализировано влияние пищевых ингредиентов на технологические свойства крема для оформления поверхности мучных кондитерских изделий. Определено влияние сахаросодержащего сырья (сахар, сахарная пудра, сахарный сироп). Изучены пенообразующая способность и устойчивость пены крема в зависимости от вида и содержания пищевых ингредиентов. Определение этих технологических факторов позволяет усовершенствовать рецептуру крема для украшения мучных кондитерских изделий, заменив сливочное масло в составе на подсолнечное масло без снижения технологических свойств.

Ключевые слова: мучные кондитерские изделия, олеогели, отделочные кремы, пенообразующая способность, устойчивость пены.