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THE PROSPECTS OF TRANS FATS REPLACEMENT IN FOOD PRODUCTS

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Analytical review of the current state of food production containing trans isomers of fatty acids has been carried out. It has been determined that the most risky products of the market segment, from the point of view of the content of harmful trans fats, are culinary and confectionery fats, margarines, spreads, shorts and foodstuffs, which they include. In addition, it has been established that margarine, confectionery and other branches of the food industry of Ukraine have a significant need for fats characterized by a narrow range of hardness, melting temperatures and other structural-mechanical and physico-chemical characteristics. In view of the above, the prospect of replacing trans fats in food, including culinary and pastry flour, has been revealed.

Rational ways of creating oleogels using monoglycerides, fatty acids, waxes, hydrocolloids, and others have been analytically established. The functional and technological properties of oleogels as an alternative substitute for trans fats in foodstuffs have been determined. The possibilities of regulating the composition of oleogels for obtaining a fat product with the necessary technological properties are considered. The expediency of using sunflower oil of high oleic type as the main component of oleogels has been established.

It is shown that not all methods of obtaining oleogels are currently ready for industrial introduction. The use in the composition of some oleogel additives that do not have a nutritional status are purely theoretical. Most oleogels lack the necessary properties that are characteristic of refractory oils. However, the combination of monoglycerides, waxes, fatty acids have significant practical and technological advantages in the production of oleogels to replace trans fats and refractory fats in foods.

Keywords: *vegetable oils, trans isomers, hydrogenated fats, oleogels, wax, ethylcellulose, monoglycerides, high-oleic sunflower oil.*

ПЕРСПЕКТИВИ ЗАМІНИ ТРАНСЖИРІВ У ХАРЧОВИХ ПРОДУКТАХ

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Здійснено аналітичний огляд сучасного стану виробництва харчової продукції, що містить трансізомери жирних кислот. Визначено, що найбільш ризикованими продуктами оліє-жирового сегмента ринку, з позиції вмісту шкідливих трансжирів, є кулінарні та кондитерські жири, маргарини, спреди, шортенінги.

Розкрито перспективи заміни трансжирів у харчових продуктах на олеогелі. Проаналізовано способи створення олеогелів. Визначено функціонально-технологічні властивості олеогелів. Розглянуто можливості регулювання складу олеогелів для одержання жирового продукту із заданими технологічними властивостями.

Ключові слова: *олії, трансізомери, гідрогенізовані жири, олеогелі, віск, етилцелюлоза, моногліцериди, олія соняшникова високоолеїнового типу.*

ПЕРСПЕКТИВЫ ЗАМЕНЫ ТРАНСЖИРОВ В ПИЩЕВЫХ ПРОДУКТАХ

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Проведен аналитический обзор современного состояния производства пищевой продукции, содержащей трансизомеры жирных кислот. Определено, что наиболее рискованными продуктами масло-жирового сегмента рынка, с позиции содержания вредных трансжиров, являются кулинарные и кондитерские жиры, маргарины, спреды, шортенинги. Раскрыты перспективы замены трансжиров в пищевых продуктах олеогелями. Проанализированы способы создания олеогелей. Определены функционально-технологические свойства олеогелей. Рассмотрены возможности регулирования состава олеогелей для получения жирового продукта с заданными технологическими свойствами.

Ключевые слова: *растительные масла, трансизомеры, гидрогенизированные жиры, олеогели, воск, этилцеллюлоза, моноглицериды, масло подсолнечное высокоолеинового типа.*

Statement of the problem. Natural oils and fats are an indispensable component in human nutrition. Liquid oils and solid vegetable fats are used in a wide range of foods. The need of the food industry in semi-solid and solid fats is rather high. This has resulted in the development of technologies for the manufacture of semi-solid and solid fats from liquid vegetable oils. The process of liquid oils hydrogenation is relatively inexpensive and widespread. The conducted medical studies confirmed the harmfulness of fats obtained by incomplete hydrogenation. Therefore, WHO called for the elimination of trans fats from food. A considerable amount of research carried out in recent years offer alternative technologies for the processing of fats and oils, in order to meet the needs of manufacturers in technological properties of fats, as well as consumers to ensure food safety.

At present, the promising ways for the replacement of trans fats are the use of natural tropical oils, liquid oils in the technologies where it is possible to replace solid and semi-solid fats, use of oleogels based on liquid vegetable oils. However, it should be noted that new forms of fats require analysis in terms of their possible industrial production, composition and properties.

This review presents analysis of the ways for the creation of oleogels and their properties for the replacement of trans fats and refractory fats in various foods. The possibilities of regulating the properties of oleogels for obtaining fat product with the necessary physical and technological properties are considered.

Recent research demonstrated negative influence of sources of trans isomers of fatty acids on a human body. The harmfulness of these substances for the human body is associated with different amounts of trans isomers consumed by humans: less than 0.5% of daily calories for natural sources, and 2% to 3% of daily consumption for artificial sources [1].

The correlation between the use of trans isomers of fatty acids, the increase in the number of low-density lipoproteins and the risk of coronary artery disease are confirmed. Low-density lipoproteins are the main transport form of cholesterol, which are mainly transported in the form of cholesterol esters.

Margarine is the most risky product in the market segment, from the point of view of the content of harmful trans fats. Spreads occupy the second position. As the content of trans fats directly depends on the technology, the basis of the production of herbal mixtures is, above all, the compounding of various components.

An alternative to hydrogenated fats is the fats obtained by transesterification and fractionation, the processes used in the food industry for the production of fats (with the required melting point). Due to this, the amount of trans fats is less in the final product: they can form 50–67% by hydrogenation, and transesterification can reduce this index even more than 10 times.

Denmark was the first country who legally reduced the content of trans isomers in fat, with a restriction of no more than 2% since 2003. By 2010, such standards have been implemented in Austria, Switzerland, Finland, Norway and Iceland. In 2015, the US Federal Food and Drug Administration formally announced that hydrogenated vegetable fats could no longer be considered safe for health and gave the food industry time to completely replace such fats in food until 2018.

Due to the proven harm of trans isomers, in the last decade research has been actively conducted in order to replace trans fats with safer fats. In parallel, the direction of the research for the creation of oleogels based on liquid oils has acquired sufficient development, which solves the problem of trans fats as well as the consumption of refractory fats. Studies on the replacement of fats with liquid vegetable oils are being conducted.

Reviews [2–5] analyze the creation of oleogels. However, in the works there is no critical analysis of the properties of oleogels and their use in various foods. This requires consideration of the properties of oleogels and the possibility of their practical use for the replacement of trans fats, refractory fats in various foods.

The purpose of the work is to identify ways to replace trans fats in foods. Objectives of the study:

– to carry out the analysis of literary sources from the methods of obtaining oleogels;

– to identify the most promising ways of industrial use of oleogels in food.

Review of the latest research and publications. Characteristics of food products containing trans isomers and ways for their replacement.

Taking into account the above, an imbalance between the modern assortment of fat products and the needs of the food industry is specified. Therefore, it is advisable to consider the importance of fat in the technological process, taking into account the criteria: raw; physiological; technological.

Nutritionists recommend that food fats meet the following requirements [6–8]:

– possess a balanced fatty acid composition;

– contain unsaturated omega-3, omega-6 and omega-9 fatty acids;

– have minimal content of cholesterol and fatty acid trans isomers.

Trans fats are the part of most foods, and can be found in chips, mayonnaise, fast food products, waffles, crackers, donuts, cookies, cheeses and other foods containing from one-third to one-half of the total fat content (Fig. 1) [9; 10].

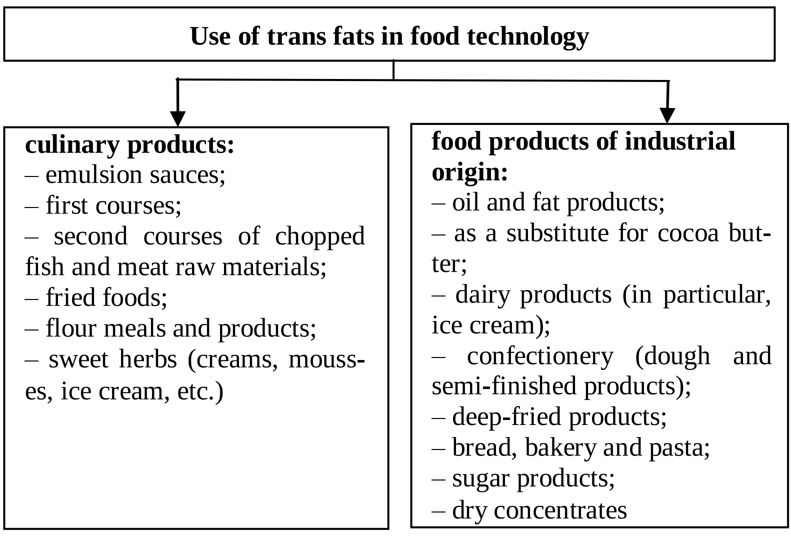

Fig. 1. Foods that may contain trans fats

About 150 million tons of fats are produced in the world, 3/5 of which are vegetable fats [11]. Today, enterprises that specialize in the production of natural fats are successfully developing, which allows to obtain an oil-fat product with the necessary physical and technological characteristics. Modern technologies make it possible to change one or more properties of fats by chemical and physical treatment. This allows to obtain oil and fat products, which provide necessary properties of finished products made with their use. The use of different processing methods allows manufacturers to use a wider range of alternative sources of raw materials that helps to increase profitability of the production.

Today, margarine, confectionery and other branches of the food industry of Ukraine have a significant need for fats characterized by a narrow hardness range, a given melting point and certain structural-mechanical and physico-chemical characteristics. For example, creation of a large number of confectionery products is impossible without the use of solid fats with certain physical and mechanical properties, including the use of tropical fats (palm, palm kernel and coconut oils). Manufacturers of fat products have an alternative: either to use trans fats for these types of products, or to use biogenic solid fats at affordable prices, i.e. tropical fats. The use of tropical fats allows to obtain products with the predetermined characteristics (margarines, spreads, confectionery fats, milk fat substitutes, chocolate, etc.). The properties of the fat phase (which is used, including fractionated tropical fats) of these products influence on a number of their important indicators, namely thermal stability, product gloss, brittleness, hardness, refractory, etc. [12].

The most common ways to solve trans fat transplants are the use of natural tropical fats or the use of individual fractions of fats. In this case, there is a problem of significant consumption of refractory fats. This determines the necessity to replace them with liquid vegetable oils. However, a simple substitute for liquid oils in most cases does not give the desired result.

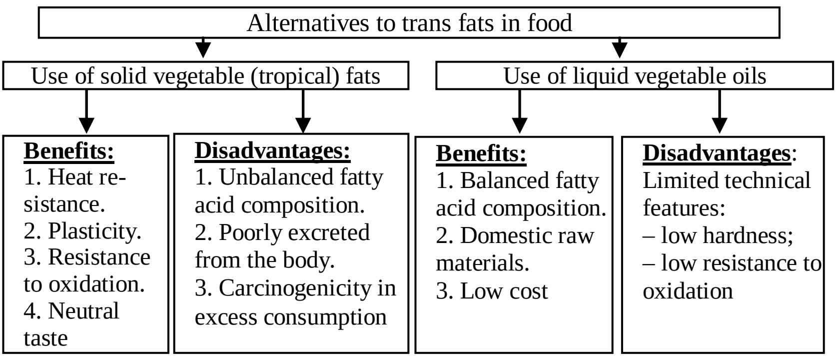

Fig. 2. Alternatives to the substitution of trans fats in food

Therefore, simple replacement of fat blends (margarines, spreads) with tropical or liquid vegetable oils is impossible without changing the food quality. This requires a change in technology, use of additional substances, creation of special fats with the necessary properties that meet the requirements – the absence of trans fats and low content of refractory fats. This led the researchers to create oleogels.

Methods for obtaining oleogels. Foreign scientists propose functional-technological ingredients [13–16], which provide transformation of liquid oils into oils with gel-like structure for introduction into food systems (Fig. 3).

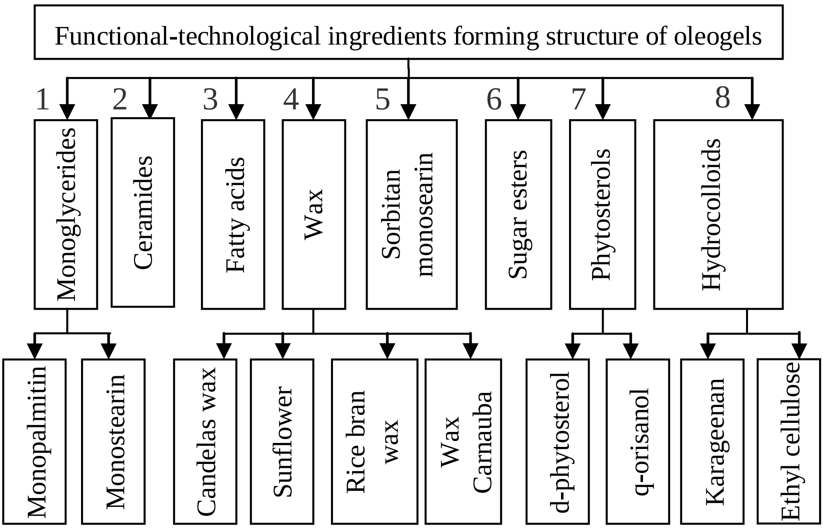

Fig. 3. Functional-technological ingredients that form the structure of oleogels

According to their structure, oleogels can be classified by the size of their gel-forming molecules: low molecular weight and high molecular weight.

The main factors forming qualitative composition of oleogels are:

– fatty acid composition;

– size of particles (when it comes to the content of phyto sterols, hydrocolloids, etc.);

– source of oil production;

– matrix structure (ratio of oil and gel forming component);

– influence and absorption of oil with gel-like structure in the human body.

Oleogels can provide a new alternative to trans fats being solid fat prepared from lipids rich in unsaturated fatty acids. To obtain oleogels, a prerequisite is the introduction of low concentration of gel in the fat system, which will provide the gel structure. During the appropriate treatment (heating, tempering, stirring, cooling), the chelator molecules are dispersed at an oil phase for the formation of a three-dimensional grid that forms the gel structure. The mechanism of transformation of liquid oil into a solid occurs due to Van der Waals forces. Like triacylglycerides, various chelators can be used to structure liquid oil by forming colloidal nets that capture liquid part of the system.

Today, the most common chelators are:

1. Monoglycerides. Increase of the concentration of monoglycerides leads to the formation of gel with a strong structure. The mixture of monoglycerides and oils was characterized in specific systems that revealed intermolecular changes for fatty systems. One of the presented monoglycerides is monopalmitin and monostearin, which can be used to form oil with a gel-like structure. However, to obtain refractory oleogels, it is necessary to introduce 10–25% of monoglycerides, which is sufficiently high in content.

2. Ceramides. Ceramides are sphingolipids in which fatty acid molecules are attached to the amino group of the sphingolysin molecule. They are food products, and can be enzymatically synthesized from milk and eggs. Ceramides are capable of forming oleogels at a concentration of 2%. Chemically homogeneous ceramides with one type of fatty acids form long thin fibrillar crystalline nets in oil. At that time, heterogeneous ceramides form sphaerolites. Along with the ability to gel formation, ceramides also have bioactive properties.

3. Fatty acids. Long-chain fatty acids can form crystalline nets at low concentrations in oil, resulting in gel formation. Their ability to gel formation increases with the length of fatty acid chain. Melting temperatures of the oils with a gel-like structure increase in direct proportion to the length of the chain.

4. Waxes. Vegetable waxes are used to obtain oleogels such as candelas, sunflowers, rice bran, carnauba wax, beeswax at concentrations of 0.5–3.0% depending on the type of wax. They include esters, alkanes, phyto sterols, fatty acids, fatty alcohols and other hydrocarbons. With a low content of beeswax, about 1% is formed by thermally and mechanically non-reversible oleogels.

5. Sorbitan monostearate. Sorbitan monostearate is a food emulsifier capable of forming water-in-oil emulsion. During crystallization in oil, sorbitan monostearate forms rod-like tubes. Oleogels with a minimum concentration of sorbitan monostearate are opaque and thermo-reversible.

6. Sugar esters. Sugar esters of fatty acids are capable of forming oleogels at low concentrations of a chelator. This may occur due to their high melting point. Oleogel formation takes place due to the formation of a crystalline grid.

7. Phyto sterols. For the formation of phyto sterol-based oleogel, d-phyto sterol and g-oryzanol are used. During the formation of oleogel, phyto sterol forms helical grooves with a diameter of 10 nm, which do not differ in size. When oil combines with phyto sterols, transparent gel is formed due to the dimensional characteristics of grooves.

Gel-like oils with the gelatin content of 0.25%, glucose glycide, demonstrated long-lasting structural and mechanical properties, namely fat stability to melting at (20±2) °C.

Oleogel is able to prevent recrystallization of curcitinases from oily medium by increasing the amount of solubilized substances. During mechanical action, microstructural changes occur in oil, namely, disruption of the oleogel structure.

8. Hydrocolloids. Hydrocolloids are a promising class of supplements for the production of oleogels. Oil gelation can be achieved by the formation of a molecular network due to physical and chemical interactions between the polymer chains. The principles of hydrophilic polymers transition to hydrophobic are used for the formation of oleogels. For example, for foamed systems, hydrophilic systems are dried and then introduced into fat systems [11]. Oleogels based on kappa-carrageenan are obtained by replacing the solvent with alcohol, followed by its separation. The obtained matrix is used for oil absorption [15]. This approach is complicated from the point of view of industrial implementation; the obtained products are characterized by certain physical dimensions, whose change is impossible.

According to Marangoni studies [14], ethylcellulose is a promising hydrocolloid, which is capable of forming solid oleogels at concentrations of 4–6%. The mechanism of gelation is concluded in the transformation of ethylcellulose together with oil into a solid state, by heating the model system to 130 °C. In the process of cooling to 100 °C, a grid is formed between the ethylcellulose chains. The advantage is the lack of the necessity to waterproof ethylcellulose.

Oleogels containing ethylcellulose are also inclined to the impact of technological factors. Scientists [13; 14] have developed a paste-like fat product that includes glycerol monoolein 45% and fat multicomponent mixture of 55% (oil, ethylcellulose). This product had stable performance, namely during mechanolysis and influence of temperature it restored its native structural and mechanical performance (thixotropy, viscosity). It should be noted that in many countries of the world the use of ethyl cellulose is prohibited.

The comparative characterization of oleogels from the point of view of conformity of their properties to the needs of the food industry shows that they need improvement. One way to ensure the required quality of oleogels is to use high quality oils with the predetermined fatty acid composition and to combine different gels.

The ways of using oleogels, oils and fatty mixtures for changing trans fats in food products.

Analysis of studies [19–29] shows the possibility of using oleogels in the composition of food (table 1).

Table 1

Use of oleogels in food composition

Name of the product	Composition of the system oleogels contained in products	Purpose of use
Chopped culinary products	Vegetable oil – 90%, ethylcellulose – 10%	Trans fat replacement, emulsion stabilization
Sausage	A mixture of oils (canola oil, cottonseed oil) – 90%, ethylcellulose – 10%	
Ice cream	High oleic oil – 87–89%, wax based on rice bran 10%, glycerol up to 2%	Trans fat replacement, emulsion stabilization, stability under mechanical action, stability under freezing conditions
Baked goods	Monoglycerides, sunflower and palm oil	Trans fat replacement, emulsion stabilization, plasticity during molding
Cookies	Mixture of carnauba and candelilla waxes – 5%, sunflower oil 95%	

Traditionally, palm oil is fractionated to produce high-melting stearin and olein, and combined with cocoa butter extract. This blend is used to make chocolate products.

Scientists investigate the process of palm oil fractionation using supercritical carbon dioxide (SC-CO_2), which is divided into four fractions, which are marked as f-PKO (f-PKO-1, f-PKO-2, f-PKO-3 and f- PKO-4). Palm oil fractions (f-PKO-3 and f-PKO-4) were specified as high oleic and used to produce cocoa butter.

One of the most common substitutes for tropical oils is rapeseed oil. Analytical studies show that rapeseed oil contains saturated, monounsaturated, polyunsaturated fatty acids with a number of carbon atoms from 12 to 24. High content of polyunsaturated fatty acids: linoleic – 18.52% and 18, 66%; linolenic – 8.05% and 8.57%. The use of rapeseed oil is promising when creating emulsion products independently or as a blend with tropical oils. This makes it possible to obtain products with a high content of essential polyunsaturated fatty acids, omega-3, omega-6 [17].

Radzievskaya I.G. and other researchers developed the technology of sweet emulsion cream, made by emulsification of the refined deodorized sunflower oil with aqueous starch solution and with the addition of fillers [18]. This made it possible to completely replace refractory fats with sunflower oil. Scientists made complete replacement of butter in finishing oil creams, which made it possible to obtain products with higher structural and mechanical properties. In addition, creams ae characterized by a lower moisture content, which positively affects their shelf life.

The authors [19] developed the technology of pralines with the corresponding technological properties by combining palm oil and flax oil in the ratio 88:12. The resulting composite mixtures of the fatty bases of praline masses possess a balanced fatty acid composition.

Widely tropical oils (palm kernel, coconut) are used in the production of ice cream for milk fat replacement, both as a base and as a glaze. In the food industry, the most common glaze on vegetable fats is glaze on the basis of coconut oil, which when covered with ice cream, forms a thin fusible layer, melting in the mouth simultaneously with ice cream. The consumer especially appreciates this. Such properties of glaze are stipulated by the low melting point of coconut oil (24…28 °C) and the ability to harden in a narrow temperature range. The palm kernel oil, which, like coconut, belongs to the group of lauric fats, and possesses similar properties.

Fat components are widely used to combine with dairy raw materials – milk fat substitutes (MFS). The advantages of their application in the composition of milk-containing products, compared to oils, are the ability to adjust the melting point of the fat phase, high antioxidant stability due to the low content of free fatty acids and the ability to long-term storage. The main problems in the technologies of dairy products are unequal replacement of milk fat with fatty raw materials and products of its processing in terms of safety and nutritional value. For the complete replacement of milk fat in the composition of new types of protein and fat products, the authors proposed to use food emulsions based on milk fat substitute obtained by the method of enzymatic transesterification [20].

The use of tropical oils in the baking industry (for the preparation of yeast, shortcrust pastry, sugar, long and shortbread cookies, gingerbread cookies, biscuits) allows:

– to produce products of the improved structure with longer shelf life, because palm oil is more resistant to oxidation than other types of fats and oils;

– to reduce the cost of production, since technological losses of palm oil are much lower than in other liquid oils and deep fat fats.

For deep-fried culinary products, much attention is paid to deep-frying fat, which possesses thermal stability and minimal absorption capacity. The minimum thermal stability of saturated fats is compensated by the addition of a complex of oxidation inhibitors such as E321 (butyl hydroxytoluene), E330 (citric acid) and E900 foam destroyer (polydimethylsiloxane).

According to scientists who develop special frying fat, it is determined that the optimum frying fat should have up to 30% polyunsaturated fatty acids. One of them is a special deep fat fryer of TM "Cargill", which contains the basis of refined deodorized oils: sunflower, palm, sunflower high oleic. This blend of oils allows you to refuse oxidation inhibitors.

It is found that the product prepared on different oils has different organoleptic characteristics. The taste of potatoes fried in palm oil is less pronounced, the texture is softer, but the crust of the potatoes fried in sunflower oil is brighter and crispy. The weight loss of the product, when fried in palm oil is 2% greater, compared to the loss of sunflower oil, which is explained by the fact that in the process of frying in sunflower oil, a crust is formed on the surface of the potato, which prevents excessive evaporation of moisture.

Taking into account that the change in peroxide value for palm oil after repeated frying does not increase as intensively as in the case of using refined oil, that is, less free fatty acids and free radicals are formed, which is definitely a positive fact. Therefore, palm oil can be offered as a cheaper substitute for frying oil [21]. Palm oil, sunflower, corn, linseed and rapeseed oil were used as the fatty oil with a PUFA ratio of omega-6: omega-3 as 10:1. It is found that the following blend is advisable for the use of fryer, balanced by the ratio ω-6 and ω-3, in the production of potato chips: palm olein 40% + corn oil 30% + rapeseed oil 30% and corn oil 50% + rapeseed oil 50%.

The manufacture of products with the combined composition of the fat phase is a dynamically developing segment. This is connected with the consumer demand for healthy foods characterized by balanced fat content, low fat and cholesterol. A large group of products that should to be replaced with trans fats is confectionery and bakery. Such production is for mass consumption and is consumed by almost all segments of the population daily. So in confectionery products fats are used in baked semi-finished products and finishing creams.

It is analytically proved that the implementation of technological process of manufacturing culinary and confectionery products, in particular from custard dough, is determined mainly by the technological properties of the fat component, which is able to influence rheological, structural-mechanical and physico-chemical properties of finished products. In the technology of manufacturing custard dough as a fat component butter, margarine, cooking oil, coconut, cotton and rapeseed oil, hydrogenated fats from vegetable raw materials, shorting agents are used. However, due to the constantly increasing cost, poor quality of food their basis has become a deterrent that does not meet the requirements of manufacturers [22–25].

The puff pastry products differ in a high fat content that determines their original layered structure and delicate texture, which are created during repeated dough layering. Solid fats are used in traditional puff pastry technology to ensure high quality finished products. It should be noted that the melting point and the aggregate state of fat significantly affect the degree of plasticization of dough. However, current trends in the food industry are mainly focused on the use of unsaturated fats, such as olive oil, which are considered more beneficial for human health. In [26], the results of the development of fat product for partial and complete replacement of solid fats in the manufacture of puff pastry are presented. A new fat product is a water-in-oil emulsion based on olive oil, emulsifier and hydrophilic thickener. The developed fat product has a structure of oleogel, which significantly depends on the properties of the emulsifier and composition of the aqueous phase. The resulting fat product is characterized by the necessary structural-mechanical and physico-chemical properties.

Scientists [27; 28] elaborated the technology of shortbread cookies based on the combination of traditional ingredients with the use of selenium-containing oils. The ratio of fatty acids ω-3 to ω-6 for flaxseed cookie is 1:1.7, for buttermilk cookies 1:3.4, to control 1:1.5 that meets the standards of daily nutrition and approaches to the diet of people at risk of cardiovascular disease by this indicator. The developed samples of cookies allow to satisfy from 18.2% to 28.5% of daily need in selenium trace element.

In pastry technology, fats not only affect structural and mechanical properties of the dough, but also determine the shelf life of finished products. Fat content of the products made from custard dough is 13.5%, and the shelf life of these products varies widely $(12…72) \times 60^2$ s at t = 0…6 °C or up to 360 days at t = –18 °C. Consequently, fats that are resistant to oxidation processes should be used to produce pastry products.

Testing the results of experimental research. We studied the replacement of margarine in custard pastry with high-oleic-type sunflower oil. The scientifically substantiated technology of production of custard dough is developed. It was found that optimal oil concentration in the formulation was 32%. At this concentration, the specific volume of baked semi-finished product is 7.3 cm^3/g, shape resistance is 1 ppm, baking – 39%, shrinkage – 4.4%. The main indicators of quality and safety of products made from custard dough using high-oleic-type sunflower oil are specified [29].

The technology of dry blend for creams manufacture by mixing powder filler with oil without spray drying is developed. In order to obtain dry mixture, trans fats and solid fats should be replaced with sunflower oil oleogel with fatty acid monoglycerides. This allows creams with high foaming ability, mechanical strength to be obtained [13]. High technological properties of creams are achieved by obtaining oleogels with a high content of fatty acid monoglycerides, which constitute 35% of the total oil content. This allows to obtain powdered semi-finished products, which are characterized by a powdery consistency, with a shelf life of 180 days with the fat content up to 40% in the dry mix and use of sunflower oil. Beta-carotene and lecithin are used as oxidation inhibitors.

The possibility of replacement of milk fat substitute in oleaginous confectionery for confectionery was investigated. Oleogel was obtained on the basis of sunflower oil, as the gel used 3% beeswax, 9% monoglycerides. The obtained oleogel was characterized by thermo-reversibility in terms of organoleptic characteristics. Products with its use were characterized by high organoleptic characteristics.

Thus, the use of liquid oils resistant to oxidation, justified in terms of the composition of fat mixtures, oleogels allows not only to preserve the quality of products, but also to improve functional and structural properties of finished products. However, new obtained fat mixtures and oleogels should be characterized by the necessary complex of technological properties (Table 2).

Table 2

Scientific-practical concept of the development of culinary and flour confectionery products using poly component fat systems based on vegetable oils

<table>
<tr><td rowspan="2">Name of indicators</td><td rowspan="2">Thermo-stable toppings</td><td>Finishing semi-finished products</td><td colspan="2">Baked semi-finished products based on dough:</td></tr>
<tr><td>shortbread</td><td>puff pastry</td><td>custard</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td rowspan="4">Technological properties</td><td colspan="4">Stability in the conditions of thermal impact, thermal reversibility</td></tr>
<tr><td colspan="4">Stability under freezing at minus (18±2) °C, defrost</td></tr>
<tr><td rowspan="2">Stability in the conditions of mechanical impact of different intensities (from 1000 to 1500 s^{-1})</td><td rowspan="2">Plasticity during molding</td><td rowspan="2">Layer formation</td><td>Cavity formation</td></tr>
<tr><td>Specific volume of finished products</td></tr>
</table>

Continuation of Table 2

1	2	3	4	5
Safety indicators	Absence of Trans fat			
Uniform indicators	Use of liquid vegetable oils. Functional-technological ingredients represented by mono glycerides, waxes, fatty acids			
Principles of production and sales	production: establishments of restaurant business, food industry enterprises			
	realization: restaurants, trade enterprises			
	minimum labor intensity and energy consumption in production and use			
	convenience of transportation			
	convenience of portioning			

Conclusion. Generalization and analysis of the conducted studies on the production of oleogels, the use of tropical oils, liquid oils resistant to oxidation showed the perspective of their use for the replacement of trans fats in food. It is shown that not all methods of obtaining oleogels are currently ready for the implementation in industry. The use in the composition of some oleogel additives that do not have nutritional status are purely theoretical. Most oleogels lack the necessary properties that are characteristic of refractory oils. However, the combination of monoglycerides, waxes, fatty acids have significant practical and technological advantages in the production of oleogels for the replacement of trans fats and refractory fats in foods. Further studies are required to obtain oleogels that have the properties of refractory fats, taking advantage of several gelling agents.

The expediency of using sunflower oil of high-oleic type in the technology of culinary and confectionery production as a medium for deep-frying and a recipe component of production from custard dough has been established. The advantages of its use are high resistance to oxidation compared to sunflower oil. The use of liquid oils with oxidation inhibitors instead of solids in those products where they do not determine the texture properties is a promising direction for enhancing functional properties of food products.

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