CHAPTER 4

Development and characterization of ice cream containing vegetable oils

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Abstract

Ice cream is considered one of the world's favorite desserts. It is important for consumers to get benefits and enjoyment from eating this sweet product. The main ingredients of ice cream are milk or cream, sugar, and sometimes egg yolks. Fruits, berries, cocoa, and vanilla are used to add flavor to the recipe. The milk or milk-egg mixture is first heated, then cooled, whipped to saturate the mass with air and obtain the appropriate texture, and frozen. Ice cream can be viewed as a multiphase system consisting of a cryo-concentrated aqueous phase, air bubbles, ice crystals and emulsified fat.

The fat in ice cream comes from the dairy ingredients, but vegetable fats such as coconut or palm oil can also be added. The fat phase ensures the optimal structure of the ice cream, gives it a rich flavor and influences the quality characteristics. It also helps to stabilize the foam, which contributes to the delicate creamy texture of the ice cream. The development of a blend of milk and vegetable fats is one of the most important factors in shaping the required texture, taste and aroma properties of ice cream. The use of liquid vegetable oils containing unsaturated fatty acids and vitamins makes it possible to create a new food product with health benefits.

The technology of ice cream using vegetable oils as an alternative to milk fats has been developed, which provides an innovative product enriched with unsaturated fatty acids. The influence of sunflower, linseed, and sesame oils on the texture of ice cream, its taste characteristics, and nutritional value was analyzed. The physicochemical properties of ice cream with the addition of vegetable oils, technological features of replacing milk fats with vegetable fats, as well as their impact on the stability of emulsions and organoleptic properties of the finished product are investigated. The technological aspects of the production of ice cream with vegetable oils, including emulsification, stabilization and freezing processes, are considered.

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The obtained results can be used to develop new types of ice cream with increased nutritional value and improved consumer characteristics.

Keywords

Ice cream, vegetable oils, texture, emulsion, sunflower oil, linseed oil, sesame oil, physicochemical properties, organoleptic properties, nutritional value, stabilization, freezing.

4.1 Relevance of developing a technology for the production of ice cream with the addition of vegetable oils

Ice cream is a popular multi-ingredient frozen dessert that includes dairy (milk, cream) or non-dairy ingredients, sugar, emulsifiers and stabilizers. It is the milk fat in classic ice cream that provides the delicate texture and mild flavor [1]. Depending on the composition, a distinction is made between traditional or classic dairy ice cream made from dairy products and alternative ice cream, in which milk fat is replaced by vegetable fats.

The fats in ice cream play an important role in shaping the texture – during low-temperature processing, fat crystals form a stable structure of the product, ensuring its creamy texture. The fat content slows down the melting process, thus ensuring the product's consumer appeal. The milk fat contained in whole milk is responsible for the excellent organoleptic characteristics of ice cream, giving it a creamy taste and flavor. On the other hand, milk fat balls distributed in the aqueous phase have different sizes, varying from 0.1 to 15 microns. At low temperatures, the fat crystals formed protrude from the surface of the fat globules, causing damage to their membrane, and fat globules aggregate. As a result, the stability of whole milk ice cream is significantly reduced [2].

Current global trends towards the consumption of "healthy" foods containing less saturated fatty acids are driving the search for a replacement for milk fat with vegetable oils. The use of vegetable oils in ice cream recipes can reduce calories, increase nutritional value and expand the range of products that can be consumed by vegans and lactose intolerant consumers. There have been studies on the use of soybean oil in ice cream, which has good emulsifying properties and provides a stable product structure. It has been found that replacing 40–50% of milk fat with soybean oil improves the stability of ice cream, as the apparent viscosity of the mixture increases due to a decrease in its particle size to 0.4–2 μm [3]. The combination of sunflower oil and extra virgin coconut oil reduces the melting rate of ice cream and ensures its stable structure [4]. Replacing milk fat with extra virgin coconut oil gives ice cream a delicate coconut flavor and aroma. However, the increased content of coconut oil reduces the resistance to melting [5]. The use of oleogels derived from candelilla wax, hemp oil and olive oil in the production of plant-based ice cream allows to create a product with good physical, chemical and sensory properties [6]. Grape and pomegranate seeds and their oil, sesame seeds and sesame oil can be used to produce ice cream with prebiotic, phenolic and antioxidant properties [7]. When a mixture of hazelnut oil and olive oil is added to the ice cream recipe, the good physical and chemical properties of the ice cream are maintained, and some characteristics, such as melting speed, are improved. The addition of a blend of oils slows down the melting rate of ice cream [8]. On the other hand, although the use of vegetable oils has a number of advantages over milk fat, it should be borne in mind that not all vegetable oils are capable of providing the required texture of ice cream, and if the technology is not followed, they can lead to phase separation of the product.

Gelatin, a protein substance derived from animal collagen (skin, bones, membranes, etc.), is traditionally used in industrial ice cream production. Due to its functional properties, gelatin effectively acts as a gelling agent, thickener and stabilizer. The overall hardness of ice cream, its resistance to melting and organoleptic properties can be changed by changing the concentration of gelatin in the ice cream recipe [9].

In the light of the need to find environmentally and economically feasible alternatives to gelatin, there is a growing interest in natural hydrocolloids of plant origin. One of the most promising among them is galactomannan, a highly polymeric carbohydrate (polysaccharide) formed from mannose and galactose residues. Due to its properties, galactomannan effectively functions as a thickener, emulsion stabilizer, and potentially helps to reduce the permeability of toxic substances [10]. Depending on the galactose-mannan ratio, it is possible to distinguish between hay fenugreek gum, guar gum, tara gum and carob gum. Guar gum is derived from the seeds of the Cyamopsis tetragonal plant, known as guar. It is a natural polysaccharide that is highly soluble in water and can form a viscous gel even at low concentrations. A characteristic feature is that the addition of guar gum contributes to the formation of a viscous consistency of the product without heating, so it is well suited as a stabilizer for ice cream [10]. Guar gum provides a stable structure in a wide range of acidity – pH 4...10. In addition, guar gum is resistant to freezing and thawing.

4.2 Characteristics and chemical composition of oils

4.2.1 Sesame oil

Sesame oil is produced by pressing sesame seeds. Unrefined sesame oil is a viscous liquid of yellow-golden or amber color with a pleasant nutty flavor, while refined sesame oil has a light-yellow color and a less intense flavor. Its advantage over other types of vegetable oils is its high antioxidant content, which extends its shelf life. Sesame oil contains the antioxidants sesamolin and sesamol, which help maintain cell integrity and healthy tissue function in the human body in the presence of oxidants [11]. The chemical composition of sesame oil is quite diverse. It contains fatty acids: saturated-palmitic – 7...10%, stearic – 4...6%, monounsaturated – oleic – 33...44% and polyunsaturated – linoleic – 40...50% and alpha-linolenic – 0.3...0.5%. In addition, sesame oil contains vitamin E, which has antioxidant and radioprotective effects and improves oxygen consumption by human tissues. 100 g of sesame oil contains 1.4 mg of vitamin E. Sesame oil phytosterols support healthy cholesterol [12]. Due to its properties, sesame oil is used in cooking and cosmetics.

4.2.2 Flaxseed oil

Flaxseed oil is obtained from flaxseeds by pressing them. In appearance, unrefined flaxseed oil is yellow with a greenish tint and is a rather viscous liquid with a specific bitter nutty and herbal flavor. A special feature of flaxseed oil is its ability to oxidize rapidly, which causes a change in taste. Refined flaxseed oil is a clear liquid with a less intense color and taste. Due to its beneficial properties, flaxseed oil is widely used in nutrition and medicine. The interest in using flaxseed oil is driven by its chemical composition. It contains saturated fatty acids: palmitic acid – 5%, stearic acid – 2...4%, monounsaturated oleic acid – 18%, and polyunsaturated alpha-linolenic acid – 50...60% and linoleic acid – 14...18%. The main value of flaxseed oil lies in its high content of alpha-linolenic fatty acid or omega-3. The ratio between omega-3 and omega-6 fatty acids in flaxseed oil is 4:1 [13]. Flaxseed oil is rich in vitamin E (tocopherols); 100 g of oil contains about 37 mg of vitamin E and tocopherols, which amount to 250 mg in 100 g of oil. In addition, flaxseed oil contains phytoestrogens or lignans, which are natural antioxidants [14].

4.2.3 Sunflower oil

Sunflower oil is obtained from sunflower seeds by pressing or extraction. Extra virgin sunflower oil has a deep yellow or amber color and a pleasant taste of roasted seeds. After refining, the oil becomes light yellow in color and has a neutral taste. The chemical composition of sunflower oil is slightly different from that of sesame and linseed oils. It contains saturated fatty acids: palmitic acid – 6%, stearic acid – 4%, monounsaturated oleic acid – 20...40%, and polyunsaturated linoleic acid – up to 70%, and alpha-linolenic acid is almost absent. Sunflower oil is rich in vitamin E (tocopherols) and phytosterols. 100 g of sunflower oil contains 40...70 mg of vitamin E. In addition, sunflower oil contains lecithin [15]. The physicochemical properties of sunflower oil vary depending on its variety [16]. Sunflower oil is widely used in cooking.

A comparative description of vegetable oils is presented in **Table 4.1**.

Table 4.1 Comparative characteristics of oils

Characteristic	Type of oil		
	Sesame	**Flaxseed**	**Sunflower**
Color	Yellow-gold or amber	Yellow with a greenish tint	Yellow or amber
Flavor/aroma	Nutty, delicate	Bitter, nutty and herbal	Saturated seedy, refined neutral
Omega-3 content, %	0.5	50…60	Very low
Omega-6 content, %	40…50	14…18	48…74
Oleic acid, %	35…45	18	20…40
Saturated fatty acids, %	14	12	10…12
Vitamin E (tocopherols), mg/100 g	1.4	20	40…70
Other compounds	Sesamol, sesamin	Lignans, phytoestrogens	Lecithin, phytosterols

Source: compiled by the authors

4.3 Materials and methods

4.3.1 Materials and laboratory equipment

The developed soft ice cream compositions with the addition of vegetable oils, such as sesame oil, linseed oil and sunflower oil, were studied.

The following raw materials were used for the production of the ice cream prototypes:

– ultra-pasteurized cow's milk 3.2% – TM "Selyanske", Ukraine;
– white crystalline sugar – TM "Premiya", Ukraine;
– guar gum – TM "Zdorovo!", Ukraine;
– sunflower seeds – TM "Vyshyachanyi vkusok", Ukraine;
– sesame seeds – TM "WinWay", Ukraine;
– flax seeds – TM "Zdorovo!", Ukraine.

All raw materials were purchased at a local supermarket (Lutsk, Ukraine).

The following laboratory equipment was used in the study: oil press Dulong ZYJ06 600W; immersion blender Moulinex Quickchef DD 655D10; soft ice cream machine Klarstein Sweet Sundue; pH meter NS 0.00-14; pycnometer; drying cabinet DHG-9035A; thermometer Testo 405V1; laboratory scales FEN-V2003; microscope BRESSER Erudit Basic Mono. The study was conducted in the laboratory of Lutsk National Technical University (Ukraine).

4.3.2 Methods

4.3.2.1 Determination of ice cream melting and whipping resistance

The resistance to melting of the obtained experimental ice cream samples was determined according to the method [17]. The resistance to melting of all ice cream samples ranged from 81% to 83%.

The creaminess of ice cream samples was determined using the method described in [18].

To do this, the known volume of the mixture before making the ice cream and the ice cream itself after freezing was recorded, and then the defeat (*O*) was calculated using the formula

$$O\% = \frac{(V_2 - V_1)}{V_1} \cdot 100\%, \tag{4.1}$$

where $O\%$ – overrun of ice cream, %; V_1 – volume of the ice cream mixture before freezing, ml; V_2 – volume of ice cream after freezing, ml.

4.3.2.2 Determination of active acidity, solids content and density of ice cream

The active acidity of the ice cream mixture was investigated using a pH meter model NS 0.00-14 with a measuring range of 0.00–14.00 pH (with an error of $\pm$ 0.01 pH).

The determination of the mass fraction of dry substances in ice cream was carried out according to the standard method [19].

The density of the obtained ice cream samples is determined using a pycnometer according to the formula

$$\rho = m_1 - m_0 + \frac{A}{m_2} - m_0 + A \times 0.99823, \tag{4.2}$$

where ρ – density, g/cm^3; m_1, m_2 – respectively, the mass of the pycnometer with a mixture of ice cream and water, g; m_0 – mass of an empty pycnometer, g; 0.99823 – density of water at 20°C, g/cm^3; A – correction for aerostatic force.

The correction for the aerostatic force was calculated by the expression

$$A = 0.001204 \times V, \tag{4.3}$$

where 0.001204 – density of air at 20°C, g/cm^3; V – capacity of the pycnometer, g.

4.3.2.3 Determination of the crystal structure and the number of air bubbles in the ice cream samples

Microscopic examination of the samples was carried out using a light microscope at a magnification of 7 × 15.

For the analysis, a small amount of ice cream was applied to the graduation grid of the Goryaev chamber, covered with a cover glass and immediately placed under the microscope. During sample preparation, ice crystals melt, but the foam remains unchanged and its structure is clearly visible. In such conditions, moisture evaporation is almost non-existent, so the shells of air bubbles remain unchanged. The air bubbles were observed in transmitted light immediately after the preparation of the samples.

4.3.2.4 Determining the firmness of foam

The firmness of foam is determined by the height of its column. Stir 100 g of ice cream into a 50 mm diameter beaker. Melt it at room temperature, which should reach 20°C. The height of the foam column is measured at the beginning of the study, and then every 5, 10, 15, 20, 30, 40 minutes, and the result is recorded. The calculation is performed using the following formula

$$\text{Foam stability (\%)} = \frac{h_1}{h_0} \cdot 100, \tag{4.4}$$

where h_0 – height of the foam column after a certain time, mm; h_1 – initial height of the ice cream scoop, mm.

4.3.2.5 Statistical analysis and calculations

All data are presented as mean ± standard deviation (SD). Statistical analysis and calculations were performed using Mathcad 14 software.

4.4 Technological process of producing ice cream with vegetable oils

The quality of ice cream is determined not only by the organoleptic properties, which are determined by the composition of the raw materials, but also by its structural and rheological characteristics. The structure of the product depends mainly on the size of the ice crystals: the smaller and more evenly distributed these crystals are, the higher the quality of the ice cream. Consistency, which describes the mechanical properties of the product, reflects parameters such as hardness, softness and density and is an important indicator of consumer value. A sample of high-quality ice cream should form a homogeneous liquid, similar in texture to heavy cream, when it melts.

Dairy ice cream recipes use milk (regular or dry) of different fat content, as well as fats of both animal and vegetable origin. This study focuses on the effect of the concentration of vegetable oils on the rheological properties of ice cream. Determining the type of these components, which depends on the recipe, significantly affects the rheological characteristics and organoleptic properties of the product. Optimization of the composition is an urgent task, as it helps to reduce the cost of products without significantly affecting their consumer characteristics.

Ice cream is a high-calorie dessert due to its high fat and sugar content. From a nutritional perspective, this can have undesirable consequences, so it is important to use alternative ingredients that reduce the calorie content of the finished product. For example, the use of lactose-free milk allows to create ice cream for consumers with lactose intolerance. In addition, the replacement of animal fats with vegetable fats helps to reduce cholesterol, lower the calorie content of the product and extend its shelf life.

The presence of free fat in ice cream is important for creating high-quality ice cream. The presence of free fat determines the 'creaminess' and 'fat content' of ice cream. An increase of more than 30% leads to coalescence, which is manifested in such a defect as 'coarseness', and with less than 10% free fat in ice cream, it is difficult to achieve a high whipping index and high taste of the product. When selecting vegetable fats as a partial replacement for milk fats, recommendations on the composition of fat fractions, the ratio of saturated and unsaturated fatty acids, crystallization and solidification parameters were taken into account (see recipes in **Table 4.2**).

Based on the random selection method, three formulations containing sunflower, sesame and linseed oils were calculated.

The essence of the random selection method is as follows: knowing the raw materials used in the recipe, the weight of one or more components is randomly set. The calculations were based on the amount of added fat, skimmed milk powder residue (SMPR), solids and sucrose (**Table 4.2**).

Table 4.2 Mass fraction of recipe components in model ice cream compositions

Prescription component, g	MC No. 1 (flax)	MC No. 2 (sesame)	MC No. 3 (sunflower)
Cow's milk, 3.2%	77.18	77.18	77.18
Flaxseed oil	8.58	–	–
Sesame oil	–	8.58	–
Sunflower oil	–	–	858
Guar gum	0.51	0.51	0.51
White crystalline sugar	13.73	13.73	13.73
Output, g	100	100	100

Source: compiled by the authors

Each of the formulations contains a certain amount of vegetable oil, namely:

1) recipe No. 1 – 50 g of linseed oil (**Fig. 4.1, *a***);

2) recipe No. 2 – 50 g of sesame oil (**Fig. 4.1, *b***);

3) recipe No. 3 – 50 g of sunflower oil (**Fig. 4.1, *c***).

a *b* *c*

Fig. 4.1 Appearance of the experimental samples of ice cream with the addition of vegetable oils: *a* – MC No. 1 with the addition of flaxseed oil; *b* – MC No. 2 with the addition of sesame oil; *c* – MC No. 3 with the addition of sunflower oil
Source: compiled by the authors

Standard physical, chemical and organoleptic methods were used in the study. The same set of products and the same amount of vegetable oils were used for all recipes.

Ice cream technologies with the addition of vegetable oils differ from the classical technological scheme by an additional operation – emulsification of the mixture (**Fig. 4.2**).

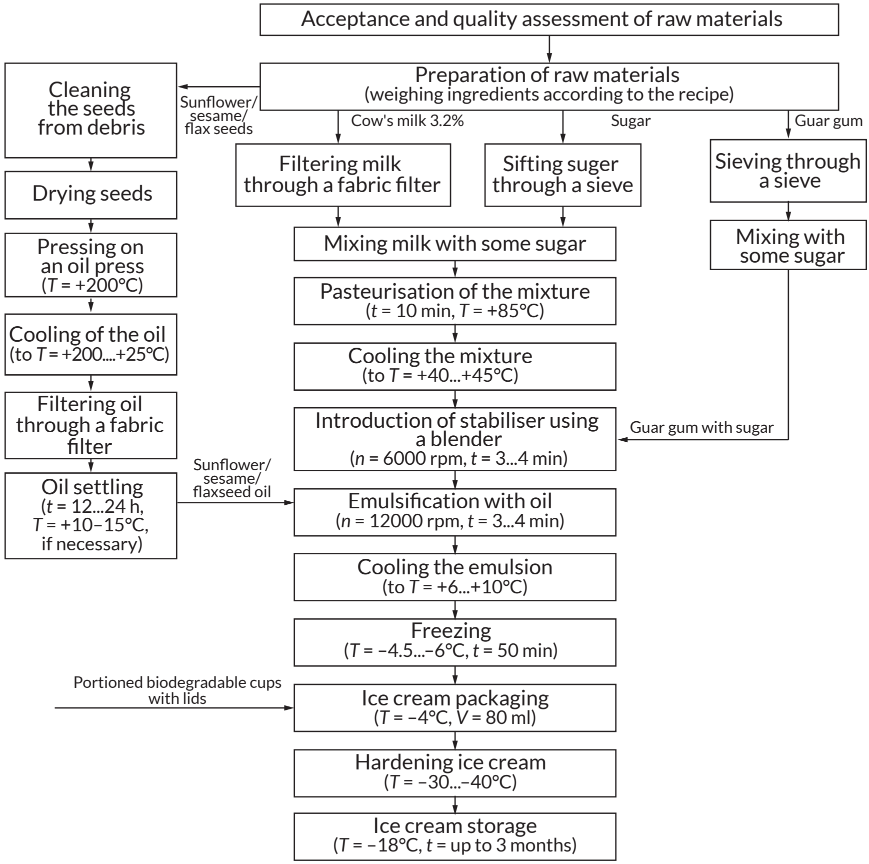


Fig. 4.2 Flow chart of ice cream production with the addition of vegetable oils
Source: compiled by the authors

To do this, part of the sugar is added to the milk and heated to a temperature of 40–45°C, then guar gum mixed with the rest of the sugar is added in small portions with constant stirring using an immersion blender. After that, the mixture becomes thicker, similar to natural drinking yoghurt. Next, the speed is increased and the oil (sunflower/flax/sesame) is added in a thin stream. These processes create an emulsion mixture.

For the production of prototypes of the finished product, the oil was obtained by pressing on an oil press Dulong ZYJ06 600W (country of origin: China), which is an environmentally friendly method of producing natural oil without the use of chemical solvents.

To make the ice cream, the oil yield from a certain amount of sunflower, flax and sesame seeds was taken into account. The yield depends on many factors, including the type, fat content, seed moisture, efficiency and capacity of the oil press, etc. Estimated oil yields for sunflower are 35–50%, flax – 30–40%, and sesame – 45–55%.

A comparative characterization was carried out for all quality indicators of ice cream produced according to the traditional recipe of liquid milk mixture and ice cream made with the addition of vegetable oils.

A tasting group of experts (TG) was involved in the organoleptic evaluation of the ice cream samples. The expert panel evaluated the ice cream on a 5-point scale, where 1 is an unsatisfactory rating and 5 is an excellent rating.

The quality indicators of the product were determined in the following sequence: appearance (consistency); color of the finished product and the appearance of the pattern on the cut; taste and smell (aroma).

The overall quality score of the sample is calculated as the arithmetic mean of the scores of the members of the Panel participating in the evaluation to the first decimal place. The average score for the ice cream indicators is shown in **Fig. 4.3**.

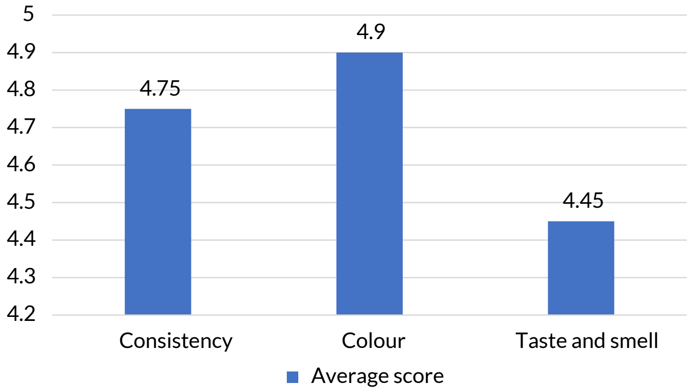


Fig. 4.3 Scoring of organoleptic characteristics of ice cream
Source: compiled by the authors

The resulting samples were tested for whipping (%) and foam stability and resistance to melting. The results are shown in **Fig. 4.4–4.6**.

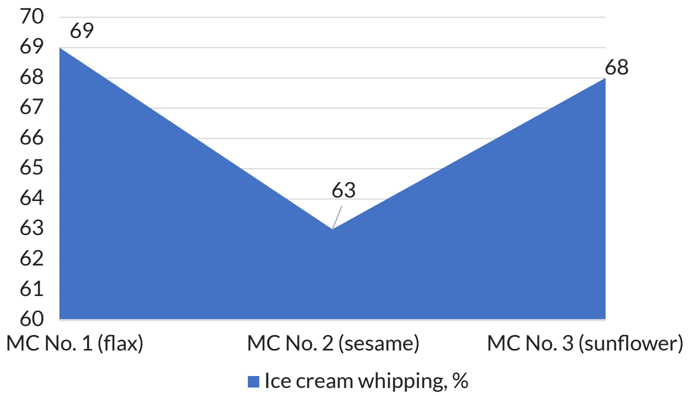


Fig. 4.4 Ice cream samples' whipping, %
Source: compiled by the authors

Thus, the defect rate of the experimental samples was in the range of 63–69%. At the same time, the use of vegetable oils leads to an increase in whipping, and therefore the quality of the finished product.

Due to the partially agglomerated fat adsorbed on the surface of air bubbles formed during the freezing process, the experimental samples achieved a high rate of whipping, which indicates a high ability of the mixture to be saturated with air.

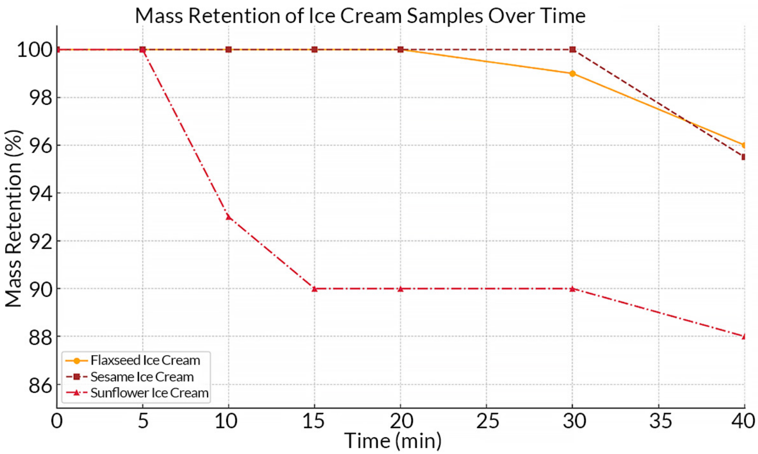


Fig. 4.5 Dynamics of changes in the height of the measuring cylinder column when determining the stability of ice cream foam

Resistance to melting is, first of all, very important for maintaining high organoleptic characteristics of ice cream, because when it leaves the freezer, it has a high temperature (**Fig. 4.6**).

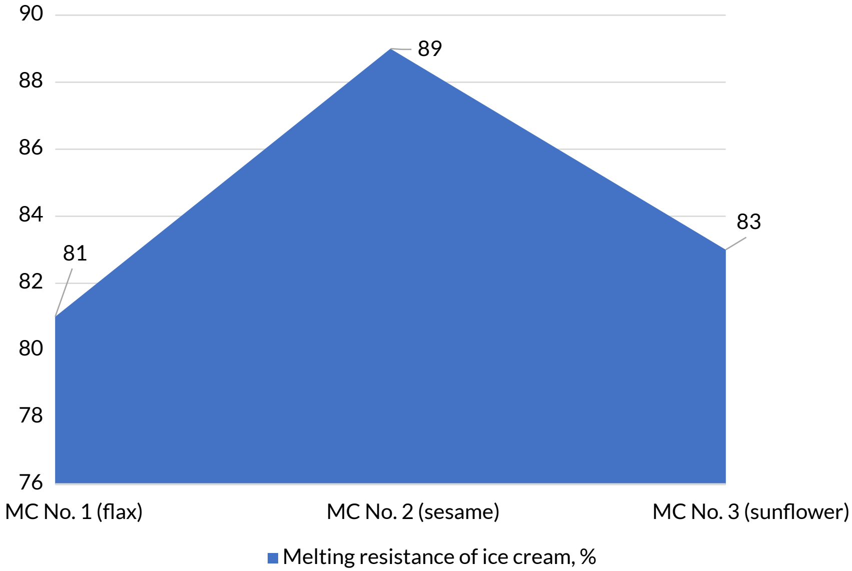


Fig. 4.6 Melting resistance of ice cream samples, %
Source: compiled by the authors

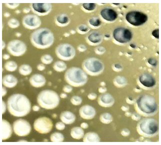
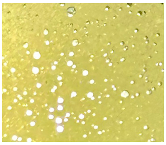
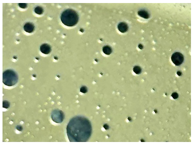
In addition to the above, the quality of soft ice cream was compared based on the density and the resulting crystalline structure of the final product after freezing.

The results of the conducted research are presented in **Table 4.3**.

A comparative analysis of the overrun indicators of soft ice cream made with the addition of various vegetable oils shows that the use of liquid vegetable oil does not lead to a decrease in the overrun of the final product. Thus, the incorporation of vegetable oils into the formulations of liquid mixtures for soft ice cream ensures the production of a product with improved sensory characteristics and physicochemical properties.

According to the results of the sensory evaluation, it was established that the experimental ice cream samples demonstrated characteristic differences in taste, color, and aroma. Considering this, flaxseed, sesame, and sunflower oils can be recommended as additional raw materials for ice cream production. Their use offers the potential to enrich the product with valuable nutrients without significantly affecting its sensory characteristics.

Table 4.3 Organoleptic and physicochemical characteristics of model ice cream compositions

Parameter	Model ice cream compositions		
	MC No. 1 (flax)	MC No. 2 (sesame)	MC No. 3 (sunflower)
Consistency	Homogeneous, whipped, without organoleptically perceptible lumps of the stabilizer, good foam stability		
Color	Homogeneous throughout the mass. Even from milky to yellowish-cream		
Taste and smell	Clean, characteristic of the given type of mixture and the raw materials used		
Mass fraction of dry substances, %, not less than	29.4	29.8	29.6
Density, kg/m^3	914.7 ± 0.2	1021.3 ± 0.3	965.9 ± 0.5
Active acidity, pH units	6.5 ± 0.05	6.5 ± 0.05	6.6 ± 0.05
Melting resistance, %	81	89	83
Whipping, %	69	63	68
Crystalline structure of ice cream			

Source: compiled by the authors

4.5 Evaluation of the biological and nutritional value of ice cream samples with the addition of vegetable oils

The fat content in ice cream is significant: it determines the structure, consistency, taste preferences, and the technological properties of the mixture during maturation and freezing.

Compared to animal fats, vegetable oils have several advantages as a partial substitute for milk fat: they are cholesterol-free, are an important source of vitamins, and contain unsaturated fatty acids that help reduce cholesterol levels in the body.

About 8% of the total fatty acids in milk fat consist of specific low-molecular volatile fatty acids (butyric, caproic, and caprylic acids). Polyunsaturated fatty acids, which have high biological activity, are present in milk fat in relatively small amounts: linoleic acid – 3–5%, linolenic and arachidonic acids – about 1%.

To compare the fatty acid composition in milk fat and vegetable oils as substitutes for milk fat, the content of polyunsaturated fatty acids (PUFAs) in ice cream with the addition of flax, sesame, and sunflower oils was theoretically calculated and compared to traditional dairy ice cream, as shown in **Table 4.4**. It is assumed that ice cream would be better sold in packaging of 75 g.

Table 4.4 Content of polyunsaturated fatty acids (PUFAs) in ice cream

	MC No. 1 (flax)	MC No. 2 (sesame)	MC No. 3 (sunflower)	Traditional dairy ice cream	Daily requirement, g
PUFAs, g	3.070	2.985	2.560	0.675	13

Based on the calculation results, conclusions were made that significant results were achieved in the content of polyunsaturated fatty acids (about 20% of the daily requirement).

Thus, the developed ice cream with the use of vegetable oils, specifically flax, sesame, and sunflower oils, has allowed for the creation of a new, physiologically valuable product, which surpasses traditional ice cream in PUFA content and provides the final product with functional properties.

When considering the developed ice cream from the perspective of preventive-dietary nutrition, one cannot overlook the energy value (calorific value) and the nutritional value of the final product. **Table 4.5** presents a comparative analysis of the nutritional and energy value of ice cream with the addition of vegetable oils and traditional ice cream.

Table 4.5 Nutritional and energy value of ice cream with the addition of vegetable oils and traditional dairy ice cream with milk fat

Content of substances per 100 g	Ice cream with the addition of vegetable oils	Traditional dairy ice cream
Fats, g	4–5	15
Proteins, g	3–3.5	4
Carbohydrates, g	20–23	19.5
Calorific value, kcal	150–160	229

Based on these data, it can be concluded that the calorific value of ice cream with the addition of vegetable oils is slightly lower than that of traditional dairy ice cream.

4.6 Conclusions

The advantages of using vegetable oils as a partial replacement for milk fat to provide ice cream with functional properties were studied.

The fatty acid composition of milk fat determines the characteristics of its texture in the final product. Milk fat is unstable to the effects of high temperatures, light, water vapor, oxygen in the air, and solutions of alkalis and acids. Under the influence of these factors, it hydrolyses, oxidizes, and becomes rancid, making it unstable during storage. Milk fat, on the other hand, is resistant to low temperatures and, if stored properly, its quality indicators do not change significantly. However, the disadvantage of products with a high milk fat content, such as ice cream, is the high cholesterol content with a high level of saturated fatty acids (up to 65%) and a low level of polyunsaturated fatty acids (no more than 4%).

Compared to animal fats, vegetable oils offer several advantages as substitutes for milk fat: they are cholesterol-free, serve as an important source of vitamins, and contain unsaturated fatty acids, which help remove cholesterol from the body.

Replacing milk fat in dietary nutrition has also proven beneficial due to the following advantages:

– ease of use;
– resistance to temperature fluctuations and bacterial spoilage;
– possibility of selecting fats according to religious dietary requirements;
– ability to regulate nutritional value.

However, not all vegetable oils are resistant to high and low temperatures. This property is determined by its type, fatty acid composition and degree of purification. Flaxseed oil is the least resistant, as it is capable of oxidation at low temperatures. Therefore, ice cream with flaxseed oil has a short shelf life. Sesame oil, due to its high content of oleic acid, practically does not change its quality when exposed to low temperatures and is resistant to cold. Ice cream with a partial replacement of milk fat with sesame oil has a long shelf life without reducing its quality. Sunflower oil is relatively stable at low temperatures, so if milk fat is partially replaced with sunflower oil, the ice cream will retain its quality characteristics.

Therefore, by applying vegetable oils, ice cream can become not only a delicious dessert but also a healthy one.

The use of new ingredients not only allows for greater variety in ice cream recipes but also helps to reduce caloric content and improve the economic performance of production.

Thus, the use of liquid vegetable oils is a promising approach for creating a product with improved consumer properties and competitiveness in the market.

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