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# Study of indicators of quality and safety of sour cream with vegetable oils

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## ABSTRACT

The article covers the quality and safety indicators of sour cream with vegetable oils, in the composition of which blended oil (sunflower oil + linseed oil) is used as a fat phase in the form of a food emulsion stabilized by an emulsifying complex containing sodium caseinate. According to the chemical composition, sour cream with vegetable oils is characterized by an increased content of the mass fraction of proteins by 0.2% and a reduced content of the mass fraction of carbohydrates by 1.7% compared to classic sour cream, which is connected with the use of food emulsion in its composition. Due to the content of food emulsion, sour cream with vegetable oils has the content of polyunsaturated fatty acids increased by 24 times and the content of saturated and monounsaturated fatty acids decreased by 82.11% and 41.2%, respectively, compared to classic sour cream. The indicator of water activity in sour cream with vegetable oils is 0.983 aw, which is lower than classic sour cream (0.988 aw). According to the results of the study of microbiological parameters, on the fifth day of storage in sour cream with vegetable oils, the titrated acidity index was 86 °T, the number of lactic acid bacteria was 107 CFU/g, and no bacteria of the *Escherichia coli* group, mould and yeast were detected; it corresponds to the normalized indicators as for classic sour cream. At the end of the storage period, the value of syneresis in sour cream with vegetable oils is 23% lower than the value of syneresis in the control sample. In sour cream with vegetable oils, during five days of storage, the value of peroxide 3.0 – 4.0 ½ O mmol/k and acid value 2.5 – 2.6 mg acid number/g are within the normalized values for blended oil (sunflower oil + linseed oil).

**Keywords:** sour cream, dairy product, blended oil, water activity, microbiological quality indicator, nutritional value, storage

## INTRODUCTION

Currently, the technologies of milk-containing products are rapidly developing, especially those in the recipe compositions in which fats of non-dairy origin replace milk fat, usually by oils and substitutes for milk fat **[1]**, **[2]**. This tendency is relevant due to the issue of resource conservation in the milk processing industry, which arose against the background of a reduction in the volume of cow milk as a raw material **[3]**. Considering the economic crisis of recent years, such an extremely expedient technological solution allows, first of all, to reduce the cost of finished products and, as a result, the retail price to meet the needs of consumers of all social categories **[4]**. However, scientists and the price reduction pay great attention to increasing the nutritional and biological value of developed and improved milk-containing products **[5]**. Improvement in the technologies of milk-containing fermented milk products is promising since including such products in the diet of the population of countries allows to solve the issue of bacterial balance in the human body **[6]**. It should be noted that using vegetable oils as fats of non-dairy origin in the technology of milk-containing products makes it possible to increase the content of polyunsaturated fatty acids while balancing the fatty acid composition of finished products

**[7]**. This makes it possible to improve the nutrition structure of the population, the analysis of which indicates a deficiency of polyunsaturated fatty acids against the background of consumption of an excess number of saturated ones **[8]**. The production of fermented milk products and the type of sour cream is relevant today **[9]** since sour cream as a classic dairy product is popular among consumers as a sauce for dishes, a basis for preparing desserts, etc. **[10]**. Thus, the technology of a milk-containing fermented milk product - sour cream with vegetable oils as an analogue of classic sour cream – has been developed. This technology involves using finely dispersed and aggregate-resistant food emulsion with a fat content of 50% based on blended oil (sunflower oil + linseed oil) and xanthan gum stabilizer. The use of food emulsion made it possible to exclude the traditional high-cost technological operation from the technological process such as dispersing the entire milk-vegetable mixture. The technology of sour cream with vegetable oils aims not only to expand the range of milk-containing products but also to use this milk-containing product as a semi-finished product to produce snack and dessert products **[11]**.

However, the developed sour cream with vegetable oils should be characterized by quality and safety indicators, similar or improved chemical composition to products obtained by classical technology.

## Scientific Hypothesis

The use of food emulsion in the technology of sour cream with vegetable oils improves the chemical composition, fatty acid composition, does not affect the safety indicators during storage.

## MATERIAL AND METHODOLOGY

### Samples

The study was conducted with two samples:
- 20% fat sour cream with vegetable oils using food emulsion;
- sour cream with a fat content of 20% as a control sample, obtained by classical technology using cream obtained from cow milk. The recipe compositions of the studied samples are given in Table 1.

**Table 1** Recipe compositions of the control sample and sour cream with vegetable oils.

| Components | Mass fraction, % |
|---|---|
| **Control sample*** | |
| Cream obtained from cow's milk (with a fat mass fraction of 20%) | 100.0 |
| Total | 100.0 |
| **Sour cream with vegetable oils** | |
| Fat-Containing Fermented-Milk Base | 99.85 |
| Xanthan gum | 0.15 |
| Total | 100.0 |

Note: Direct application bacterial preparation. It is not indicated in the formulated composition.

### Chemicals

Distilled water, $H_2O$ (TOV Novokhim, Ukraine).
Phenolphthalein alcoholic solution, $C_{20}H_{14}O_4$, 1.0% (Shostka Chemical Reagents Plant, Ukraine).
Sodium hydroxide, NaOH, 0.1 N (TOV Khimlaborreaktiv, Ukraine).
Cobalt sulphate solution, $CoSO_4$, 2.5% (TOV Khimlaborreaktiv, Ukraine).
Sodium methylate, $CH_3ONa$ (ATK Ukraine, Ukraine).
Sodium sulphate, Na2SO4 (AT ZPD, Denmark).
MRS-agar (Conda, Ukraine).
Concentrated hydrochloric acid $H_2SO_4$ (Shostka Chemical Reagents Plant, Ukraine).
Boric acid $H_3BO_3$, 2.0 % (ATK Ukraine, Ukraine).
Sodium hydroxide NaOH, 33.0 % (TOV Khimlaborreaktiv, Ukraine).

### Animals, Plants and Biological Materials

Iprovit SSK bacterial preparation (Institute of Food Resources NAAS of Ukraine, Ukraine) containing *Lactococcus lactis* ssp. *lactis; Lactococcus lactis* ssp. *cremoris; Lactococcus lactis* ssp. *diacetilactis; Streptococcus salivarius* ssp. *thermophilus*.

### Instruments

Laboratory thermometer (TOV Standard-Lab).

Mohr pipettes, (TOV SkyLab).
Bunsen beaker (TOV SkyLab).
Conical flask (TOV SkyLab).
Glass rods (TOV SkyLab).
Titration assembly (TOV Labour-Technik).
Thermostat TSO-80 (TOV Ukragrotest).
Gas chromatograph (GE LifeSciences BPG 100/500, Germany).
Petri dish (TOV Termolab).
Counter of colonies of microorganisms JL-1C (TOV Spectrolab).
Microscope XS-5520 LED (TOV Micromed).
Analytical scales (Thermoengineering LLC, Ukraine)
Kjeldahl flask (TOV SkyLab).
Water bath (TOV Ukragrotest).
Cylinders with a capacity of 10 and 50 cm$^3$ (Thermoengineering LLC, Ukraine)
Exhaust fume hood (TOV Simvolt, Ukraine).
A glass funnel with a diameter of 3-4 cm (TOV SkyLab).
Installation for distillation of ammonia (Thermoengineering LLC, Ukraine).
Water activity analyser (TOV Simvolt, Ukraine).
Refrigerator (TOV Axcis, Ukraine).

## Laboratory Methods

The titrimetric method determined the titrated acidity, which is based on the neutralisation of acids contained in the investigational product with a sodium hydroxide solution in the presence of an indicator according to **[12]**. Determination of the fatty acid content was carried out by chromatographic according to **[13]**. The mass fraction of fat was determined according to **[14]**, the mass fraction of protein – by Kjeldahl method **[15]**, and the mass fraction of carbohydrates according to **[16]**. The number of viable lactic acid bacteria, *Escherichia coli* bacteria, mold and yeast was determined by the method of sowing serial dilutions in agar nutrient media according to **[17]**. The peroxide number was estimated according to **[18]**, and the acid number – according to **[19]**. Syneresis determined by the centrifugal method. The same amount of product was weighed into two glass tubes with a capacity of 10 cm$^3$, closed with stoppers and centrifuged for 10 min at a speed of 1000 min$^{-1}$. The layer of whey, that settled on top of the sample, was determined on a scale in cm$^3$. Water activity was determined using the water activity analyser Walcom WA-60A, in the measurement range of 0-1 Aw (0-100% rh). Samples at 20 °C were collected in a container and placed in the measuring chamber. A water activity probe is installed from above. The measurement cycle lasts 3-5 minutes, after which the water activity and temperature values for each probe are displayed on display.

## Description of the Experiment

**Sample preparation:** Sour cream with vegetable oils was obtained by fermentation of a mixture consisting of a finely dispersed food emulsion based on blended oil (sunflower oil + linseed oil) with a fat content of 50% and skimmed cow milk in a thermostat with the subsequent addition of xanthan gum (Table 1) **[11]**. Classical sour cream as a control sample was obtained by adding a bacterial preparation to cream with a fat content of 20% obtained from cow milk (Table 1), followed by their fermentation in a thermostat at a temperature of 30 °C until the titrated acidity of the clot reaches 60 °T.

**Number of samples analyzed:** During the experimental studies, 9 samples were used, the chemical, fatty acid composition, water activity in 6 samples, microbiological quality indicators, titrated acidity, peroxide and acid numbers were determined in 3 samples.

**Number of repeated analyses:** All measurements were performed 3 times.

**Number of experiment replication:** The number of replicates of each experiment to determine one value was 5 times.

**Design of the experiment:** Fatty acid composition, mass fractions of fat, protein, carbohydrates were determined in the obtained sour cream with vegetable oils and the control item according to the methods **[13]**, **[14]**, **[15]**, **[16]**, respectively, as well as water activity using water activity analyser Walcom WA-60A.

Sour cream with vegetable oils was cooled to a temperature of 0 – 6 °C and stored at this temperature for 5 days in a refrigerator. Every 24 hours, the number of lactic acid bacteria, *Escherichia coli* bacteria, mold fungi, and yeast was determined according to the method **[17]**, peroxide, acid number – according to the methods **[18]**, **[19]**, titrated acidity – according to the method **[12]**, syneresis – determined by the centrifugal method.

## Statistical Analysis

The STATISTICA Microsoft Excel editor it in combination with XLSTAT processed experimental data using mathematical statistics methods. The accuracy of the obtained experimental data was determined using the Student's t-test with confidence coefficient ≤0.05 with many parallel definitions of at least 5 (confidence probability $p = 0.95$).

## RESULTS AND DISCUSSION

A comparative analysis of the chemical composition of sour cream with vegetable oils and sour cream obtained by classical technology is given in Table 2.

**Table 2** Chemical composition of sour cream with vegetable oils in comparison with the control.

| Sample | Mass fraction, % | | |
|---|---|---|---|
| | **Protein** | **Fat** | **Carbohydrates** |
| Control | 2.6 | 20.0 | 3.5 |
| Sour cream with vegetable oils | 2.8 | 20.0 | 1.8 |

According to the data in Table 2, it can be seen that the mass fraction of protein in sour cream with vegetable oils is higher by 0.2% compared to sour cream obtained by classical technology. It is explained by the fact that sour cream with vegetable oils consists of 60% skim milk, which chemically has a higher mass fraction of protein **[20]** compared to cream obtained from cow milk **[21]**, which is used in classical technology sour cream.

Also, it should be noted that the protein composition of sour cream with vegetable oils, in comparison with the control parameters, is characterized by the content of sodium caseinate due to the use of finely dispersed food emulsion in which it is included. Therefore, there is an assumption that sour cream with vegetable oils will provide consumers with energy for a long time, since caseinates, compared to other milk proteins, are digested much longer by the human body **[22]**, **[23]**.

As for the content of carbohydrates, their content is lower in sour cream with vegetable oils (by 1.7%) because this product consists of 40% food emulsion, which does not contain carbohydrates, and 60% cow defatted milk, which is a carrier of carbohydrates – lactose, being a growth medium for lactic acid bacteria during the fermentation of a normalized mixture **[24]**, **[25]**. Currently, the reduced lactose content in the food product can positively affect the human body by preventing lactose intolerance **[26]**, **[27]**.

Mass fractions of saturated, monounsaturated and polyunsaturated fatty acids in sour cream with vegetable oils are presented in Table 3.

**Table 3** Fatty acid composition of sour cream with vegetable oils in comparison with the control.

| Sample | Mass fraction, % | | |
|---|---|---|---|
| | **Saturated fatty acids** | **Monounsaturated fatty acids** | **Polyunsaturated fatty acids** |
| Control | 11.80 | 7.10 | 0.52 |
| Sour cream with vegetable oils | 2.11 | 4.17 | 12.49 |

Analysis of fatty acid composition (table 3) shows a reduced content of saturated and monounsaturated fatty acids compared to the control by 82.11% and 41.2%, respectively. In addition, a 24-times increased polyunsaturated fatty acids in sour cream with vegetable oils is observed compared to the control.

The content of vegetable oils explains this effect on the fatty acid composition - blended oil (sunflower oil + linseed oil) in the form of a food emulsion within sour cream with vegetable oils, which differ mainly in the unsaturation of fatty acids **[28]** in comparison with the milk fat contained in classic sour cream, which, on the contrary, mainly contains saturated fatty acids **[29]**.

The increased content of polyunsaturated fatty acids in sour cream with vegetable oils is a positive point, as today there is a need to encourage consumers the consumption of such acids against high consumption of saturated ones **[30]**, **[31]** for the prevention of various painful conditions and diseases, in particular, atherosclerosis and ischemic heart disease **[32]**, **[33]**.

The indicator of water activity in sour cream with vegetable oils compared to classic sour cream is given in Table 4.

**Table 4** Indicator of water activity in sour cream with vegetable oils and control.

| Sample | Water activity indicator, aw |
|---|---|
| Control | 0.988 |
| Sour cream with vegetable oils | 0.983 |

Table 4 shows that the water activity value in sour cream with vegetable oils is lower than in the control. The activity of water in food products is determined by the degree of connection of water with other food ingredients and determines the speed of many chemical and enzymatic reactions occurring in food products **[34]**.

In sour cream, the water phase is bound primarily by milk proteins **[35]**. However, there is a food emulsion in the composition of sour cream with vegetable oils, which contains sodium caseinate forming a gel **[36]** due to better water binding than other milk proteins **[37]**.

According to **[38]**, the shelf life of sour cream obtained by classical technology is 5 days at no higher than 6 °C. That is why the indicated storage conditions of classical sour cream were taken as a standard for experimental determination of the change of titrated acidity, syneresis, microbiological safety indicators, peroxide and an acid number of sour cream with vegetable oils.

The titrated acidity and microbiological indicators of sour cream with vegetable oils in the storage process, presented in Figure 1 and Table 5, respectively, were compared with the normative indicators for classic sour cream.

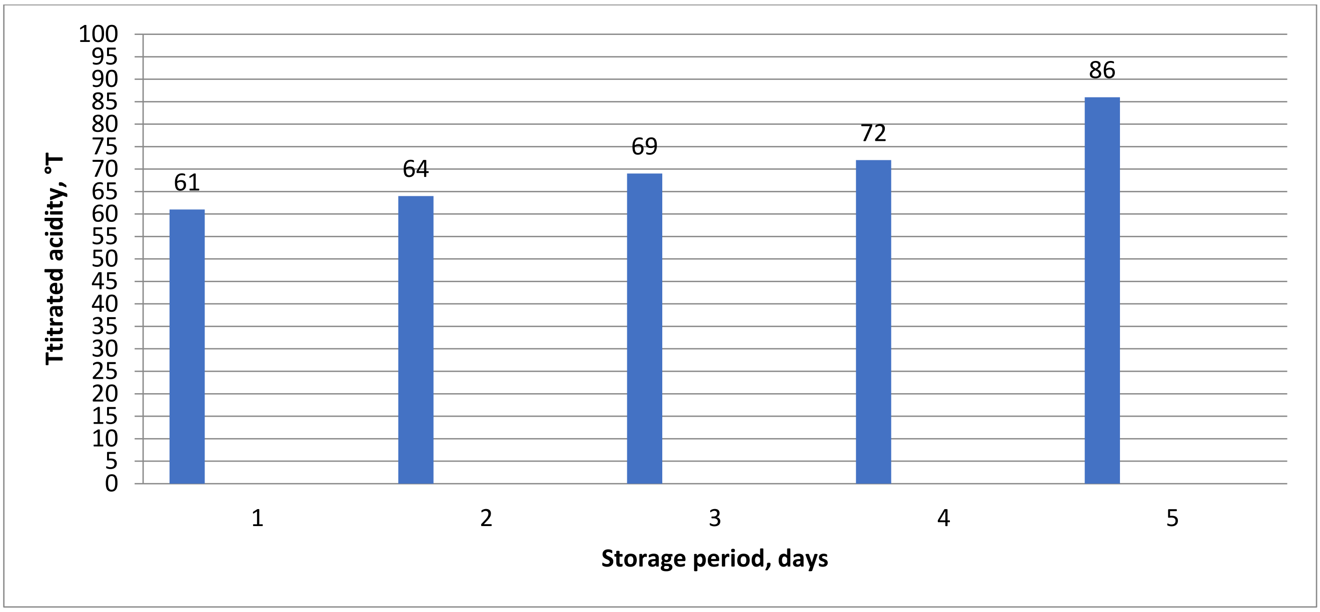


**Figure 1** Changes in the titrated acidity of sour cream with vegetable oils during storage.

**Table 5** Microbiological parameters of sour cream with vegetable oils during storage.

| Indicator | Duration of storage, days | | | | | Standard [38] |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | |
| Number of lactic acid bacteria CFU/g | $10^8$ | $10^8$ | $10^7$ | $10^7$ | $10^7$ | Not less than $1.0 \times 10^7$ CFU/g |
| Escherichia coli bacteria in 0.01 g | Not found | | | | | Not allowed in 0.01 g |
| The number of mold fungi CFU/g | | | | | | Not more than 50 CFU/g |
| Amount of yeast, CFU/g | | | | | | Not more than 50 CFU/g |

According to the figure 1, the index of titrated acidity of sour cream with vegetable oils on the fifth day of storage was 86 °T, which meets the regulatory requirements **[38]**, according to which the index of titrated acidity of classic sour cream should be no more than 100 °T.

As seen from the data in Table 5, many viable lactic acid bacteria in sour cream and vegetable oils are within limits at the end of the shelf life.

For the consumer to receive health benefits, fermented milk products shall have viable microorganisms throughout the shelf life **[39]**, **[40]**, **[41]**.

Bacteria and groups of *Escherichia coli*, mould and yeasts were not detected in sour cream with vegetable oils at the end of the shelf life.

The degree of syneresis of sour cream with vegetable oils compared to classic sour cream in the storage process is presented in Figure 2.

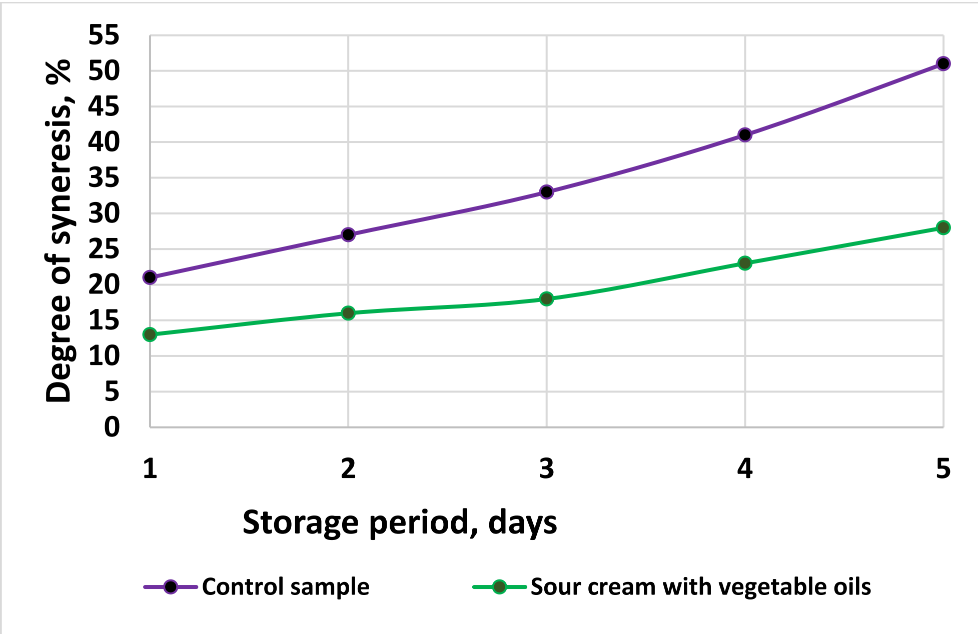


**Figure 2** Degree of syneresis of sour cream with vegetable oils compared to classic sour cream during storage.

From the data in Figure 2, it can be seen that the value of syneresis on the first day of storage of sour cream with vegetable oils is 12%, which is lower than the value of syneresis in the control sample (21%). At the end of the storage period, the value of syneresis in sour cream with vegetable oils (28%) is 23% lower than the value of syneresis in the control sample, which is 51%.

The degree of syneresis depends on the gel's ability to hold bound water **[42]**. The decrease in the degree of syneresis occurred due to the moisture-binding capacity of sodium caseinate **[43]**, contained in the food emulsion, and xanthan gum **[44]**, which are components of sour cream with vegetable oils. Considering this, the decrease in syneresis in sour cream with vegetable oils correlates with the decrease in the water activity indicator (Table 4).

The index of peroxide and acid number of sour cream with vegetable oils during the storage process, presented in Table 6, was compared with the normative indicators for blended oil **[45]**, which is the fat phase of this product.

**Table 6** Indicator of peroxide and acid number of sour cream with vegetable oils during storage.

| Indicator | Duration of storage, days | | | | | Standard [42] |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | |
| Peroxide number, ½ O mmol/k | 3.0 | 3.0 | 3.0 | 3.0 | 4.0 | not more than 10 ½ O mmol/k |
| Acid value, mg acid number/g | 2.5 | 2.5 | 2.5 | 2.6 | 2.6 | no more than 4.0 mg acid number/g |

According to the data in the Table 6, the peroxide and acid numbers are within the established norms during the standard storage period in accordance with **[38]** in sour cream with vegetable oils.

Vegetable oils are more prone to oxidative deterioration with the formation of compounds of a peroxide nature, due to a significant content of unsaturated fatty acids **[46]** in comparison with animal fats, the composition of which is mainly represented by saturated fatty acids **[47]**, **[48]**.

Therefore, the peroxide number is one of the main safety indicators, which determines the degree of freshness of oils and food products based on them **[49]**.

Therefore, according to the research results, the ingredients of the recipe composition and the temperature regimes for the production of sour cream with vegetable oils do not affect the quality and safety indicators and are within the standard values for sour cream obtained traditionally.

## CONCLUSION

There was conducted a study of the chemical composition and water activity of sour cream with vegetable oils, which contains a finely dispersed food emulsion with a fat content of 50% based on blended oil (sunflower oil + linseed oil), with a comparison with the normalized indicators of classic sour cream. The changes in microbiological indicators, peroxide, and acid number values in sour cream with vegetable oils were studied during 5 days of storage at temperatures of 0 – 6 °C as a standard period and mode of storage of classic sour cream. The determined chemical composition of sour cream with vegetable oils showed that the protein content is increased by 0.2%, and the carbohydrate content is reduced by 1.7% compared to classic sour cream, which is explained by the content of skimmed milk and food emulsion in it, which does not contain carbohydrates. According to the study of the fatty acid composition of sour cream with vegetable oils, an increased polyunsaturated fatty acid (12.49%) was revealed compared to classic sour cream (0.52%). The content of saturated and monounsaturated fatty acids in sour cream with vegetable oils compared to classic sour cream is reduced by 82.11% and 41.2%, respectively. A reduced indicator of water activity was established in sour cream with vegetable oils (0.983 aw), compared with classic sour cream (0.988 aw). According to the date of the 5th day of storage, sour cream with vegetable oils has an index of titrated acidity of 86 °T, the number of viable lactic acid bacteria is $10^7$ CFU/g, and bacteria of the group of *Escherichia coli*, mold and yeast were not detected, which coincides with the normalized indicators as to sour cream obtained by classical technology. The value of syneresis in sour cream with vegetable oils on the fifth day of storage is 28%, which is 23% less than the value of syneresis in the control sample. It was found that the value of peroxide and acid number of sour cream with vegetable oils during 5 days of storage is within the normalized values for blended oil (sunflower oil + linseed oil) and are (3.0-4.0) ½ O mmol/k and (2.5-2.6) mg acid number/g, respectively. So, the developed sour cream with vegetable oils is characterized by an improved fatty acid composition in terms of the content of polyunsaturated fatty acids, and its quality and safety indicators are within the normative values for classic sour cream.

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