

Effect of Vegetable Fats on the Quality and Safety of Food Products

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Abstract—This article is devoted to the study of the possibility of using vegetable fats in the production of flour confectionery products, in particular, sugar cookies, instead of the margarine as a traditionally used component. The leading approach to solve this problem is the methodology of replacing oil and fat products in the form of margarine with specialized vegetable fats for the confectionery industry. It is possible to comprehensively consider the quality of new types of flour confectionery products. The article presents the results of research on the use of specialized vegetable fats in the domestic confectionery industry and abroad, the technological process of production of flour confectionery products, in particular, sugar cookies, made with the replacement of margarine with vegetable fats. The most rational types of vegetable fats used to achieve the purpose of research are established. As a result of complex research of quality of new types of cookies and on the basis of production check the technical documentation for the new range of sugar cookies is developed and coordinated. Solved the problem of seasonality and storage facilities, extended shelf life products in two times, the formulation of products with reduced price and reduced the cost, improved production and overall increased competitiveness of their products. Standard and generally accepted methods of raw materials and finished products research on organoleptic, physical, chemical, microbiological and safety indicators were used during the research. The article presents the results of studies to establish the possibility of replacing margarine in flour confectionery products with cheaper and balanced in composition of fatty acids vegetable fats. The quality indicators are investigated and the use of these fats in the production of flour confectionery products is justified. According to the research results, the formulation and technical documentation for new types of sugar cookies with using vegetable fats instead of margarine were developed.

Keywords—specialized fats, healthy food, cookies, quality indicators, shelf life, technical documentation, resource-saving technologies.

I. INTRODUCTION

The problem of proper and balanced nutrition is now becoming increasingly important. The quality of food is crucial, as it affects the processes occurring in the human body. Many factors are involved in the formation and preservation of food quality. The most important of which are: the quality of natural ingredients and formulations, production, technology and equipment, production

processes, storage and sale. Replacing animal fats with vegetable fats is one way to eliminate these problems [1-5].

In the production of flour confectionery products as a fat product is often used margarines derived from hydrogenated fats containing transisomers, which often are cause of cardiovascular and other diseases.

It is proved that the use of these products increases the risk of cardiovascular disease. Studies conducted in the United States of America, which involved groups of 80 thousand people of different age. This study had been continued about 20 years and showed that eating transisomers of fatty acids increases the likelihood of cardiovascular disease in 2 times. At the same time, the mortality rate was greater than 1.5 times. Replacing saturated fatty acids with unsaturated ones reduces the possibility of cardiovascular disease by more than 22 % [6-10]. Despite this, fats are an important source of energy. The cleavage of fats releases a large amount of energy - 9.3 kcal, while the cleavage of 1 g of proteins and carbohydrates produces 4.2 kcal of energy [11].

In addition, fat is a structural element of cell membranes, it provides mechanical strength of cells, participates in the conduction of nerve impulses, in the process of digestion, delaying the emergence of hunger [12,13].

The nutritional value of fats is determined by their composition and digestibility.

Vegetable fats rich in essential fatty acids, including ω_3 and ω_6 are recommended by Food and Agriculture Organization (FAO) and World Health Organization (WHO) to be used instead of hydrogenated fats.

In addition, vegetable fat has a number of advantages against margarine and butter:

- It is dehydrated, microbiologically clean, has a long shelf life (up to 24 months.);
- gives the possibility to obtain homogeneous stable emulsions,
- fats are hydrogenated, therefore, less susceptible to oxidation, which helps to extend the shelf life of products in which they are included;
- has a neutral taste, without foreign tastes and odors, which emphasizes the organoleptic advantages of the other components of the formulation, thereby expanding the taste advantages of the product;

- made from natural, mainly vegetable raw materials using advanced processing technologies;
- does not contain cholesterol, which is beneficial for the health of consumers, as it reduces the risk of heart disease in middle-aged and older people;
- allows to reduce the cost of the formulation and reduce the cost of production, without reducing the quality of finished products [5,14].

The advantages of vegetable fats are reflected in the development of new formulations of confectionery products of increased nutritional value, in which fat is one of the prescription components that determine their consumer properties [15-17].

Studies conducted on this problem, both in Russia and abroad, determine the relevance and justify the need for setting the topic to study the possibility of using vegetable fats in confectionery formulations, in particular, cookies. The proposed formulations should have a balanced fatty acid composition corresponding to the formula of a healthy diet, and do not have transisomers of fatty acids, and contribute to the prevention of cardiovascular diseases.

The study of foreign and Russian literature on this problem allowed us to establish the theoretical possibility of using vegetable fats in the production of flour confectionery products, in particular cookies.

Animal fat is triglyceride triatomic fat glycerol and fatty acids; triglyceride content is more than 95%.

The refining operation increases to almost 100%. Fats contain lipids, which are not soluble in water, but are well soluble in organic substances.

There is huge importance of different fats in diets. Having a high caloric content, fats allow the body, being in an experimental situation, to carry out vital activities during the month period.

The absence of polyunsaturated fatty acids in food leads to the development of atherosclerosis, thrombosis and other diseases in humans.

The composition of fats contains vitamin complexes, the absence of which causes beriberi. One of the classification features in the classification of fats is raw materials [14,16].

Classification of fats by type of raw materials is the following: animal fats and vegetable fats. Due to the differences in the composition of fats, fatty acids have the peculiarity of reducing the quality and nutritional value in the process of long-term storage.

The problem of fat stabilization in storage is an important scientific and practical problem.

Spoiling fats is a complex chemical process. Hydrolysis leads to cleavage of water molecule bonds, joining at the place of released valences, forming two structural elements-fatty acid residues and glycerol [17,18].

Industrial processing of fats involves operations that allow obtaining high quality fats and resistant to long-term storage. These are such branches of the fat processing industry as hydrogenation of fats, transesterification and separation of glycerides.

The obtaining specialized fats for the food industry are concentrated to the creation of fat with a balanced composition and the absence of fatty acid isomers. This is achieved by using a traditional method of fat processing with innovative biotechnologies.

Technologies for fractionation of oils of tropical origin

(palm, Shea and others) and obtaining analogues and equivalents of cocoa butter on the basis of isolated fractions enriched with triglycerides have been developed to obtain fats that have high hardness and do not contain transisomers.

Loders Crocclan company has developed non-tempering, non-lauric, transisomer-free fats. Fats of new generation are fats for fillings.

The firm "Aorpus Olie" has developed new modifications of fats used to prevent "graying" chocolate.

The range of Russian manufacturers is increasing the number of products where baked goods are used as the basis of products glazed with glaze. The use of shortening "Akoyoke" company "Karlhamns" due to its uniqueness ensures the stability of the fat system to migration. For the same purpose - to prevent the migration of liquid fats from the filling to the surface of the chocolate mass or glaze, so-called barrier fats are recommended.

The purpose of our research was to develop a technological process for the production of cookies with an increased shelf life

- To achieve this goal the following tasks were solved:
- analysis of the use of vegetable fats in the confectionery industry;
 - study of technological process of production of flour confectionery products;
 - establishment of the most effective and appropriate type of vegetable fat to replace margarine raw materials;
 - development of technological modes of production and recipes of sugar cookies and replacement of part of margarine on vegetable fats;
 - approbation of the developed technologies in the conditions of existing production facilities;
 - study of quality indicators of sugar cookies with vegetable fats at storage;
 - approval of regulatory and technical documentation for the newly developed range of sugar cookies.

II. METHODS

For the purpose of development of technological process of cookie production with the increased shelf life we were used two methods: passive - through the use of sealed packaging to reduce hydrolytic processes and preserve the protein part of the product; and active chemical action-replacement of margarine unstable from the point of view of oxidative processes with more stable vegetable fat; and introduction a preserving agent to the formulation.

In this study of raw materials and the finished product, the indicators regulated by standards and characterizing the composition and properties of their constituent parts, such as fats, proteins and carbohydrates were determined.

Microbiological studies were conducted for compliance with the requirements of Sanitary Regulations and Standards 2.3.2.1078-01 (§ 1.5.5 and 1.5.5.10).

The scheme of the study is presented in Fig. 1.

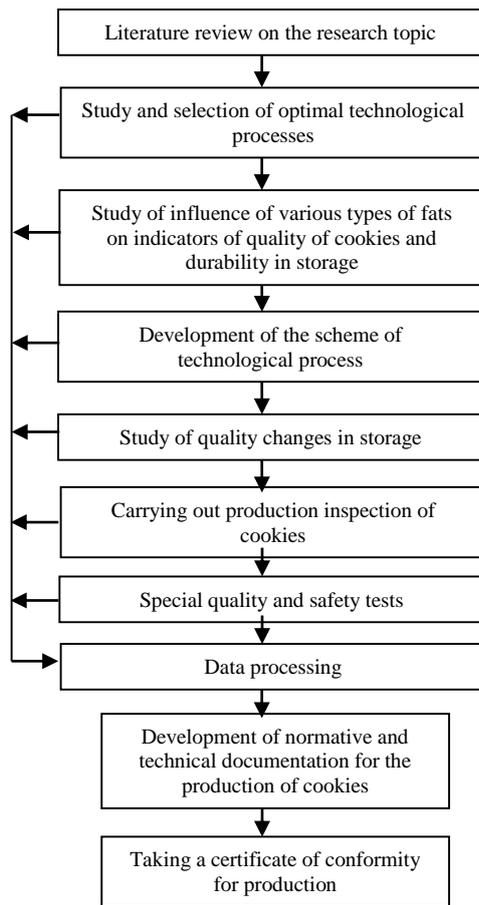


Fig. 1. Scheme of the experiment

III. RESULTS AND DISCUSSION

Fats of vegetable origin, presented on the Russian market by foreign firms, are intended for the production of confectionery products of improved quality and increased resistance in the storage process.

In order to choose the most suitable type of vegetable fat corresponding to the optimal price-quality ratio, we considered various types and trademarks of the main manufacturers of vegetable fat mixtures:

Limited liability company (LLC) "Rost-Line"(St. Petersburg);

LLC "Pischevje ingredientj" (Moscow);

LLC "Sojuz" (Moscow);

LLC "Delo vseh" (Moscow);

Dairy and fat factory of Novosibirsk, Nizhny Novgorod, Saratov.

Study was carried out on the basis of the agreement on scientific cooperation between the Institute of veterinary medicine and biotechnology of the Omsk State Agrarian University named after P.A. Stolypin and LLC "Slastena" of Omsk. The methodology of the search for innovative technologies for the production of cookies was to find the optimal composition of the product corresponding to the physiological needs of a human. The design of new products should include increasing their shelf life, improving consumer properties, eliminating the negative impact of innovative raw materials, increasing its bioavailability and reducing destruction in production.

At the first stage of our study we were conducted the choice of vegetable fat for the sugar cookies, the creation of a new formulation, its use and testing of experimental samples. Experimental batches of products were laid for storage in different temperature regimes and studied according to the scheme approved by the "Rosпотребнадзор" (Russian Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing).

According to the study results there were developed, agreed and approved in the prescribed manner regulatory and technical documentation for a new type of cookies with extended shelf life. The planned shelf life is half a year instead of 3 months, thus, the storage capacity is extended by 2 times.

The results of studies of quality indicators of vegetable fats revealed the most optimal fat produced in Malaysia, which has the trade name "Palmaleon". Its melting point is 37.5-38.0°C, color is white, taste is neutral, it is an environmentally friendly product. Comparative analysis of cookies produced on fat and margarine revealed that such a quality indicator as wetting in the experimental sample is better than in the control one. Also, the experimental samples were better chewed due to the formation of a porous surface throughout the volume of products and the smallest air bubbles that were formed when knocking down vegetable fat. Organoleptic parameters were also improved due to the strengthening of plastic properties in the test and stabilization of the test formation processes. The experimental samples developed according to the new recipes were called "N-N-Naka", had a yellow color, regular shape, pleasant taste, smooth surface, clear pattern and crumbly structure. On the fracture of the cookie, the pores were evenly distributed, when chewing such a cookie was finer than a cookie with margarine.

Within of raw materials were used the conservation agent - sorbic acid, the flavoring identical to natural, palm oil "Palmoleon" refined, bleached, deodorized.

Packages, packs, metal cans, boxes weighing from 0.3 to 2.0 kg were used as packaging material.

The inner layer was lined with parchment, paraffin paper, cellophane, etc.

In accordance with the program of sanitary and epidemiological examination, resource tests were carried out to confirm the claimed shelf life of cookies from the end of the technological process for no more than 180 days at a storage temperature of 18±5°C in accordance with the requirements of the Methodical instructions 4.2.1847-04 "Sanitary and epidemiological assessment of the validity of the shelf life and storage conditions of food products" (§ 3.10) and Sanitary Regulations and Standards 2.3.2.1078-01 during the putting into production according to the shortened scheme.

According to the protocol of laboratory inspection the presented samples of cookies were investigated with the following periodicity taking into account the reserve coefficient 1.2: background, 60 days, 120 days, 180 days, 207 days on the following indicators:

- organoleptic;
- humidity;
- mass fraction of fat;
- alkalinity;
- sorbic acid;

- microbiological contamination in normalized and decivolimes (bacteria of the E. coli group, yeast, mold, number of mesophilic aerobic and facultative anaerobic microorganisms), pathogenic, including Salmonella.

In the protocol of examination was noted that during the entire shelf life, organoleptic parameters remained unchanged, view on the fracture: uniform porosity, without voids. There is a slight decrease in humidity according to physical and chemical indicators, which remains within normal limits. The results of physic and chemical and microbiological studies are presented in Table 1.

TABLE I. RESULTS OF COMPLEX EXAMINATION OF SUGAR COOKIES "N-N-NAKA"

№	Name of indicators	Test result	Allowable value
1	Background coliform bacteria	not detected	not allowed in 1.0-0.1 g
2	Yeasts	not detected	not more 50 colony-forming units in 1 g
3	Total aerobic mesophilic count	less than $1 \cdot 10^2$	$1 \cdot 10^4$ colony-forming units in 1 g
4	Pathogenic, including Salmonella	not detected	not allowed in 25g
5	Fungus	not detected	not more 100 colony-forming units in 1 g
6	Humidity	3.8%	3.0-8.5 %
7	Mass fraction of fat in terms of dry matter	15.9%	7-26 %
8	Alkalinity	0,6 deg.	not more than 2 deg.
9	60 days coliform bacteria	not detected	not allowed in 1,0-0,1 g
10	Yeasts	not detected	not more 50 colony-forming units in 1 g
11	Total aerobic mesophilic count	less than $1 \cdot 10^2$	$1 \cdot 10^4$ colony-forming units in 1 g
12	Pathogenic, including Salmonella	not detected	not allowed in 25 g
13	Fungus	not detected	not more 100 colony-forming units in 1 g
14	120 days coliform bacteria	not detected	not allowed in 1.0-0.1 g
15	Yeasts	not detected	не более 50 colony-forming units in 1 g
16	Total aerobic mesophilic count	less than $1 \cdot 10^2$	$1 \cdot 10^4$ colony-forming units in 1 g
17	Pathogenic, including Salmonella	not detected	not allowed in 25 g
18	Fungus	not detected	not more 100 colony-forming units in 1 g
19	180 days coliform bacteria	not detected	not allowed in 1,0-0,1 g
20	Yeasts	not detected	not more 50 colony-forming units in 1 g
21	Total aerobic mesophilic count	$2 \cdot 10^2$	$1 \cdot 10^4$ colony-forming units in 1 g
22	Pathogenic, including Salmonella	not detected	not allowed in 25 g
23	Fungus	not detected	not more 100 colony-forming units in 1 g
24	Humidity	6.4%	3-8.5 %
25	Mass fraction of fat in terms of dry matter	15.9%	7-26 %
26	Alkalinity	0.6 deg.	not more than 2 deg.

The studied indicators during storage characterized the product as a stable, compliant, which enables to transfer the study results of cookies "N-N-Naka" for the entire range manufactured by the confectionery factory LLC "Slastena" and other factories producing confectionery.

IV. CONCLUSION

The quality indicators had no negative dynamics, which characterized the product as stable. According to the results of the study, it is necessary to transfer the research of sugar cookies "N-N-Naka" to other types of cookies produced by LLC "Slastena". Specifications for cookies with a shelf life of 6 months were developed, agreed and approved.

The economic efficiency of the introduction of the new technology amounted to 35 kg of margarine per 1 ton of cookies, which in monetary terms is 1.5 thousand rubles per 1 ton.

In addition, the introduction of resource-saving technology for the production of cookies using vegetable fats has provided the following advantages in the production:

- improved production culture;
- solved the problems of seasonality and storage facilities;
- eliminated the dependence of production on the instability of margarine products;
- improved product quality;
- increased shelf life of sugar cookies sugar varieties 2 times;
- reduced recipe and reduced the cost of production;
- increased competitiveness.

It is also possible to select the fats for the production, to attract new types of raw materials and to produce high quality products.

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