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SEMI-FINISHED PRODUCT TECHNOLOGY FOR FROZEN DESSERTS

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Abstract. *The analysis of literary sources showed that the creation of products with reduced glycemic load and functional properties are new ways of improving the technologies of ice cream and frozen desserts. It has been proven that lowering the glycemic index is possible by replacing sugar with fructose or other sugar substitutes. Provision of functional (prebiotic) properties is expedient to be carried out at the expense of the introduction of lactulose. It has been proven that the rational formulation of the mixture from the point of view of the properties of the obtained semi-finished product should be considered formulations based on serum with the content of lactulose 1%, fructose 11%, stabilizer 0.4%, dry milk 8%. The optimal pasteurization process for the semi-finished product was determined - at a temperature of 80...82°C for (5.8...6.2)×60^{-1}s. A technological scheme for obtaining a semi-finished product for frozen desserts based on whey with lactulose, fructose, stabilizer was developed. A set of data characterizing the quality of the developed semi-finished product was obtained, and its high nutritional and biological value was proven. Modes and terms of storage of semi-finished products are substantiated: temperature - 4...6°C, no more than 3 months, in unsealed form – no more than 48 hours.*

Key words: *semi-finished product, frozen desserts, prebiotic, fructose, lactulose, cheese whey.*

Introduction.

Production of ice cream and frozen desserts is one of the most promising segments of the dairy industry. Ice cream is an affordable complete food product with high digestibility and a valuable source of important functional nutrients. The technologies of frozen dessert products allow adding additives that play the role of functional and technological components to their composition. This makes it possible to expand the range of targeted products for various types of food, taking into account age, individual needs, national and social requests [1].

The analysis of modern nutrition shows its inconsistency with the requirements of nutrition due to insufficient consumption of proteins, minerals, vitamins and an overload of saturated fats and easily digestible carbohydrates. The modern diet needs to improve the recipes of frozen products according to priority directions: increasing the content of functional ingredients (sulfur-containing amino acids, dietary fibers) against the background of reducing the content of fatty components and reducing the sugar content. The modern approach to the creation of food products is definitely related to the use of the concept of glycemic indices and glycemic load [2].

It is the presence of simple sugars in ice cream that determines its high glycemic index, which forces consumers to significantly limit its consumption, and patients with diabetes, cardiovascular diseases or obesity to exclude ice cream from their diets altogether. Solving this problem is possible in two ways: making unsweetened ice cream or using sweeteners or fructose instead of sugar [3]. By the way, unsweetened

ice cream is extremely popular in European countries and in Japan, where they make ice cream with the flavors of meat, seafood (shrimp, octopus, cuttlefish), seaweed, beer, as well as vegetable ice cream – tomato, pumpkin, carrot, garlic, onion, cucumber with spicy herbs, beet, potato, etc. However, such ice cream is not popular in Ukraine and is not produced by any manufacturer. Ukrainians perceive ice cream exclusively as a dessert. Therefore, today the problem of lowering the glycemic index of ice cream can only be solved by using sweeteners or fructose [4]. Thus, the scientific and practical task of creating a new generation of frozen desserts with reduced glycemic load, enriched with functional ingredients, is relevant and timely.

The purpose of this work is the scientific substantiation and development of the semi-finished product technology for frozen desserts based on whey with lactulose and fructose.

In accordance with the set goal, the following tasks were to be solved:

- determine the rational ratio of components in the semi-finished product;
- to study the complex of physico-chemical and technological properties, nutritional and biological value of the semi-finished product;
- draw up regulatory documentation, determine its consumer characteristics and main areas of use in the production of culinary products;
- to develop recipes and technologies of ice cream and dessert products.

Main text.

Today, the food industry is rapidly developing new product platforms and bringing new product categories to the market. The main goal of this activity is the economic growth of economic entities, therefore, most types of food products contain a large number of food additives that create the identical natural structure, taste, color of the product, etc. But the majority of food additives have either a synthetic origin or are subjected to deep physico-chemical influence during production, which determines their harmful effect on human health.

In the segment of frozen dessert products, the distinguishing feature of which is the multi-stage production process and the need to use special equipment, all modern technologies involve the use of foam and structure-forming food additives for the formation of a whipped and stable structure [5].

Experts in the dairy industry note that the direction of creating low-calorie ice cream through the use of vegetable fat substitutes is quite developed, however, numerous medical studies have proven the harm of such products to health, so more and more consumers refuse such a dessert and prefer more healthy products. However, unlike the countries of Europe, America and Asia, this segment of the frozen products market is unfilled in Ukraine. Therefore, technologists face the urgent problem of developing new technologies and adjusting the recipe composition of ice cream and frozen desserts in order to increase the content of protein and dietary fiber [6] against the background of reducing the amount of fat and sugar [7].

A promising way to solve this problem is to use low-fat dairy secondary raw materials as a basis for ice cream, such as casein, whey, sour milk cheese, low-fat goat milk, concentrated milk protein, etc. [8].

One of the ways to increase the dietary fiber content is the use of vegetable (pumpkin, carrot, tomato), fruit (apple, quince, etc.) and berry purees as a filler for

dairy products or as a base for ice cream [9]. At the same time, the researchers note that due to the content of pectin substances and fiber, fruit and berry and vegetable purees play the role of a moisture-retaining and emulsifying component in food systems, and the presence of easily digestible sugars (mainly fructose and glucose) allow to exclude or limit the amount of sugar [10].

A new approach to the use of unused natural properties of raw materials can make it possible to maximize their functional properties, which will increase the economic efficiency of technologies by reducing the use of food additives and sugar, as well as increase the nutritional and biological value of finished products.

The analysis of the diet of Ukrainian citizens shows its non-compliance with the requirements of nutrition due to insufficient consumption of proteins, minerals, vitamins and an overload of simple carbohydrates. The modern diet requires improvement in the production of products in priority directions: functional and low-fat food products, with reduced sugar content or without sugar and with a low glycemic index [11]. The assortment of ice cream with sugar substitutes in Ukraine is insignificant, production volumes are limited to the production of ice cream with xylitol and sorbitol. The modern approach to the creation of food products is connected, in particular, with the use of the concept of glycemic indices and glycemic load.

Consumer demand for healthier products is driving down the sugar content in dairy products. Sugar plays an important role in ice cream not only for flavor, but also for texture, color and viscosity. There are natural and artificial sweeteners designed to reduce sugar levels [12]. However, there is little information on the effect of high-intensity sweeteners and fat substitutes on the perception of sensory properties of ice cream [13].

In recent years, in many scientific works of Ukrainian and foreign scientists (A.M. Dorohovych, V.F. Dotsenko, N.A. Didukh, D. Richarda), considerable attention has been paid to the production of food products with sugar substitutes.

It is proposed to solve the problem of reducing the glycemic index of ice cream by using sugar substitutes (stevia, lactite, sorbitol, aspartame) [14] and fructose [15].

The technology of ice cream with fructose, prebiotic and sour milk cheese was developed, which ensure the production of high-quality ice cream with reduced glycemia and improved nutritional and biological value [16]. It was found that the introduction of sugar substitutes – fructose and sorbitol into ice cream increases the content of bound moisture by 4.2%, which improves the structure and consistency of ice cream and reduces the glycemic index of the finished product by 8.75%.

At the current stage, many researchers will develop ice cream with prebiotics (usually inulin or other non-starch oligosaccharides) [17] or probiotics [18, 19].

The effect of adding probiotics on the quality indicators of ice cream was studied [20]. According to the authors, the whipped texture of ice cream was found to improve the gastrointestinal tolerance of probiotics compared to natural yogurts and fruit yogurts, as evidenced by an in vitro stomach survival study of probiotics (B. animalis). In addition, it was determined that the addition of B. animalis decreased the pH, but did not affect the physicochemical properties and melting of ice cream, and obtained good sensory evaluations and satisfactory probiotic viability [21].

Currently, a promising direction is the use of dairy processing products in the production of ice cream – buttermilk, whey, sour milk cheese, yogurt [22, 23], which is expedient from the point of view of manufacturability, high nutritional value, and rational use of by-products of dairy production.

Considering the above, it can be concluded that dairy technologists are conducting quite intensive scientific work to find new ways to improve recipes and technologies of ice cream and frozen desserts in the direction of creating products with a reduced glycemic index. Thus, the scientific substantiation and development of the technology of frozen dessert products with a low glycemic index based on low-fat dairy raw materials is relevant today.

The further aim of our work was to study the effect of different concentrations of stabilizer and fructose on the foaming ability and foam stability of the control and whey-based mixture. To do this, a certain amount of stabilizer and fructose was measured, introduced into the serum and the mixture was mixed until the stabilizer was completely dissolved. In a water bath, the system was brought to a temperature of 70...75°C and held for (10...15)·60 s^{-1}. Cooled to room temperature. Model mixtures based on whey with a fructose content of 10-12% and a stabilizer content of 0.1...0.6% were subject to research. The study of the foaming ability and foam stability of the samples was carried out according to the methods described in section 2. The results of the studies are presented in fig. 1-3.

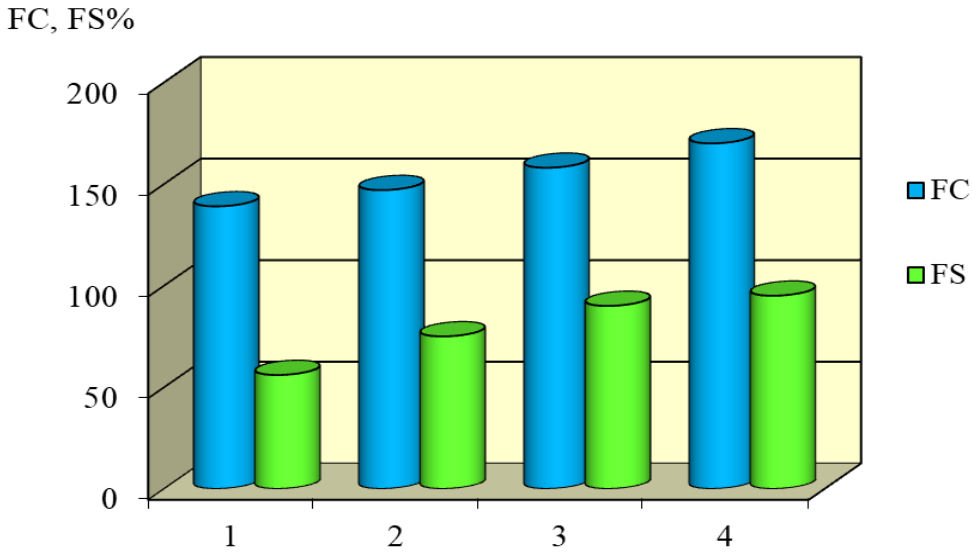

Figure 1 – Foaming capacity (FC) and foam stability (FS) of control (1) and mixtures based on serum with a stabilizer content of 0.2; 0.4; 0.5 and 0.6% with a fructose content of 10%.

The analysis of the obtained results allows us to draw the following conclusions. With an increase in the concentration of the stabilizer in the system, its foaming ability first increases to a maximum value, and then gradually decreases. This regularity is characteristic of all nonionic surface-active substances, which, in our opinion, can be explained as follows.

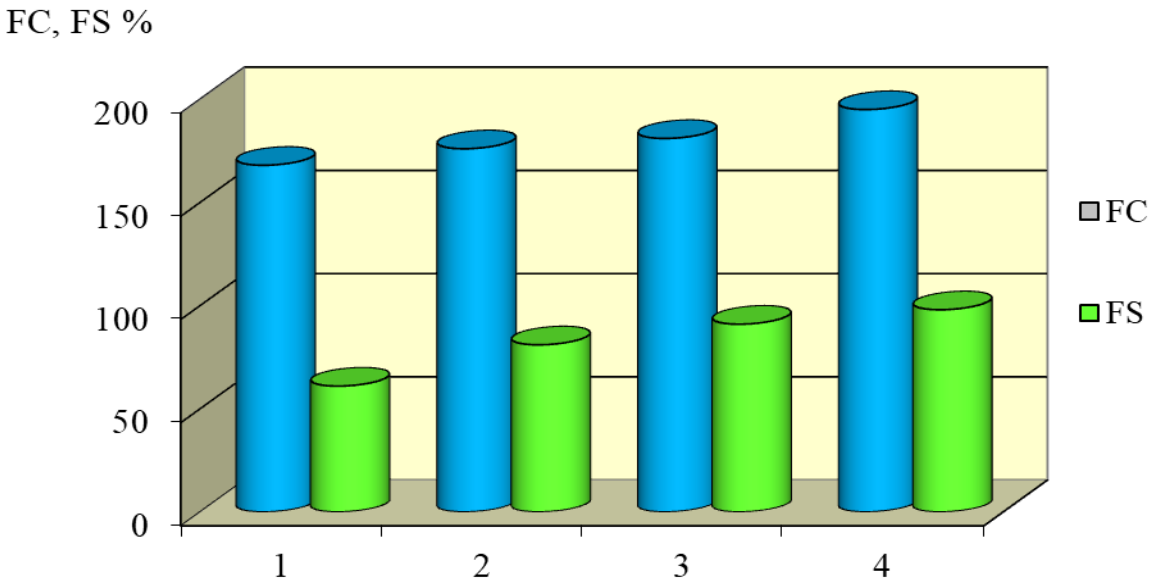

Figure 2 – Foaming capacity (FC) and foam stability (FS) of control (1) and mixtures based on serum with a stabilizer content of 0.2; 0.4; 0.5 and 0.6% with a fructose content of 11%.

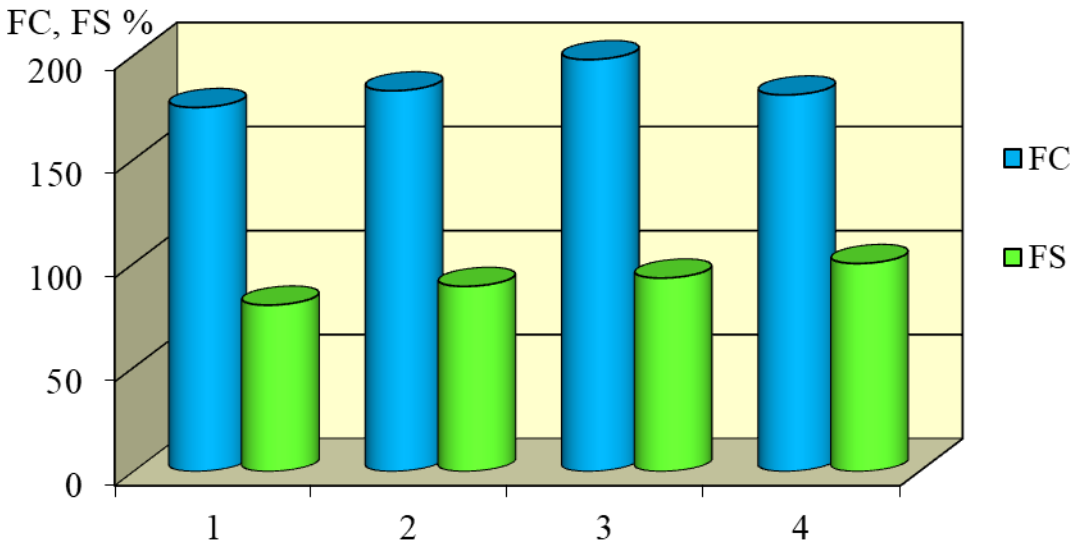

Figure 3 – Foaming capacity (FC) and foam stability (FS) of control (1) and mixtures based on serum with a stabilizer content of 0.2; 0.4; 0.5 and 0.6% with a fructose content of 12%.

In the stabilizer concentration range of 0.4%, the foaming ability increases and reaches maximum values. This interval corresponds to the critical concentration of micelle formation, at which the formation of an adsorption layer with maximum mechanical strength is completed, which prevents the coalescence of bubbles of the gaseous dispersion phase. The decrease in the critical concentration of micelle formation is explained by the presence of a synergistic effect during the interaction of the stabilizer we have chosen with milk protein, the amount of which increases with the increase in the concentration factor.

A further increase in the concentration of the stabilizer (0.6%) above the critical concentration of micelle formation leads to the fact that the rate of diffusion of molecules to the surface layer decreases due to the increase in the micellar concentration of the components of the stabilization system. At the same time, the surface tension of the mixture practically does not change, and the foaming ability gradually decreases. Thus, the most rational formulation of the mixture should be considered formulations based on serum with a fructose content of 11.0%, stabilizer 0.4.

Based on a series of preliminary studies, a basic technological scheme for the production of semi-finished products for frozen desserts was developed (fig. 4).

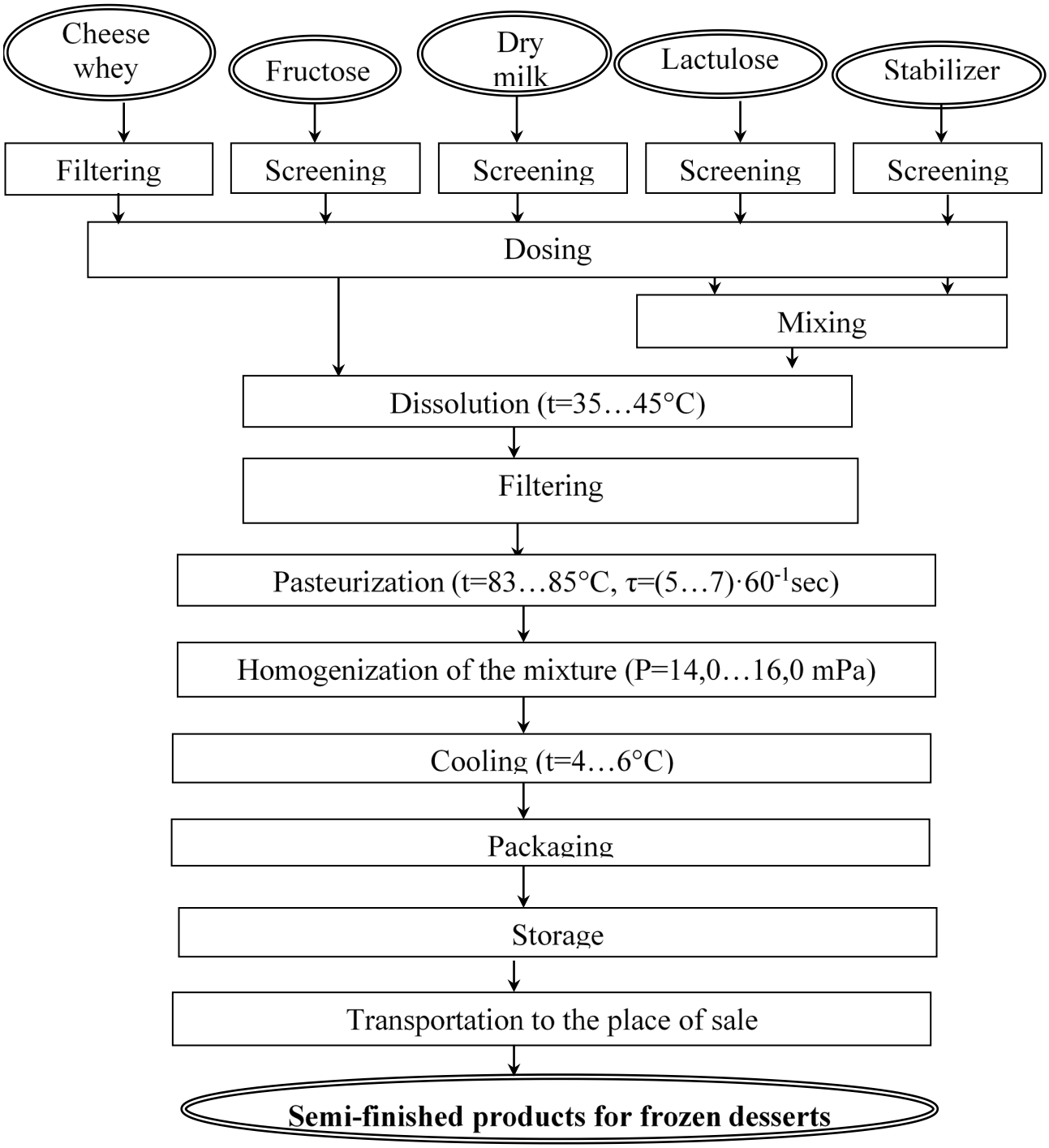

Figure 4 – Basic technological diagram of a semi-finished product

The semi-finished product technology substantiated in the previous sections is low-waste, resource-saving and easy to implement. The production of the developed semi-finished product can be carried out both at the enterprises of the dairy industry and at the enterprises of the restaurant industry. However, since the main raw material of the developed semi-finished product is inexpensive whey, its transportation from dairy plants to restaurant enterprises can significantly increase the cost of the semi-finished product. In connection with this, it is advisable to produce the developed product at dairy plants, and then use it as a semi-finished product with a high degree of readiness at restaurant enterprises.

During the study of the process of freezing desserts from a semi-finished product, as well as those made according to traditional technology (a control sample), it was found that during the preparation of soft ice cream based on a semi-finished product, it is rational to carry out the freezing process for $(6...7)\cdot 60^{-1}$s. The obtained data were used during the development of a technological scheme for the preparation of soft ice cream and frozen desserts based on semi-finished products (Fig. 5).

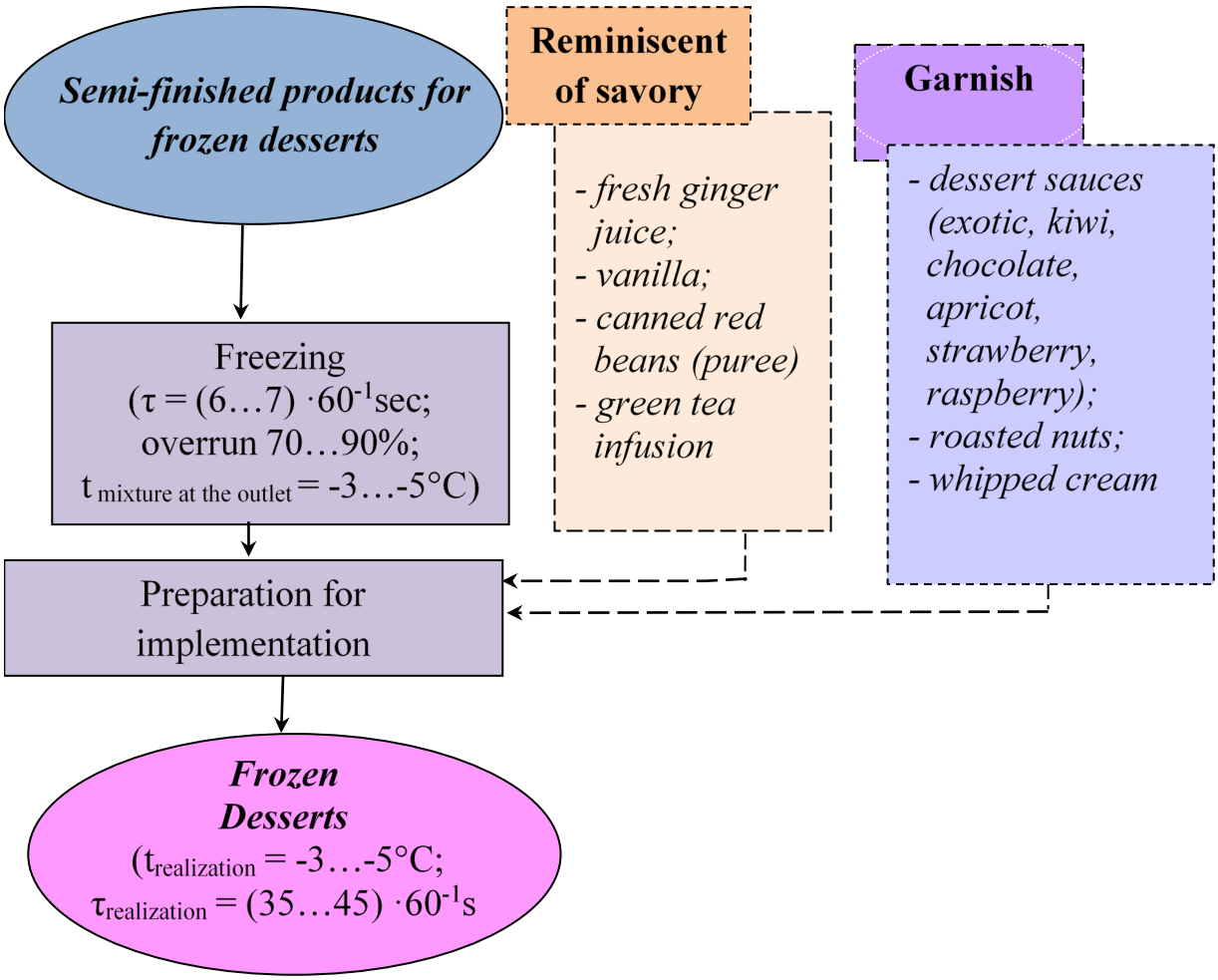

Figure 5 – Schematic diagram of the production of frozen desserts from semi-finished product

Summary and conclusions.

The analysis of literary sources showed that the creation of products with reduced glycemic load and functional properties are new ways of improving the technologies of ice cream and frozen desserts. It has been proven that lowering the glycemic index is possible by replacing sugar with fructose or other sugar substitutes.

Provision of functional (prebiotic) properties is expedient to be carried out at the expense of the introduction of lactulose. It has been proven that the rational formulation of the mixture from the point of view of the properties of the obtained semi-finished product should be considered formulations based on serum with the content of lactulose 1%, fructose 11%, stabilizer 0.4%, dry milk 8%. The optimal pasteurization process for the semi-finished product was determined – at a temperature of 80...82°C for $(5.8...6.2)\times60^{-1}$ s.

The whipping ability was 70±1.8%, the ability to form stable foams was 80±2.0%.

A technological scheme for obtaining a semi-finished product for frozen desserts based on whey with lactulose, fructose, stabilizer was developed. A set of data characterizing the quality of the developed semi-finished product was obtained, and its high nutritional and biological value was proven. Modes and terms of storage of semi-finished products are substantiated: temperature -4...6°C, no more than 3 months, in unsealed form – no more than 48 hours.

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