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THE SUBSTANTIATION OF DEVELOPMENT OF MOUSSES TECHNOLOGY USING WHEAT STARCH

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Annotation. This work is dedicated to the substantiation of development of technology of fruit and vegetable mousses using wheat starch and surfactant – Tween 20. The innovative idea of product with foamy structure was expounded, the implementation of which will allow to provide obtaining of the final product with stable quality indicators, new consumer characteristics and will give an opportunity to carry out the production technological process with distinct industrial signs.

The foaming capacity and foam stability of "wheat starch-Tween 20" model systems depending on the heat treatment temperature and starch concentration were investigated. The rational foaming zone was determined that will allow to obtain foamy structure of mousses. The model systems behavior was studied by the determining of their viscosity. It was confirmed that the controlled regulation of dynamic phase transitions of starch with surfactant provides food systems' colloidal stability.

Keywords: mousse, wheat starch, innovative idea, innovative strategy, foamy structure, foaming capacity, foam stability.

ОБҐРУНТУВАННЯ РОЗРОБКИ ТЕХНОЛОГІЇ МУСІВ З ВИКОРИСТАННЯМ ПШЕНИЧНОГО КРОХМАЛЮ

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Анотація. Дану роботу присвячено обґрунтуванню розробки технології плодових та овочевих мусів з використанням пшеничного крохмалю та поверхнево-активної речовини (ПАР) – Твін 20. Викладено інноваційний задум продукту з піноподібною структурою, реалізація якого дозволить забезпечити отримання кінцевої продукції зі стабільними показниками якості, новими споживчими характеристиками та надасть можливість реалізувати технологічний процес виробництва з вираженими індустріальними ознаками.

Досліджено піноутворювальну здатність та стійкість піни модельних систем «пшеничний крохмаль-Твін 20» залежно від температури теплової обробки та концентрації крохмалю. Встановлено раціональну зону піноутворення, що дозволить отримати піноподібну структуру мусів. Вивчено поведінку модельних систем шляхом визначення їхньої в'язкості. Підтверджено, що кероване регулювання динамічних фазових переходів крохмалю разом з ПАР забезпечує колоїдну стабільність харчових систем.

Ключові слова: мус, пшеничний крохмаль, інноваційний задум, інноваційна стратегія, піноподібна структура, піноутворююча здатність (ПЗ), стійкість піни (СП).

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Introduction

Nowadays, the food production companies and restaurants are going through dynamic development that leads to severe competition. It should be noted that the products offered to consumers are normally provided in a broad range, but there are niches that require filling. One of such niches includes dessert products with foamy structure including sweet dishes.

The market of foamed desserts demonstrates that in the recent years the range of such products somewhat has increased due to producing by food companies whipped desserts containing mainly milk products, such as whipped cream, sour cream, milk, curd, etc. Food production companies and restaurants offer consumers limited range of desserts, prompting producers to innovation.

Therefore, it can be stated that the current products on the market constantly need updating and complying with modern technology trends and consumption shows the effect of time «weariness» [1-6].

Market relations require food manufacturers to create a wide range of competitive products with high consumer properties. Therefore, the development of mousse technologies with fruit or vegetable product and the possibility of industrial implementation of the technology is a promising trend.

Problem statement

The review of restaurants' assortment shows that their culinary products are in significant proportion accounted for sweet dishes that are mostly creams, jellies and ice-creams, however, they do not fully meet consumer demands for a number of reasons [1-2].

One of the sweet dishes varieties is mousse and this kind of dessert is not often listed on the restaurant menu due complexity and multistage production, also instability of raw matter and ready product. It should be noted that food companies do not offer this particular product to consumers. In view of the above, the implementation of innovations in mousse production technology is an actual trend and it would broaden the range of restaurants' desserts, as well as meet consumer demands.

Literature review

It is known that for foamy structure desserts production different foam and structure generating agents are used that form the rheological properties of the finished product and improve its organoleptic properties. Application vegetable matter for this purpose also allows rational use of local resources on top of improving on quality and product range. The research on the issue of foamy structure technologies involved many scientists: Peresichnyi M.I., Grinchenko O.O., Deynychenko H.V., Kaprelyants L.V., Iorgachova K.G., Vasylenko Z.V., Grytsevych V.A., Vasylyeva O.O., Voznenko M.A., etc. [7].

The authors [8] suggest production of dairy dessert with foamy structure using j- and k-carrageenan. Foaming of the recipe mixture is ensured due to the presence of surfactants in it. Modified starch, j- and k-carrageenan, agar, xanthan and highly etherified pectin are suggested as new foaming agents. These substances provide stabilization of colloidal systems, including raw milk based foamy structure.

In research papers [9] the information is found on using milk and buttermilk as foaming agents. With their application the foam acquires fine-grained structure and is characterised with good stability. Today the foaming agents of high efficiency are made of whey being obtained by ultrafiltration of whey protein concentrate, followed by drying. Such concentrate has high foaming capacity and foam stability. Using whole blood proteins of slaughtered animals or its plasma is also important as foaming agent. Use of hydrolyzate of soy protein facilitates increasing of foaming capacity.

Using milk-protein semi-products together with whey and gum Guara is a promising way to dessert assortment varying [10-16].

Functional mixtures allow obtaining a high quality finished product. Due to it the manufacturing process is simplified, shelf life is prolonged, and economic efficiency is improved. There has been rapid growth in production and consumption of milk and vegetable based creamed products, for formation and stabilization of which both food additives of various origins and vegetable material are used.

The review of the research papers proves on feasibility of combining different foam and structure generating agents as the foamy dessert ingredients for providing specific structural and mechanical properties [10-18].

Main part

The article aims at substantiation of mousse technology with the use of wheat starch. Such technology is based on selection of recipe components and determining their content for ensuring specified quality of the final product. Substantiation of such technology provides determination of maximum performance for foaming capacity and foam stability through combined use of surfactants and wheat starch and their subsequent stabilization through implementation of starch transition phases.

With account to analytical research and innovative idea we defined the innovation strategy for the development of a new product showing in the table 1.

Table 1– Innovative idea of a new product

Index	Description	Implementation
Product idea	Ready-to-eat mousse (packaged product for retail or restaurant sale), manufactured using fruit or vegetable matter, wheat starch and surfactants, obtained through technological process, based on starch transition phases with involved surfactants.	Obtained experimentally.
Product description	Appearance: rectangular or round shape (for retail sale) any shape for restaurants. Consistency: foamy, gassy, fine-pored, homogeneous by dispersion, non-flowable, stable. Colour, smell, taste are good, well expressed, according to the recipe components, moderately sweet.	Obtained by selection of materials and implementation of technological process, based on starch transition phases.
Product conception	Ready-to-eat mousse with relevant organoleptic, physical and chemical properties. It is characterized with stable quality throughout its shelf life.	Market research for creamed desserts.
Cost, target segment	It is of affordable price acceptable for customers with different levels of income.	Business calculations.
Packing	Packed in plastic containers of 100 – 150 g.	Aseptic automated packing.

The innovative strategy is based on substantiation of used foam agent and stabiliser and interaction between fruit or vegetable matter, foaming agent and wheat starch.

One of the main conditions for obtaining products with foamy structure is the use of foam generators, including traditionally used egg whites, gelatine or whipped cream and different technological influences (heating or cooling treatment).

The major issue in obtaining foamy systems is formation of stable highly dispersed foam that defines the organoleptic properties of the finished product and process parameters according to the selected recipe components.

Literary sources indicate to two traditional technologies of fruit and berry mousse production, namely, by using gelatine and semolina as structure forming agents, but they have certain drawbacks. Thus, gelatine's functional properties are likely to decrease at high-temperature that leads to mousse with low gel-forming capacity and slows the process towards obtaining the final product.

The disadvantage of using semolina for mousse production is the need for pectin-containing substances and semolina with unstable characteristics. The varied thermal processes and multistage technology makes production stepwise and does not allow continuous production.

Therefore, given the above and based on the innovative strategies the working hypothesis is generated that shall regulate the dynamic phase transitions of starch containing material together with surfactants. It shall allow development of a new mousse production technology and its industrial implementation.

It is expected that mousse technology can be implemented through dynamic phase transitions of functional substances under the following conditions:

– the involved substances should have expressed phase transitions that will manifest in obtaining technological effects;

– at the first technological stage thermodynamically unstable foam with high foaming capacity must be obtained, which shall be stabilized at the second stage of the continuous process by applying additional heat and mechanical energy;

– carrying out process implementation towards obtaining foamy structure and its fixing through single-vector heat flow mode.

In view of the existing substances and processing methods the way to the problem solving narrows as there is only small number of substances that would create a new phase at maintaining congeniality with the dispersion medium. In this view starch is a unique substance being a heterogeneous system since starch paste is a dispersed system with a certain density whose characteristics depend on the process parameters.

Therefore, mousse technology relies on scientific substantiation of foam formation system using wheat starch and low molecular surfactants (Tween 20), followed by its stabilization that will allow obtaining foamy structure and ensure its stability over time. The set technological task shall be solved in two stages:

– defining parameters that will allow obtaining unfixed foamy system with certain foaming capacity, as a phase of continuous process;
– implementation these parameters for whipped system that will stabilize foamy structure and provide high-organoleptic properties of the finished product with long shelf life.

In order to substantiate mousses technology with using wheat starch the following must be defined:

– the patterns of foaming capacity and foam stability for model systems with using wheat starch and surfactants;
– wheat starch content for providing foaming capacity of maximum performance and foam stability;
– reasonable parameters for mousse production process using wheat starch and surfactants.

Justification of wheat starch content that acts as a stabilizer of the food system must be carried out with account to heat treatment of the recipe mixture that determines viscosity at various stages of the process.

Viscosity, foaming capacity and foam stability of model systems «wheat starch – Tween 20» at different heat treatments (Fig. 1-3) were studied in order to identify the patterns of heat treatment affecting the properties of foam system at using wheat starch. The concentration of Tween 20 in model systems is 0.25%.

The Fig. 1 shows that swelling and gelatinization of model systems is accompanied by viscosity change. They proceed depending on temperature. It is established that viscosity of model systems at treatment temperature of 60 °C is linear; increasing of viscosity occurs from 0.0018 Pa·s to 0.0025 Pa·s. At 70 °C treatment viscosity indexes increases 1.4 times for the system (respectively to 60 °C) with 8.0 % starch concentration and 4 times for 12.0 %.

Viscosity curve at 80 °C has an extreme character, since 1.4 times increase is observed in the system at the starch level of 6.0 %, and at 12.0 % concentration it grows 14.4 times. It is seen that the viscosity index 4.0 % (0.0022 Pa·s) of gelatinized starch dispersion at the temperature of 80 °C practically does not differ from the starch dispersion viscosity index 12.0 % at 60 °C that is 0.0025 Pa·s. Experimentally proved that the model system with 10.0 % starch concentration at the temperature of 60 °C (beginning of gelatinization) is characterized by viscosity index at 4.0 % of starch dispersion at the temperature of 80 °C (the temperature of complete gelatinization of starch) that solves the technological problem.

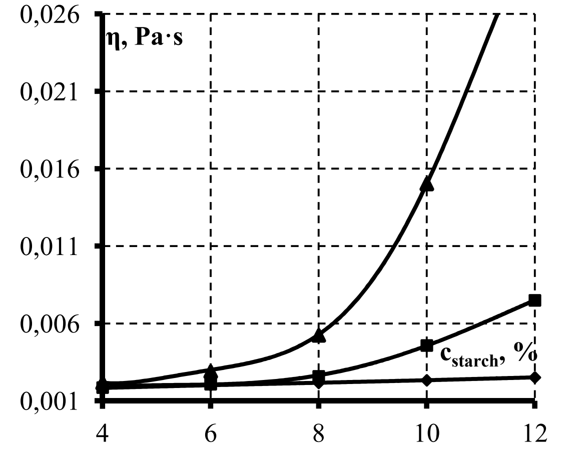

Fig. 1. Dependence of the model systems viscosity «wheat starch – Tween 20» on starch concentration at temperatures: ♦ – 60 °C, ■ – 70 °C, ▲ – 80 °C

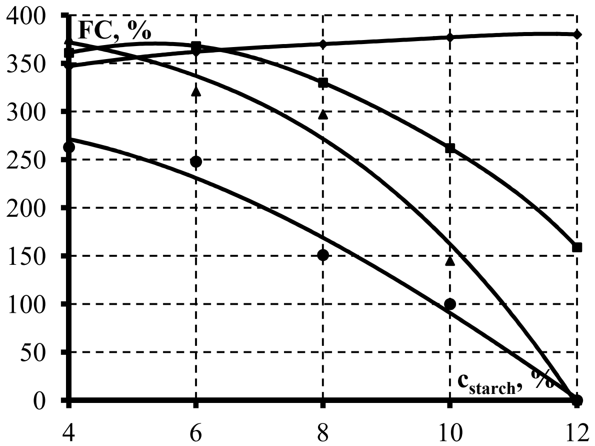

Fig. 2. Dependence of the model systems foaming capacity «wheat starch – Tween 20» on starch concentration at temperatures: ♦ – 60 °C, ■ – 70 °C, ▲ – 80 °C, ● – 90 °C

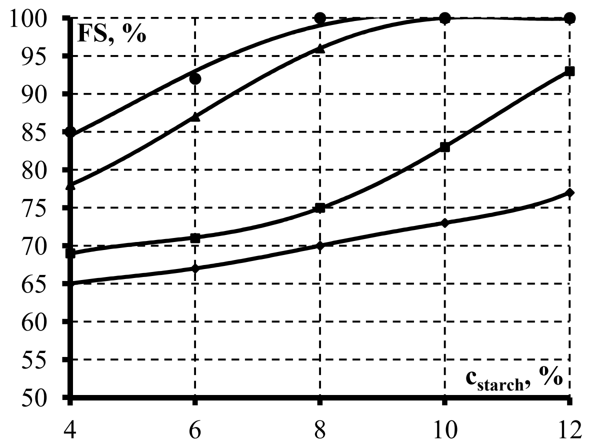

Fig. 3. Dependence of the model systems foam stability «wheat starch – Tween 20» on starch concentration at temperatures:♦ – 60 °C, ■ – 70 °C, ▲ – 80 °C, ● – 90 °C

Similar relation is typical for foaming capacity and foam stability index in the model systems using wheat starch and Tween 20. Increasing temperature increases viscosity that causes decrease of foaming capacity and increases foam stability. It is established that at the temperature of 60 °C, i.e. at the beginning of gelatinization when there is no significant increase in viscosity with increasing starch concentration in the system, the highest foaming capacity performance is observed at 350 – 380 %, while foam stability stays at 65 – 77 %. It is stipulated by colloidal instability because the system is dominated by starch grains incapable of keeping the structure, and rather contributes to its destruction. Almost 100 % foam stability is typical for systems containing 8.0 – 12.0 % starch at processing temperature 80, 90 °C and 12 % starch at processing temperature of 70 °C. Foaming capacity for the systems with 8.0 % starch concentration made 160 – 270 %, for 10.0 % starch concentration it made 90 – 160 %. Model systems in which starch concentration was 12.0 % did not whip at all at processing temperatures of 80, 90 °C and at 70 °C foaming capacity performance was at 160 % that is insufficient for the innovative implementation.

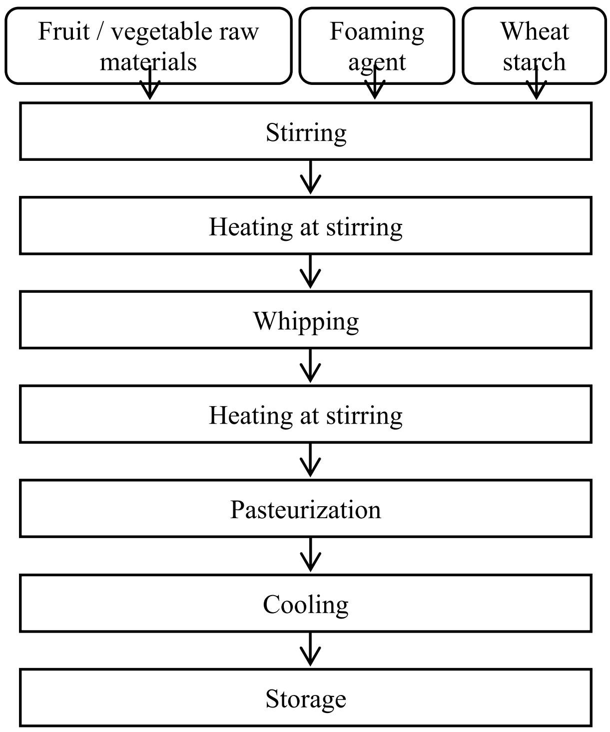

Fig. 4. Basic mousse production diagram using wheat starch

Following the results of experimental researches the basic mousse production diagram was drawn (Fig. 4) showing the combination of recipe components and their heating at stirring until starch gets gelatinized at 60±2 °C; followed by whipping of recipe mixture at the temperature of 60 – 65 °C with gradual increased to 85±2 °C. To secure microbiological index on regulatory level, pasteurization was carried out at the temperature of 95±2 °C ensuring stability of the obtained foam system.

Under the suggested diagram, wheat starch with Tween 20 performs as foaming agent and system stabilizer. It is possible due to the unique property of starch to form colloidal dispersions (starch paste) under hydrothermal treatment. Basically, paste formation is forced hydration of starch component, which is achieved using certain temperatures. Under these conditions, hydration degrees of starch dispersions are different. At low temperature (60 – 65 °C) 10.0 % starch dispersion is characterized by indicators at 4.0 %, which allows implementation of the innovative idea.

The use of thermal breaks at starch gelatinization enables gelatinization of the particular portion of starch that would not obstruct foam generating process and under such conditions whipping will be carried out towards obtaining mousse structure. In order to stabilize foam system, additional heating shall be applied a single-vector mode (to 85±2 °C) that will cause gelatinization of the rest of starch with achieving the effect of concentration stabilization of foam and final product obtaining. Under these conditions, the production process is continuous and is carried out at high temperatures reaching the temperatures of pasteurization providing long shelf life.

Conclusions

The analysis of marketing research in sweet dishes with foamy structure currently offered by restaurants and food companies, showed feasibility in developing mousse production technology. The innovative strategy for product design based on interaction between fruit or vegetable raw material with foaming agent (Tween 20) and wheat starch that would ensure colloidal stability of the finished product is described herewith.

The proposed scientific hypothesis is confirmed by experimental studies based on adjustment of dynamic phase transitions of wheat starch using Tween 20 that allows implementation of new mousse production technology. The basic mousse production diagram is drawn that may allow introducing industrial production in order to fill the market niche.

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ОБОСНОВАНИЕ РАЗРАБОТКИ ТЕХНОЛОГИИ МУССОВ С ИСПОЛЬЗОВАНИЕМ ПШЕНИЧНОГО КРАХМАЛА

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Аннотация. Данная работа посвящена обоснованию разработки технологии плодовых и овощных муссов с использованием пшеничного крахмала и поверхностно-активного вещества (ПАВ) – Твин 20. Изложены инновационный замысел продукта с пенообразной структурой, реализация которого позволит обеспечить получение конечной продукции со стабильными показателями качества, новыми потребительскими характеристиками и позволит реализовать технологический процесс производства с выраженными индустриальными признакам.

Исследованы пенообразующие способность и устойчивость пены модельных систем «пшеничный крахмал-Твин 20» в зависимости от температуры тепловой обработки и концентрации крахмала. Установлено рациональную зону пенообразования, что позволит получить пенообразную структуру муссов. Изучено поведение модельных систем путем определения их вязкости. Подтверждено, что управляемое регулирование динамических фазовых переходов крахмала вместе с ПАВ обеспечивает коллоидную стабильность пищевых систем.

Ключевые слова: мусс, пшеничный крахмал, инновационный замысел, инновационная стратегия, пенообразная структура, пенообразующая способность, устойчивость пены.

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