

ABSTRACT AND REFERENCES

TECHNOLOGY AND EQUIPMENT OF FOOD PRODUCTION

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IMPROVING A VACUUM-EVAPORATOR WITH ENLARGED HEAT EXCHANGE SURFACE FOR MAKING FRUIT AND VEGETABLE SEMI-FINISHED PRODUCTS (p. 6-13)**Andrii Zahorulko**

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Most of the designs of vacuum-evaporators for concentration have the problem of heat supply stabilization over the entire heat exchange surface. This is due to the presence of a steam shell, which complicates the uniform heat supply. The shortcomings also include the lack of the possibility of the rational increase in the heat transfer surface, which in turn affects the duration of thermal treatment and product quality. In order to eliminate the main disadvantages of vacuum-evaporators, it is proposed to use the method of heat supply with increased heating surface. To solve the set improvement tasks, it is proposed to use modern flexible film resistive electric heaters of radiation type (FFREhRT). They are characterized by low inertia, metal capacity, ease of automation and maintenance. Such electric heater is capable to ensure the uniformity of heat flow and to take any geometric shape of the heat transfer surface.

In accordance with the design and technological solution, it is proposed to perform heating with the heat-insulated FFREhRT, which is also located in the hollow space of the stirrer and blades shaft and blades, instead of steam shell. Thus, the increase in heat transfer surface from 3.7 m³ to 4.15 m³, that is by 12 %, is ensured.

We detected a decrease in boundary shear stress at an increase in temperature: if $t=10\text{ }^{\circ}\text{C}$, $q_0=79\text{ Pa}$; respectively, $t=70\text{ }^{\circ}\text{C}$, $q_0=12\text{ Pa}$. Effective viscosity at $t=10\text{ }^{\circ}\text{C}$ is $\eta_{ef}=392\text{ Pa}\cdot\text{s}$, for $t=70\text{ }^{\circ}\text{C}$ $\eta_{ef}=2\text{ Pa}\cdot\text{s}$. In the course of testing the model sample of the VEHS during concentration (50...65 °C), shear rate was determined: 0.5...2.5 s⁻¹. Effective viscosity is within 2.0...4.5 Pa·s. The improved VEHS is

characterized by the reduced duration of entering the stationary mode decreased by 29 % compared to the prototype (MZS-320). The effectiveness of the design and technical solution is proved by a decrease in the weight of the unit by 35 %, of specific metal capacity by 42 %, of treatment duration by 12 %.

Keywords: concentration, organic products, vacuum-evaporator, paste-like semi-finished product, flexible film resistive electric heater.

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IMPROVEMENT OF THE TECHNOLOGY OF GARDEN STRAWBERRY JAM IN COMBINATION WITH APPLE PUREE (p. 14-22)

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Strawberry jam is the most popular and valuable product of processing from strawberries, the technology of production of which involves the use of pectin solution to form the necessary jelly-like consistency, which, in turn, is accompanied by an increase in production costs and complication of manufacturing process. To solve the problem, we proposed the technology of production of strawberry jam from strawberries with the replacement of pectin solution with apple puree in the quantity of 1, 2, 3, 5, 10, 15, 20, 25, 30, 35 and 40 % of the weight of berries followed by boiling to the content of dry soluble substances of not less than 62 %, packing in a glass container with the capacity of 250 cm³, sealing, sterilization and storage at the temperature of 20±1 °C. The experiment should be repeated thrice. We studied the content of dry soluble substances, sugars, organic acids, and ascorbic acids in jams. The organoleptic indicators of jam quality were assessed by the 5-point scale. The results were analyzed by the Tukey criterion at the significance level of 5 % ($p \leq 0.05$).

It is determined that by the content of dry soluble substances, jams meet the requirements of DSTU 4900, according to which mass fraction should be not lower than 62 %, of sugars – 56.2–57.2 %, titrated acids – 0.6–0.8 %, ascorbic acids – from 30.0 to 38.7 mg/100 g at its preservation at the level of 47.7–55.5 %. The study of organoleptic quality indicators showed that the addition of apple puree in the amount of 20 % and higher led to an increase in the estimate of jam consistency, which was caused by the formation of the necessary jelly-like consistency. However, the addition of puree of over 25 % resulted in a decrease in overall score due to deterioration in the appearance of jams. It was proved that 25 % of apple puree should be added in order to obtain optimum jelly-like characteristics of strawberry jam.

Keywords: strawberries, production technology, strawberry jam, apple puree, organoleptic evaluation.

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INFLUENCE OF MICROBIAL POLYSACCHARIDES ON THE FORMATION OF STRUCTURE OF PROTEIN-FREE AND GLUTEN-FREE FLOUR-BASED PRODUCTS

(p. 23-32)

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The formation of a structure of certain dietary bakery products and flour confectionery products made without wheat flour is difficult due to the absence of gluten. There is a constant search for effec-

tive structure-forming agents to replace gluten proteins. We investigated an influence of microbial polysaccharides (MPS) of xanthan, enposan, and gellan on the formation of a structure of gluten-free and protein-free bread and gluten-free muffins in the study.

The ability of a model protein-free system based on corn starch was studied to form dough with addition of xanthan, enposan, and gellan in the amount of 0.1...0.5 % by weight at Brabender farinograph. It was found that presence of the investigated microbial polysaccharides in the amount of 0.3...0.5 % enabled the formation of dough with indicators that ensured formation of the necessary structure of dough without gluten.

We investigated an influence of MPS on resilient-elastic and plastic-viscous properties of gluten-free dough. It was found that reopex properties disappeared in protein-free dough due to addition of xanthan. Viscosity of protein-free dough with addition of 0.3...0.5 % of xanthan by the mass of starch reached the values, which are characteristic for wheat bread dough. The amount of MPS of 0.1 % by weight of finished products is sufficient in gluten-free confectionery dough for muffins. Effective viscosity increased by 2...3 times for all investigated MPS and provided the desired consistency of dough for formation by the sedimentation method in this case.

We studied quality indicators of baked products with addition of the investigated MPS. It was shown that their use in certain quantities leads to an increase in the specific volume and to ensuring of the porous structure of baked products. Crumbling of products decreased during storage, which indicated a slowdown of hardening processes in gluten-free systems with xanthan, enposan, and gellan.

All studied MPS exhibited the same nature of influence on certain indicators, but xanthan had the greatest effect, and gellan – the least one.

Keywords: protein-free bread, gluten-free muffins, microbial polysaccharides, structural-and-mechanical properties, quality indicators.

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STUDYING THE EFFECT OF ELECTROSPARK TREATMENT OF MILK WHEY ON THE PROCESS OF ITS FERMENTATION AND QUALITY OF THERMOACID CHEESE (p. 33-40)

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The paper reports a study into the influence of electrospark dispersion of current-conductive granules of magnesium and manganese in the environment of milk whey on the process of its fermentation in the technology of making soft thermo-acid cheeses the type of “Adyheyskyy”.

The object of this study was milk whey, obtained from the thermo-acid settling of cheeses. To prepare the coagulant, it was treated in an electric discharge chamber with a current-conductive layer of magnesium or/and manganese granules manganese over 30...120 s.

It has been established that the result of such a treatment of milk whey is the increased magnesium content, by 1.8 to 4 times on average, and the increased manganese content, by 1.5 to 3.8 times on average, depending on the treatment duration.

It has been proven that it was characteristic, of all the examined samples, to demonstrate a natural growth of titrated acidity during fermentation. However, the samples enriched with mineral elements following the electrospark treatment over 30...60 s have shown a more intensive growth in titrated acidity. Similar results were ob-

tained when using milk whey from cottage cheese. Although at the initial stages of fermentation (0...6 hours) the increase in acidity was somewhat slower, which has an objective explanation related to the effect of enhanced acidity of the starting whey (50...60 °T) on lactobacilli.

It was established that the production cycle is significantly reduced in case of using the proposed technology of acidic whey-coagulant for making thermo-acid cheeses.

There is also an increase in the utilization coefficient of technological equipment and its resources. A given technology does not require significant areas for the introduction of an innovative electro-physical technique, and, instead, given the reduced fermentation time, it contributes to reducing the number of containers involved in the preparation of coagulant.

It has been established that the use of acidic whey, produced from raw materials enriched with magnesium and manganese, in the technology of thermo-acid cheese contributes to its enrichment with valuable mineral elements. It also provides for a more complete use of the protein potential of milk and, consequently, increases the thermo-acid cheese yield by 1.8...6.5 %.

Keywords: milk whey, electrospark discharges, magnesium, manganese, soft thermo-acid cheese.

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RESEARCH OF RECIPE COMPONENTS INFLUENCE ON THE PROPERTIES OF DAIRY-PROTEIN MASHES FOR SEMI-FINISHED PRODUCTS (p. 41-48)

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The paper reports a study into the influence of formulation components, such as potato fiber, white sugar and egg mélange, on the characteristics of milk-protein mashes for heat-treated semi-finished products.

We studied the effective viscosity and moisture-retaining power of mashes and found out a significant influence of potato fiber in the amount from 0.5 % to 2.0 % on characteristics. A tendency has been observed to a decrease in the above-indicated values with the addition of 10 % of white sugar in all model samples. It was found that egg mélange also reduced the moisture-retaining power of mashes by 13.5±0.6 % and effective viscosity by 76.0±1.4 Pa·s on average, but there was the opposite effect at heat treatment of semi-finished products.

Taking into account the overall influence of all components, it is rational to add 1.5 % of "Potex" and 10 % of sugar and 10 % of egg mélange to the cottage cheese (instead of wheat flour).

According to the indicators of water activity (a_w) in milk-protein mashes, we found that the addition of potato fiber in the above amounts reduced the specified indicator from 0.961 to 0.952. a_w was at the level of 0.964 in the control mash with wheat flour. Binding of water occurred at the activation of aqueous systems of milk-protein mashes and spoilage processes slowed down.

The influence of various heat treatment (frying at temperature of (155±5 °C) and baking (185±5 °C) on qualimetric indicators of semi-finished products has been established. We observed the smallest weight losses in the sample with 2.0 % of potato fiber. They were

4.3±0.2 % and 6.2±0.1 %, respectively. The study results confirmed the possibility of using the specified above component to reduce the weight losses of semi-finished products after heat treatment.

The addition of “Potex” provided necessary efficiency in the processing of milk-protein mashes for mechanical shaping of semi-finished products.

Keywords: semi-finished products, milk-protein mashes, potato fiber, heat treatment, effective viscosity, moisture-retaining power, water activity.

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DETERMINING THE EFFECT OF FORMULATION COMPONENTS ON THE PHYSICAL-CHEMICAL PROCESSES IN A SEMI-FINISHED FLOUR WHIPPED PRODUCT UNDER PROGRAMMED CHANGES IN TEMPERATURE (p. 49-56)

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The method of a differential thermal analysis has been applied to investigate the physical-chemical and chemical processes that occur in a semi-finished whipped flour product under conditions of a programmed change in temperature. Qualitative assessment of the processes that take place in the examined samples during thermal transformations has been performed.

We have explored the influence of formulation components of a semi-finished whipped flour product on mass losses, the rate of transformations, and the dehydration processes occurring under non-isothermal conditions at a constant heating rate of 10 ± 1 °C/min while heating up to a temperature of 300 °C.

Synergetic interaction between xanthan and gelatin has been confirmed. It was established that the introduction of a xanthan solution to a gelatin solution, the base of a semi-finished whipped flour product, improves structure and enhances its thermal stability during heating. It is likely that this occurs due to the redistribution of associated and non-associated hydroxyl groups, which contributes to forming a large number of inter-molecular hydrogen bonds.

We have proven the catalytic effect of the enzyme transglutaminase in the system gelatin-xanthan on the interaction between the amino groups of lysine and the γ -carboxamide group of glutamine residues bound by a peptide bond. This effect ensured a higher level of crosslinking the macromolecules of a protein framework and substantially slows down the dehydration process in a semi-finished whipped flour product.

Our study has established minimum losses of the adsorption-bound moisture in semi-finished whipped flour product, which is likely due to an increase in the degree of binding the groups of –OH and flour proteins, which predetermines the formation of intermolecular hydrogen bonds with the proteins of a gluten complex.

The influence of xanthan, sugar, transglutaminase enzyme, flour, on the ranges of dehydration has been investigated, which depend on different forms of moisture binding in a semi-finished whipped flour product. We have determined the temperature intervals of moisture loss at different shapes and binding energy in a semi-finished whipped flour product.

The results obtained have practical significance for establishing the rational temperature conditions for baking a semi-finished whipped flour product, namely 140 ± 5 °C.

Keywords: semi-finished whipped flour product, thermal analysis, dehydration, non-isothermal conditions, synergetic interaction.

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INVESTIGATION OF CRYOMECHANOCHEMISTRY PROCESSES IN THE DEVELOPMENT OF NANOTECHNOLOGIES OF SUPPLEMENTS PREPARED FROM CHLOROPHYLL CONTAINING VEGETABLES AND DISCOVERY OF HIDDEN CHLOROPHYLL FORMS (p. 57-65)

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Processes of cryomechanochemistry in development of food nanotechnologies of supplements as frozen pastes in the nano-dimensional form prepared from chlorophyll-containing vegetables (CCV) such as spinach, celery and parsley were studied. The nanotechnologies are based on the use of an innovative complex action of cryogenic “shock” freezing and low-temperature fine-dispersed grinding accompanied by the processes of cryomechanodestruction and cryomechanochemistry. The developed nanotechnologies make it possible not only to preserve a and b chlorophyll, β -carotene and other BAS contained in raw materials but also to more fully extract hidden inactive and bound biopolymers (protein, polysaccharides) of the BAS forms in a readily digestible form. The bound inactive forms of chlorophyll and other BAS in CCV found in processing by means of cryotechnology to obtain health improving products (frozen cryopastes in a nanoscale form) were revealed. It has been found that CCV contain 3.0...3.5 times more chlorophyll and other BAS in a bound form than can be extracted from fresh chlorophyll-containing vegetables. It was shown that weight fraction of BAS in

cryopastes prepared from CCV is 2.5...3.5 times higher than in fresh vegetables. The mechanism of these growth processes was revealed.

It was established that activity of oxidizing enzymes (peroxidase and polyphenol oxidase) in rapidly cryo-frozen CCV depends on the final product freezing point. Freezing to the temperature of $-35...-40$ °C in the middle of the product results in a complete inactivation of oxidizing enzymes whereas freezing to -18 °C leads to a 1.4...1.5-time increase in enzyme activity as in the case of enzyme activation under the action of heat treatment of raw materials at $+35$ °C. Mechanisms of the processes of cryomechanochemistry associated with mechanocracking and complete inactivation of oxidizing enzymes were disclosed.

The developed cryopastes from CCV have no counterparts and are the source of a unique complex of BAS (a and b chlorophylls, β -carotene, L-ascorbic acid, phenolic compounds, etc.). Using the cryopastes obtained, a green line of health improving products was developed where CCV supplements act as natural dyes, thickeners, or texture stabilizers.

Keywords: cryo-mechanochemistry, cryogenic “shock” freezing, chlorophyll-containing vegetables, chlorophyll, health improving products, hidden forms of BAS.

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DEVELOPMENT OF A FOOD ANTIOXIDANT COMPLEX OF PLANT ORIGIN (p. 66-73)

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An antioxidant complex has been developed for use in oils, fats, and food products, which must be enriched with biologically active substances of plant origin. Rational conditions have been examined for obtaining of water-ethanol extracts from plant raw materials: oak bark, eucalyptus leaves, and green tea leaves. An antioxidant has been derived capable of preventing the oxidation of fat-containing products, preserving their high nutritional value. The antioxidant substances of natural origin will make it possible to create products, balanced in composition, with prolonged shelf life while preserving the initial natural composition and the structure of components. In addition, the devised antioxidant is an additional source of substances that help the body fight free radicals, which form as a result of physical and mental stresses. The composition of antioxidants of plant origin includes antioxidant vitamins (tocopherol and ascorbic acid), plant phenols and thiol antioxidants (glutathione, lipoic acid), and microelements. These components are involved in the processes that inhibit oxidation. In addition, these antioxidants include selenium, zinc, folates, and other substances.

Planning experimental studies for each type of a plant raw material in terms of the antioxidant activity of selected substances was based on a complete first order factor experiment.

Synergistic effect of antioxidant substances has been established at a simultaneous use of extracts from oak bark, eucalyptus leaves, green tea leaves.

The devised antioxidant prolongs the period of induction of a model substance (sunflower oil) by 2.7 times, whereas when using antioxidants from each type of plants the best indicator of the prolonged induction period was 1.9. Thus, the devised antioxidant could help preserve the quality and safety of fat-containing foodstuffs. The use of a given antioxidant may be proposed for food products for people who require additional antioxidants and biologically active substances in the diet. In particular, it is important for athletes.

Keywords: antioxidant, free radicals, plant raw materials, oxidation, biologically active substances, induction period, extraction.

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