

Представлено дослідження впливу рецептурних компонентів – картопляної клітковини «Potex», цукру-білого та яєчно-меланжу на характеристики молочно-білкових замісів для напівфабрикатів термічно оброблених.

За зміною ефективної в'язкості та вологоутримувальної здатності замісів встановлено, що суттєвий вплив на показники має картопляна клітковина в кількості від 0,5 % до 2,0 %. Для всіх модельних зразків спостерігається тенденція до зниження вище вказаних значень при додаванні 10 % цукру-білого. Встановлено, що яєчний меланж також знижує в середньому вологоутримувальну здатність на $13,5 \pm 0,6$ % і ефективну в'язкість на $76,0 \pm 1,4$ Па·с замісів, але за термічної обробки напівфабрикатів спостерігається зворотний ефект.

Враховуючи загальний вплив всіх компонентів раціональним є додавання до молочно-білкової основи (замість борошна пшеничного) 1,5 % «Potex» і по 10 % цукру та яєчного меланжу.

За показниками активності води (a_w) молочно-білкових замісів встановлено, що додавання картопляної клітковини у вище зазначених кількостях знижує цей показник від 0,961 до 0,952. У контрольній суміші з борошном пшеничним зафіксована a_w на рівні 0,964. При активації водних систем молочно-білкових замісів вода зв'язується і процеси псування уповільнюються.

Встановлено вплив різної термічної обробки (смаженні за температури – $(155 \pm 5$ °C) та запіканні $(185 \pm 5$ °C) на кваліметричні показники напівфабрикатів. Найменші втрати маси спостерігались для зразка із кількістю картопляної клітковини «Potex» на рівні 2,0 % та становили $4,3 \pm 0,2$ % та $6,2 \pm 0,1$ %. Результати досліджень підтверджують можливість використання вище зазначеного інгредієнта для зменшення втрат маси напівфабрикатів за термічного оброблення.

Додавання «Potex» забезпечує необхідну ефективність при обробленні молочно-білкових замісів для формування напівфабрикатів механічним способом

Ключові слова: напівфабрикати, молочно-білкові заміси, картопляна клітковина, термічна обробка, ефективна в'язкість, вологоутримувальна здатність, активність води

RESEARCH OF RECIPE COMPONENTS INFLUENCE ON THE PROPERTIES OF DAIRY-PROTEIN MASHES FOR SEMI-FINISHED PRODUCTS

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1. Introduction

One of the ways to improve properties of product structure and food diets in general is introduction of specially treated vegetable raw materials. The approach makes it possible to correct consistency directly and to balance a chemical composition

of products in terms of the content of dietary fiber, micro- and macronutrients, vitamins, proteins, and other nutrients. A search for new functional and technological ingredients made of available raw materials, development of technologies for products with such additives and studying of their consumer properties are urgent tasks for the dairy industry.

The expansion of the range of products made of cultured milk cheese occurs both by improvement of methods for obtaining of a protein clot, and technologies of products with inclusion of ingredients that change organoleptic and functional properties [1]. The combination of dairy and vegetable raw materials opens new opportunities for obtaining of biologically full-valued high-quality semi-finished products based on cultured milk (or milk protein concentrates). Specialized companies or units produce such products usually. The development of combined products is possible by changing of a chemical composition and structure of a milk-protein base by introduction of plant coagulants [2]. In addition, producers use functional-and-technological ingredients that increase dietary properties and biological value, and provide product structuring [3].

It is necessary to comply with certain requirements for formulation components in production of semi-finished products based on milk-protein concentrates. Mashers should be sufficiently elastic without additional moisture to give possibility to shape products mechanically. Compliance with the mentioned requirements ensures production of a product with appropriate appearance and without additional weight losses. The features of production of semi-finished products make it possible to prepare protein-vegetable mashers of traditional ingredients included in formulations, such as cultured milk cheese, egg mélange, white sugar, wheat flour, and other vegetable raw materials [4].

The use of specially treated low-calorie dietary fiber at the amount of 221 kcal per 100 g of product and plant systems can have some advantages for development of semi-finished products based on milk-protein concentrates. Firstly, it is reduction of the caloric content of a product by replacement of flour and simultaneous improvement of consumer's product properties and enrichment. Secondly, it is possibility of implementation of the technology on existing equipment with correction of qualimetric characteristics of products.

There is a manufacturing practice of the use of dietary fiber (DF) in formulations of meat-and-vegetable semi-finished products to stabilize structural- and-mechanical properties of products, to improve shaping processes, and to reduce losses of moisture due to thermal influence. Thus, treatment of raw materials with addition of fiber reduces stickiness of mixtures for meat semi-finished products [5, 6]. It is likely that the use of DF, including potato fiber, will give the corresponding technological effect in combination with cultured milk cheese, which is a basis of semi-finished products (SFP).

"Potex" potato fiber (PF) binds water (1:(12...13)) and fat (1:(4...5)) at room temperature and weak mixing. There is additional moisture binding at heating and, therefore, there is consolidation of a product, which is important for heat-treated semi-finished products. PF has a neutral taste and aroma and it sustains low pH values [6]. The latter characteristic is important for combination with non-fat cultured milk cheese, which has pH of 4.1...5.2 units. Dietary fiber shows moisture-binding properties in fermented dairy drinks, spreads, and curd products. Analysis of relevant studies [7, 8] confirms the relevance of the problematics.

Taking into account the technological properties of the above-mentioned potato fiber, its inclusion into the composition of mashers will help to expand a range of heat-treated semi-finished products based on cultured milk cheese and to save raw materials. However, the use of PF to replace flour requires more research.

The desire of producers to save dairy raw materials, especially its protein component, and to ensure profitability of

production leads to changes in traditional technologies and rationalization of a composition, that is production of cheese semi-finished products with addition of non-dairy proteins and other nutritional supplements [9]. The economic expediency does not always coincide with the desire to obtain high quality indicators and the corresponding nutritional value of a product. In this regard, the urgent task is to improve the technology of heat-treated cheese semi-finished products with preservation of traditional methods for production of milk-protein base and simultaneous expansion of the range due to introduction of DF.

2. Literature review and problem statement

Authors of papers [10, 11] present the results of studies, which show an increase in production of semi-finished products based on milk-protein concentrates. There are heat-treated products and products made of raw materials of animal and vegetable origin among them. The reason is a high demand of the population for fast food at competitive prices. The authors showed that the volumes of ready to cook heat-treated and frozen semi-finished products tend to increase in the general structure of food products in Ukraine. Their range is much wider in most countries of the world.

Tarta de Queso, Quesada Pasiega (Spain), Käsekuchen (Germany), Sagittario and Peanut Cheesecake (Italy) present semi-finished products based on milk-protein concentrates in different countries. Cheesecake ANCEL, Dessert glacé Cheesecake and Desserts ile flottante (France), Cheesecake Gateau Fromage (Canada) and others also produce them in industrial volumes. Producers use Mató, Requesón, Burgos, Villalón (Spain), Neufchatel (France), Quark (Germany), Filadelfia (USA), etc. traditional dairy protein products as the basis for their production [12].

However, issues related to the minimization of raw material costs and the attempt to maintain market positions through introduction of classic modified products into production remain unresolved. Local dairy companies produce the following range of heat-treated semi-finished products based on cultured milk cheese: baked puddings, dumplings, including "lazy" dumplings, pancakes and benderykies. Producers use mainly cultured milk cheese, which makes up about 49...86 % of weight of a finished product, and wheat flour in production. The moisture content is 72 % in dough and 76 % in a filling. [11]. The technological scheme of production of classic semi-finished products consists of the following operations: acceptance of raw materials by quantity and quality, preparation of formulation components, preparation of a mash, shaping of products, heat-treatment or freezing of semi-finished products, packaging and storage [13].

According to previous studies [14], mashers for semi-finished products should have a moisture-retaining power (MRP) (82.0±2) %. The growth of MRP leads to too dense consistency, which complicates the process of mechanical shaping of products. There are several methods of high-temperature heat-treatment of semi-finished products at temperatures of 150... 280 °C. The main ones are boiling and frying; and combined ones are baking and boiling with subsequent frying [15, 16].

An increase in moisture of semi-finished products based on cultured milk cheese affects a quality and duration of shelf life negatively. It accelerates enzymatic processes. Key factors in multiplication of microorganisms in such products are mois-

ture content, water activity (a_w), pH value and redox potential. Food stability and water activity are closely linked [17]. The value of water activity ensures normal development for most bacteria. It should be in the range of $a_w=0.97...0.99$.

The technology of production of semi-finished products based on milk-protein concentrates with heat treatment implies special requirements for cultured milk and vegetable ingredients, both classic and researched ones. The requirements include certain elasticity for shaping of products mechanically without additional moistening. When one replaces wheat flour (WF) with other vegetable ingredients, including specially treated DF, one must comply with the above requirements to obtain semi-finished products with appropriate characteristics and attractive appearance. It needs further investigation of influences of various components, such as sugar, melange and DF, on properties of meshes based on cultured milk cheese and finished products.

Dietary fiber (dietary, vegetable, ballast substances) is a complex of biopolymers, which contain polysaccharides (cellulose, hemicellulose, pectic substances), as well as lignin and related proteins that form cell walls of plants. The structure of such substances and their intermolecular interaction determine properties of dietary fiber in general. The main ones are ability to retain moisture, to change the state at thermal treatment and to influence the quality of food [18].

According to the University of California (USA), San Francisco Medical Centre (USA), there is a problem in provision of the daily rate of intake of dietary fiber for a human body [19]. Thus, according to the norms of fiber consumption, 14 g of fiber is necessary for every 1,000 calories [20]. A daily need for DF is: 19...25 g for children from 1 to 8 years, 31...38 g for men, and 26...25 g for women [21].

Producers use various dietary fibers widely as a technological ingredient in the food industry [22–24]. There is a practice of using of dietary fiber with moisture-retaining power to increase viscosity and enrichment in dairy products (fermented beverages, spreads, cheese products) [25, 26].

There is information on the combined cheese product thermally treated at a temperature of $65\pm 5^\circ\text{C}$ with 6 % of wheat bran, 1 % of arabinogalactan and low-fat cultured milk cheese in paper [27].

Authors of work [28] investigate compatibility of potato fiber with various formulation ingredients at the organoleptic level. The results of experimental studies show an improvement in consistency of bakery products at combination of fiber with starch [28]. Potato fiber is a competitive ingredient in many products in meat, baking and confectionery industries according to works [5, 22]. According to the manufacturer's recommendations [29], the amount of potato fiber in heat-treated meat semi-finished products should be: 0.8...1.5 % for frying and 0.5...1.0 % for boiling.

However, the analysis of sources [5, 22, 28, 29] shows the limitedness of data on the use of potato fiber in technologies for traditional semi-finished products based on milk and protein.

“Potex” potato fiber (Lyckeby Culinar, Sweden) is a by-product of starch production. It is made of cell walls of potatoes. PF is a light-gray dispersed powder of coarse grinding (with particles less than 1 mm), high water absorption and moisture retention properties. It is resistant to high temperatures. “Potex” includes hemicellulose, pectin, cellulose, lignin, and others. PF contains also phytic acid, which is important for absorption of minerals [28, 29].

The use of potato fiber in semi-finished products to replace wheat flour with low-calorie dietary fiber and retain

moisture and fat during production, heat treatment and storage may be effective. It is possible to consider potato fiber as a promising raw material for combination with a milk base, such as cultured milk and other recipe components for production of semi-finished products [5, 6].

The traditional components of semi-finished products are white sugar (not more than 10 %), egg mélange (not more than 10 %) and wheat flour. The amount of the last ingredient varies from 6...7 % (baked pudding) to 12 % (cottage cheese pancakes and “lazy” dumplings) in semi-finished (formulations) technologies [30]. The basis of substitution of ingredients is a need to clarify an influence of individual functional-and-technological components compatible with the base and their compositions on physical-and-chemical parameters of milk-protein mixtures for semi-finished products.

The real problem is a lack of a comprehensive approach to solution of tasks identified in the review. All the mentioned above makes us suggest that it is advisable to carry out a study of the influence of formulation components of non-dairy origin, such as potato fiber, on properties of meshes and ready-to-cook heat-treated semi-finished foods.

3. The aim and objectives of the study

The objective of this study is to examine the influence of “Potex” potato fiber, white sugar, and egg mélange on properties of milk-protein meshes for heat-treated semi-finished products.

We set the following tasks to achieve the objective:

- investigation of the influence of “Potex” PF, white sugar, and egg mélange on properties of meshes for semi-finished products;
- determination of water activity in milk-protein meshes with different amounts of potato fiber to clarify storage parameters;
- proving the influence of thermal treatment on qualitative parameters of semi-finished products based on milk-protein meshes with dietary fiber.

4. Materials and methods to study the influence of dietary fiber, white sugar and egg mélange on properties of meshes

We used low-fat cultured milk cheese (LFCC) with a mass fraction of moisture of $(76.0\pm 2)\%$, protein – $(18.0\pm 1.1)\%$, and lactose – $(1.8\pm 0.8)\%$.

We mixed low-fat cultured milk cheese of the temperature of $2...10^\circ\text{C}$ thoroughly with “Potex” PF, white sugar, and egg mélange in different ratios. We used wheat flour made according to TU U 15.6-27784401454-001:2006 for the control sample. The duration of the mixing process (4...8 min) coincided with the industry standard. We could provide it on the existing equipment. We sent meshes of a temperature of 15°C for the following heat treatment: frying – $155\pm 5^\circ\text{C}$ and baking – $185\pm 5^\circ\text{C}$ for 7 min and 30 min, respectively, to determine qualitative parameters.

Wheat flour (WF) had the following physical-and-chemical parameters: mass fraction of fat – $(1.1\pm 0.1)\%$, protein – $(10.3\pm 0.1)\%$, carbohydrates – $(70.0\pm 0.3)\%$. The energy value of WF (calorie content) was 1,396.12 kJ (334.0 kcal) per 100 g of product.

Table 1 gives the chemical composition of “Potex” PF [29].

Table 1
Chemical composition of “Potex” potato fiber

Composition	Amount, %
Pectin and hemicellulose	47.0
Cellulose	23.0
Hydrocarbons (including starch)	17.0 (12.0)
Water / Protein	9.0 / 5.0
Minerals (ash)	4.0
Fat (including saturated fat)	0.3 (0.06)
Total amount of fiber	65.0

The phosphorus and potassium content were 60.0 and 1,200.0, respectively, in mg/100 g.

We used egg mélange (EM) with a mass fraction of moisture – 75.6±0.1 %, fat – 9.1±0.3 %, protein substances – 12.2±0.2 % [31].

White sugar (WS) had a mass fraction of moisture – (0.2±0.1) %, carbohydrates – (99.8±0.1) %.

Table 2 gives variants of formulations for milk-protein mashes for semi-finished products with PF and a control sample.

Table 2
Variants of formulations for milk-protein mashes for semi-finished products

No. of sample	Components ratio for mash samples, %				
	LFCC	WS	WF	«Potex» PF	EM
*1	74.0	10	6	–	10
2	79.5	10	–	0.5	10
3	79.0	10	–	1.0	10
4	78.5	10	–	1.5	10
5	78.0	10	–	2.0	10

Note: * – control sample

We determined rheological parameters of milk-protein mashes using “Reotest II” rotary viscometer with a measurable cylinder-cylinder system by recording the deformation (flow) kinetics curves [32].

The water activity of mashes was determined using Rotronic device of the Hygro Palm AW modification manufactured by Rotronic AG (Switzerland) with a measurement range of 0...1 a_w , sample temperature of 5...50 °C and an accuracy of ±0.01 a_w , ±0.1 °C.

We determined heat treatment losses by the weight method based on the difference in weight of samples.

The studies were repeated three times and processed the data mathematically using Microsoft Excel 2007 to provide accuracy of the obtained results. There is more detailed description of the progress of the experiment, as well as definitions and calculations in paper [33].

5. Results of studying the influence of formulation components on the properties of semi-finished products

5.1. The effect of “Potex” potato fiber, white sugar, and egg mélange on the properties of mashes for semi-finished products

We defined the acidity in LFCC (a base for mashes for semi-finished products) at the level of 206.0±2.2 °T, WRP – 57.5±1.7 % and effective viscosity – 352.2±3.2 Pa·s by standard methods.

The ranges of the use of “Potex” PF are from 0.5 % to 2.0 % in mashes to determine their rational quantity and influence on properties of a mash.

We investigated the dependence of characteristics of two-component mashes on the amount of PF in the first stage. Table 3 gives the results.

Table 3
Dependence of characteristics of mashes on the amount of potato fiber

Components ratio, %			Titrated acidity, °T	MRP, %	Effective viscosity, Pa·s
LFCC	PF	WF			
*94.0	–	6.0	194.9±1.0	76.9±1.3	590.5±2.3
99.5	0.5	–	200.1±1.3	64.3±1.2	405.5±2.0
99.0	1.0	–	198.6±1.1	69.2±1.4	565.0±2.2
98.5	1.5	–	197.4±1.0	77.5±1.7	610.1±2.5
98.0	2.0	–	196.7±1.1	81.1±1.6	848.2±2.7

Note: * – control sample; – values close to the control sample

PF changes the moisture-retention power of two-component mashes for semi-finished products according to the study. There was an excessive consolidation for mashes of low-fat cultured milk cheese with 2 % of PF. The effective viscosity value exceeded the control sample by 257.7±2.5 Pa·s in this sample. Test samples of mashes with 1.5 % of PC with an effective viscosity of 610.1±2.5 Pa·s were the closest to the control sample. There was a similar situation for MRP indicator, where the deviation of the sample with 1.5 % of PF from the control sample was 0.6 % and it was within the deviation limits. The ability of PF to absorb water relates to a degree of hydrophilicity and a number of biopolymers present in them, a nature of a surface, porosity of particles and their size.

We defined the influence of white sugar in the amount of 10 % on characteristics of mashes with PF in the second stage. Table 4 gives the results.

Table 4
Influence of white sugar in the amount of 10 % on the characteristics of mashes with potato fiber

Components ratio, %			Titrated acidity, °T	MRP, %	Effective viscosity, Pa·s
LFCC and 10 % of WS	PF	WF			
*84.0	–	6.0	186.0±1.7	43.2±1.3	322.9±2.2
89.5	0.5	–	179.0±1.7	52.3±2.1	345.9±2.2
89.0	1.0	–	178.0±2.2	53.8±1.7	469.6±2.5
88.5	1.5	–	176.0±2.1	55.3±1.6	519.0±2.8
88.0	2.0	–	172.0±1.6	62.8±1.6	586.9±2.0

Note: * – control sample; – values close to the control sample

White sugar reduced the acidity of a mash more than PF. Samples, which contained 10 % of sugar, 88 % of LFCC and 2.0 % of DF had an acidity 24.7 °T less than those with 98.0 % of protein component and 2.0 % of PF.

It was also established that white sugar reduced MRP and effective viscosity of model samples. MFP decreased by 18.3±1.6 %, and the effective viscosity – by almost 261.3±2.3 Pa·s with the introduction of sugar in the amount of 10 % and 2.0 % of PF comparing with the similar sample without white sugar.

Table 5 gives the influence of egg mélange in the amount of 10 % on the characteristics of mashes with PF.

Table 5

Influence of egg mélange in the amount of 10 % on characteristics of mashes with potato fiber

Components ratio, %			Titrated acidity, °T	MRP, %	Effective viscosity, Pa·s
LFCC and 10 % of EM	PF	WF			
*84.0	–	6.0	196.0±2.0	54.2±1.6	264.2±2.7
89.5	0.5	–	144.1±2.0	54.8±1.7	324.4±3.0
89.0	1.0	–	142.0±1.8	56.4±1.7	440.3±3.1
88.5	1.5	–	139.0±2.2	59.9±1.7	486.6±3.1
88.0	2.0	–	137.1±1.9	67.6±1.6	772.2±2.2

Note: * – control sample; – values close to the control sample

The non-dairy components added to LFCC with PF (namely white sugar and egg mélange) do not accelerate the spoilage process according to the experimental data (Tables 3–5). We defined the absence to an increase of acidity in milk-protein mixtures without a change of corresponding values of low-fat cultured milk cheese.

We found that egg mélange reduces MRP and effective viscosity of mashes with “Potex” for heat-treated semi-finished products. The control sample, which included 10 % of egg mélange and 2.0 % of PF, had the closest to the control sample MRP and the effective viscosity of 181.6±2.2 Pa·s.

The studies were performed on the effective viscosity and MRP indicators of mashes (obtained by formulations from Table 2) for semi-finished products to determine the overall effect of all the formulation components (Fig. 1).

Sample No. 4, which contained 78.5 % of CC, 1.5 % of PF, and 10 % of egg mélange and white sugar, was close to the control sample by MRP and effective viscosity indicators. The deviations of MRP were from 1.2 to 2.9 %, and the effective viscosity was 78.6±0.9 Pa·s and 24.5±1.0 Pa·s, respectively, in samples No. 2, 3. We observed the maximum values of the above indicators in sample No. 5. We recorded the increase in MRP and effective viscosity at the level of 2.2±1.1 % and 83.7±2.3 Pa·s, respectively, comparing with the control sample. Therefore, the effective viscosity is a limiting factor for shaping the samples mechanically. The samples No. 1 and No. 5 had a titrated acidity of up to 150.0 °T and a moisture content of 54.0 to 62.0 %.

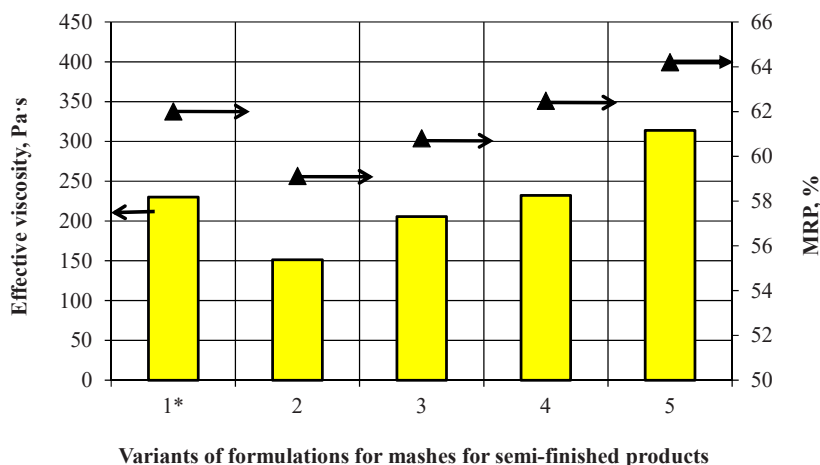


Fig. 1. Effective viscosity (←) and MRP (→) of milk-protein mashes for semi-finished products: * – control sample

5. 2. Determination of water activity in milk-protein mashes with different amount of potato fiber for clarification of storage parameters

Changes in formulation components of milk-protein mashes for semi-finished products require determination of water activity indicator (a_w) to confirm storage conditions. Fig. 2 shows the results of determination of the water activity in mashes with different amounts of potato fiber according to the formulations from Table 2.

Analysis of the obtained data (Fig. 2) shows that milk-protein mashes with PF have a decrease in the water activity index, due to peculiarities of water-binding of dietary fibers, in comparison with the control sample (No. 1). a_w value ranged from 0.961 to 0.952 in all samples of milk-protein mashes with PF. Such values lead to some slow-down of the growth of microorganisms and hydrolytic chemical reactions. Activation of water systems in composition of milk-protein mashes with PF and egg mélange leads to water binding by another mechanism than using PF or WF alone.

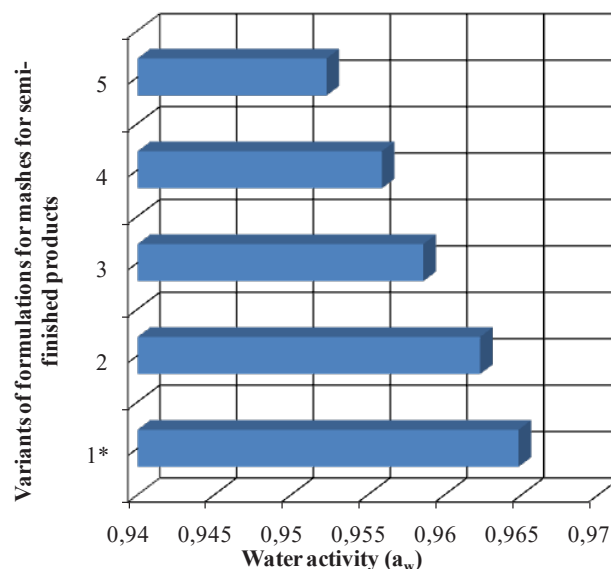


Fig. 2. Water activity in mashes with different amounts of potato fiber

5. 3. Proving the influence of heat-treatment on qualimetric characteristics of semi-finished products based on milk-protein mashes with dietary fiber

Fig. 3 shows data on weight losses at heat treatment at 185±5 °C (baking) and 155±5 °C (frying) of mashes with PF mixes from 0.5...2.0 %.

The maximum weight losses at heat treatment occurred at the level of 13.1±0.2 % in the control sample. The loss decreased in the range from 1.9 % to 6.7 % when we replaced from 0.5 % to 2.0 % of wheat flour with PF, even with a decrease in the mass fraction of moisture content of the mixture. Addition of DF had a positive effect on the rearrangement of moisture in the direction to the bound one with higher energy levels. The content of free moisture decreased in

the model samples of semi-finished products with different amounts of PF. The consolidation of the structure is a limiting factor for the samples with addition of 2.0 % of PF at the organoleptic level.

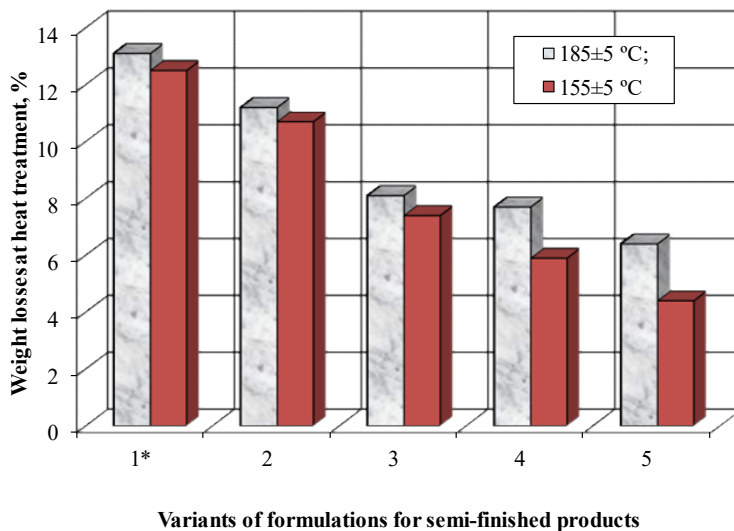


Fig. 3. Weight losses of semi-finished products at temperatures of 185±5 °C and 155±5 °C

6. Discussion of results of studying the influence of formulation components on properties of milk-protein mashes for semi-finished products

We detected the influence of PF and traditional formulation components on properties of multicomponent mashes for semi-finished products (titrated acidity, moisture-retaining power, effective viscosity and water activity). “Potex” combines biopolymers with different affinity for water in its composition. Pectic substances and some hemicelluloses relate to the category of hydrophilic colloids with the ability to absorb and retain water.

According to the studies (Tables 3–5), potato fiber and egg mélange increase the moisture-retaining power of mashes by 23.6 % and 5.6 %, respectively. It is likely that PF substances interact with moisture in milk-protein base, LFCC, through formation of H-bound poly-associates involving water molecules and H-bound hydrophilic functional groups. Such molecules become more ordered and hydrophobic groups aggregate due to dispersion forces. When combined with moisture, hydrophilic substances of PF absorb moisture quickly; they increase in size, which increases the effective viscosity of the system.

Besides “Potex”, addition of 10 % of egg mélange also increases the viscosity by 181.7 Pa·s (Tables 3–5). We observed the effect due to profound changes in the physical state and chemical structure of proteins and dehydrating property of white sugar.

The acidity of the main component, that is low-fat cultured milk cheese, determines the acidity of the model samples of milk-protein mashes for semi-finished products.

Taking into account a degree of influence of individual components, namely white sugar, DF and mélange on the model samples, it is possible to change the above-mentioned characteristics of the finished product purposefully.

Addition of “Potex” instead of wheat flour reduces the water activity (Fig. 2) in formulations for semi-finished products, because DF consists of empty cells made of cellulose. Other components are hemicellulose and pectin, which are mainly between empty cells. Based on the above, a_w indicator is appropriate for confirmation of the mechanism of action of various factors at the stages of production, storage and forecasting of stability of semi-finished products.

Proteins of egg mélange coagulate at heat treatment. They form a strong structure together with LFCC and DF. We can see this visually as mass consolidation. “Potex” partially binds free moisture in mashes before heat treatment, which helps to preserve the mass of finished products after high temperatures. Addition of the dietary fiber mentioned above promotes moisture retention, enveloping and strengthening of the protein framework. Interaction of moisture in cultured milk cheese and “Potex” determines stability of the structure. Higher amounts of pectin, cellulose and hemicellulose in PF, and different fractional composition comparing to wheat flour at the same time leads to a different level (higher) of binding of free moisture in the mashes. The reduction of weight losses in semi-finished products at heat treatment confirms this result indirectly (Fig. 3).

A limitation for the practical implementation of the study results is a need to specify a maximum amount of DF when changing a type of DF in order to prevent excessive consolidation of products at heat treatment. Taking into account the much smaller influence of mélange and white sugar on rheological characteristics of semi-finished products, we can use the obtained dependencies.

The prospects for further research relate to selection of DF with similar properties for solution of technological problems of another product range.

7. Conclusions

1. We determined the influence of all formulation components on the characteristics of mashes for semi-finished products. We registered MRP at the level of 62.5±1.1 % for the model sample, which contained cultured milk cheese, 10 % of egg mélange, 1.5 % of potato fiber and 10 % of white sugar. The effective viscosity of the mash was 232.1±2.2 Pa·s and the titrated acidity was 142.0±1.6 °T. They were as close as possible to the corresponding parameters of the sample with wheat flour. The values did not exceed the standards, which confirmed shaping of mashes mechanically.

2. According to the study, addition of potato fiber reduces the water activity indicator in milk-protein mashes for semi-finished products. a_w value ranged from 0.961 to 0.952 after addition of “Potex” in the amount from 0.5 % to 2.0 %. There was a tendency to decrease in the water activity, which made it possible to adjust a_w level by addition of different amounts of potato fiber. It changes this indicator the most actively.

3. According to the results of determination of the influence of different heat treatment, we determined qualitative indicators of semi-finished products based on milk-protein mashes with “Potex”. We observed the highest mass losses

during frying (155 ± 5 °C) and baking (185 ± 5 °C) for the wheat flour control sample and they were 12.5 ± 0.1 % and 13.1 ± 0.2 %, respectively. Addition of the maximum amount of PF (2.0 %) reduced the weight losses of model samples under

the specified temperature modes, and they were 4.3 ± 0.2 % and 6.2 ± 0.1 %, respectively. Addition of DF reduced the content of free moisture in the model samples of semi-finished products, which reduced the weight losses at heat treatment.

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