Section 2. EQUIPMENT OF FOOD PRODUCTION ENTERPRISES AND IMPROVEMENT OF PROCESSES AND APPARATUSES OF FOOD PRODUCTION ENTERPRISES

DEVELOPMENT OF THE COMPLEX OF TECHNOLOGICAL EQUIPMENT FOR THE PRODUCTION OF COOKIES PIEs

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The processes of bakery products, namely baking buns, is analyzed. It allowed to specify the iressential drawbacks. The equipment for baking buns is characterized by low efficiency, endurance, thermal stress of heating surfaces during baking, and metal consumption. The corresponding processes and apparatuses are in effective and require improvement that is possible due to the use of electrical contact heating. In the framework of the defined task, the complex of technological equipment for the manufacture of baked buns with the use of electric contact heating is elaborated, and thermal influence on the samples of semi-products by means of this method is studied. In particular, highly technological equipment is chosen, the baking device with the electric contact heating is designed. This equipment resulted in a corresponding technological aggregate. Technical innovation of the aggregate is the application of the facilities for baking, which work in a combined regime of infrared heating in combination with electric contact. Reduction of technological process duration, decrease of energy and metal consumption, high efficiency are among the major preferences of the device. Experimental investigations determined that when electric contact method was used, the heating was more intense than heating by means of heat transfer. It makes application of the first method more reasonable. The authors received data regarding the changes in specific electric transfer useful for working out of rational modes for the combined baking of buns with the use of electric contact heating.

Keywords: cakes, bakery products, complex, equipment, electric contact heating, infrared heating, baking.

STUDY OF PROCESSING ULTRAFILTRATION CURDY WHEY

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The question regarding the implementation of the process of separation of curdy whey with ultrafiltration is considered, the analysis of the results of the theoretical and experimental investigations of ultrafiltration concentration of curdy whey is presented. Basic parameters effect of the process of membrane curdy whey on the productivity of ultrafiltration membranes are studied. Rational technological parameters of the ultrafiltration process of curdy whey in a blind mode, and in the mode with the use of pulsating mode of raw materials supply are determined. The
perspective ways for conducting the process of ultrafiltration concentration of the albumen-carbohydrate milk raw material are represented.

**Keywords:** whey, process, ultrafiltration, membrane, separation, treatment.

**Formulation of the problem in general.** Whey is a liquid by-product of the dairy industry produced during the manufacture of cheeses and casein. As a raw material, it has many applications in food technology due to the functional and nutritional properties of its proteins [1].

Whey protein concentrate is made by very fine filtration of whey to concentrate the proteins into small volume which are then dried to soluble powder. Such whey protein concentrates are used as food product ingredients in the hotel and restaurant industry for making of various culinary and confectionery, bakery products, pastry cream, crab sticks, cakes, sauces, infant formulas, tonic drinks etc. An important aspect of whey proteins is their success as emulsifiers in food systems. Many studies have been carried out to identify the optimum conditions under which whey proteins individually and in mixtures perform as emulsifiers.

Application of membrane concentration (e.g., ultrafiltration) during the processing of such low-fat protein-carbohydrate raw milk (curdy whey) opens considerable opportunities for dairy companies from both the creation of new technologies increase of profitability, and environmental safety [2].

**Analysis of recent research and publications.** Today development of membrane fractionation techniques including ultrafiltration (UF), reverse osmosis and microfiltration, enabled the production of wide whey protein products, such as whey powder, whey protein concentrate (WPC), whey protein isolate, whey protein hydrolysate and pure lactoglobulin and lactalbumin [3].

Whey protein concentrates are products with protein content variations from 35–80%. The most widely used method for the production of WPC is ultrafiltration. Whey protein isolate is a high-quality product containing approximately 95% of proteins.

Along with that among the factors hindering the introduction of membrane methods, in particular ultrafiltration in the food industry, it should be noted insufficient development of theoretical propositions about the processes occurring with UF-treatment of protein-carbohydrate dairy raw material, lack of objective experimental data on the characteristics, properties and the conditions of modern UF-membranes [4; 5].

**The purpose of the article** is to study the performance of semi-penetrate ultrafiltration membranes and a choice of rational parameters for ultrafiltration concentration of curdy whey.

**Main materials of the research.** Ultrafiltration retains (in the liquid product termed retentate) any insoluble material or solutes larger than about 20 000 Da molecular weight. The rest of the whey stream passes through the membrane, driven by the applied pressure and is called permeate. Permeate
contains most of the lactose, minerals and water from the whey. Retentate, the volume of which is about 1–4% of the nutritional whey, is spray dried to a powder containing 35–85% protein as desired.

One of the main characteristics of UF-membrane is productivity. There are initial productivity membranes, i.e. the performance of new membrane in the initial period of operation, and the actual performance that characterizes the work of membranes in conditions of continuous operation [6; 7].

M. I. Belyaev department of equipment of food and hospitality industry studies the performance of PAN UF-membranes and the choice of rational parameters of the process of curdy whey separation. In order to improve the UF-separation process of curdy whey, the method of raw materials pulsating supply was used. The intensification of the process of curdy whey ultrafiltration is due to the combined impact on the gel-layer formed on the surface of the membrane, and periodic discharge pressure in the pressure channel and the hydraulic fluid strike the surface of the membrane.

The required pressure in the space under membrane of UF-module is created by the compressor changed it from 0,2 MPa to 0,5 MPa. Speed pulsating flow of curdy whey into the working chamber of UF-module changed by adjusting the performance of the peristaltic pump. After 20...30 minutes, the ultrafiltration rate was constant, the measured amount of the filtrate that passed through the membrane for a time period of 10 minutes [8].

Permeability dependencies of GR61PP and GR81PP UF-membrane on technological parameters of the membrane concentration include pressure P, temperature t, duration of the process \( \tau \), injection speed were studied on the experimental installation of peristaltic feed raw materials, shown in Fig. 1–3.

From the above dependence of GR UF-membranes performance on pressure process of membrane treatment of curdy whey (fig. 1), it is seen that the pattern of productivity change with the increased filtration pressure is the same for both investigated membranes. At pressure values from 0,2 to 0,4 MPa performance of the membrane intensely increases.

On the site of pressures from 0,4 to 0,5 MPa at a curdy whey ultrafiltration the productivity of both membranes slows considerably.

Graphic dependence of temperature of curdy whey on performance of GR UF-membranes (fig. 2a) shows that the temperature increase in curdy whey from 20 to 50\(^\circ\) C in the case of a deadlock mode, and in the case of pulsating supply of raw materials, there is a significant increase in the performance. If temperature of curdy whey ranges from 50 to 70\(^\circ\) C the performance increases, but slowly.
Fig. 1. Dependence of GR ultrafiltration membranes productivity on pressure in curdy whey membrane separation at 20° C: 1; 2 – GR81PP membrane in dead-end mode and pulsating mode of supply of raw materials; 3; 4 – GR61PP membrane in dead-end mode and pulsating mode of raw materials supply

Thus, based on the analysis of the results of research concerning the effect of temperature process of UF-separation curdy whey, it is possible to conclude that the most rational temperature value is 40...50° C.

According to the data, depending on the duration of GR UF-membrane productivity (fig. 2b), the deadlock for the first 1,5...2,0 hours, a sharp decrease productivity membranes, as already noted, due to the formation of the surface polarization layer of macromolecular substances. Further ultrafiltration of curdy whey also reduces membrane productivity but to a much lesser degree. During treatment with pulsating supply of raw materials, the productivity of membranes also reduced, but a slow pace characterized this reduction. Further UF-treatment curdy whey to avoid the productivity of GR membranes slow considerably in degree.

The use of pulsating supply of raw materials increases productivity semipermeable membranes average of 1,3...1,5.
An important factor that significantly affects the process of UF-treatment of curdy whey with a pulsating mode supply of raw material is the frequency pulsating supply of raw materials. On this occasion, we investigated the effects of frequency of the pulsating supply of raw materials for the productivity GR UF-membrane. The research results are presented in fig. 3 [9].

Data analysis pattern shows that increasing the frequency pulsating supply of raw materials resulting to increased productivity UF-membranes. Intensive increase productivity of both membranes is happening with increasing frequency pulsating supply of raw materials to values 90...100 min\(^{-1}\), then the productivity on UF-separation curdy whey increased slightly.

Based on the complex of experimental studies we can conclude that the pulsating supply of raw materials significantly intensifies the process of
ultrafiltration curdy whey. The most rational modes of the process of UF-separation curdy whey using GR semi-penetrate membranes mode at the pulsing supply regime of raw materials is pressure of 0,4...0,5 MPa, temperature of curdy whey – 40...50º C , the duration of the process 2,5...3,0 hours , the frequency of pulsating supply is 90...100 min⁻¹.

Fig. 3. Dependence productivity GR ultrafiltration membranes from pulsating supply of raw materials in membrane separation curdy whey at the temperature 20º C, pressure P = 0,5 MPa: 1 – GR81PP membrane; 2 – GR61PP membrane

Conclusion. Thus, analytical and experimental studies showed the limits of technological regime for obtaining protein concentrates in the UF-separation of curdy whey.

Based on the above we can conclude that the application of membrane technology in the manufacturing protein concentrates can simplify the process of concentration curdy whey. Moreover, the membrane treatment of curdy whey by ultrafiltration made it possible to get quality protein concentrate unchanged native properties of the product. Thus, carrying out this process is not costly.
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ANALYTICAL RESEARCHES OF ENERGY CONSUMPTION OF PULSATION MILK HOMOGENIZER

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The article contains analytical researches of one of the promising types of machines for fat emulsions and milk homogenization – pulsation homogenizer that has a piston with openings. This piston makes oscillation movement with the help of the crank gear in the cylindrical chamber. High efficiency of such homogenizer is conditioned by emulsion acceleration when the piston makes oscillation movement. Such movement increases emulsion dispersion level with the increase in slip velocity of the fat particle (globule) relatively milk plasma according to Veber’s fracture criterion.

Correlation of kinematic and design factors of the pulsation homogenizer with one piston with its energy consumption was not researched before. Thus, the aim of the article is to design mathematical apparatus in order to define energy consumption of the pulsation homogenizer of milk with one piston.

The influence of basic parameters of pulsation homogenizer is investigated: frequencies and amplitudes of piston motion, diameters of piston and its openings, sizes and mass of piston on energy consumption of pulsation machine with one piston. The equations are received to determine instantaneous and calculation values for power determination of pulsation homogenizer.
We analyzed the received curves of the three components of instantaneous power and also the total instantaneous power of the pulsation homogenizer depending on the oscillation frequency of the piston and average power of the pulsation homogenizer depending on the frequency and the pulsation amplitude.

The largest contribution to total power belongs to the power on overcoming of inertia forces, and the smallest one belongs to the power for giving the energy to the liquid that pulsates in piston openings. The chart of total power is asymmetrical. Increase in the rotation frequency by 20-25% results in the increase of the power consumed by homogenizer more than twice. At \( n=3000 \text{ rpm} \) and \( r=50 \text{ mm} \) the power of homogenizer equals 3.5 kW.

The suggested calculation procedure of energy consumption is recommended for use on the stage of the engineering design of the pulsation machine. It enables to define specific consumption of the homogenizer power and its efficiency compared to other equipment used for homogenization.

**Keywords:** homogenization, pulsation homogenizer, energy consumption, analytical researches.

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**EFFECT OF EGGPLANT PROCESSING ON REDUCTION OF OIL ABSORBING WHEN ROASTING**

**A. Tokar, S. Myroniuk**

Eggplant fruits have high dietary and medicinal properties and are a valuable raw material for canning and cooking.

During the storage of eggplant fruits there are changes of their physical and chemical properties depending on the conditions and duration of storage. The important indicator of raw preservation is natural weight loss occurring due to evaporation (transpiration) of moisture and fruit breathing. In the production of snack-canned eggplants there is the absorption of a large amount of oil limiting their consumption because of the high calorie content. When soaking eggplants cut into slices there is water absorption by cells due to more internal pressure. The cells swell but not much as their strong and united wall resists stretching which is caused by increasing cell sap volume. The more water is absorbed into the cells the less oil will be absorbed when roasting them.

An effective way to reduce oil content in fried vegetables is their pre-soaking or blanching in water, moisture will prevent absorption of oil. During roasting adsorbed water consisting of dipolar molecules interacts with oil forming hydrophobic effect. Mixed oil and water form separate layers that is emulsion. Hydrogen bonds between water molecules are transformed tangentially to the nonpolar surface, which leads to forming solvate shell that will prevent oil absorption by vegetable cells. Under the influence of high temperature of oil when roasting some amount of moisture removes in the form of steam, oil absorption, porosity of vegetables grows. Powerful flow of steam pushes and is gradually absorbed into the outer layer of the vegetable. With further roasting oil penetrates through capillaries into the fruit, fills the intercellular space initially and then penetrates cells of which the moisture partially evaporates.
The process of oil absorption and thus the quality of finished products largely depend on physical and chemical properties of vegetables related to the conditions of storing raw materials.

**Keywords:** eggplant, roasting, oil, soaking, blanching, absorbing.

**THE INTENSITY OF CRYOGENIC PROCESSING OF MEAT PRODUCTS**

O. Chernyushok, V. Fedorov, O. Kepko

One of the important conditions of meat products preservation is a maintenance of their high quality and nutritive value. Usage of cold treatment enables preservation over a long period. Cooled products after preservation insignificantly differ from fresh ones. The article contains research regarding determination of the cooling process intensification of meat products subject to their size, temperature and air velocity. Necessity of the meat products freezing will increase their preservation term. Velocity of the processes inside the frozen meat products, influencing their quality, is significantly lower than in the cooled products.

The Authors researched the dynamics of the heat flow density during the cooling of meat products. It is determined that total heat-transfer coefficient varies from 12 to 10 W/(m²·K); for the purposes of applied calculations one can use 11 W/(m²·K).

Freezing of the samples in the similar conditions increases an average \( q \) proportionally to increase in \( \Delta t \), at the same time \( \alpha \) is not increasing and amounts to average 12 Vt/(m²·K).

An impact of temperature and air velocity \( q \) and \( \tau \) were researched during the development of rational regime for freezing of meat stuffing products. When air temperature decreases from – 20 to – 60 ºС and velocity decreases by 5 m/s, \( \tau \) is also decreasing from 52 to 8 minutes but \( \alpha \) is increasing from 48 до 52 Vt/(m2·K). Air velocity change from 3 to 10 m/s increases \( \alpha \) from 36 до 74 Vt/(m2·K).

**Keywords:** cooling, freezing, meat products, intensity, heat flux density, heat transfer coefficient.

**DURATION OF THE MAIN STAGES OF PREPARATION OF A LIQUID SOURDOUGH DETERMINED INDIRECT METHODS**

Y. Dolomakin, I. Babanov, I. Zhitneckiy

Unlike a lot of works, where the object of research is the finished product, our investigation were led during its preparation directly, which made the possibility to identify the specific values of time intervals, which can be divided into the process of mixing the liquid wheat sourdough, half-finished product of baking enterprises.

Basically readiness of the semi-finished product is determined by distribution of the concentration of components throughout the volume of the bowl,
but this method is very complicated and costly. The work presents an indirect method of determining the readiness of liquid sourdough. The method is based on the condition of equality of the torques. It is expressed in the form of equality of the torque applied to the semi-finished product during the motion of the rotor of the mixer and the moment of resistance at the walls and bottom of the cup.

According to the study preparation process of sourdough can be divided into several stages. In a first stage the torque begins to increase at a very high speed. Duration of sourdough preparation makes up 12% of the total time. In the second phase, the torque reached its maximum begins to decrease at a rate twenty times less than on the first stage. The duration of this stage is about 28% of the time. Thereafter third stage takes 60% of whole time. At this stage, change interval of torque increase, which indicates the beginning of system counterweight and the end of its readiness.

At the final stage sourdough acquires a dynamic state in which backward for the strength contacts between the particles of flour are destroyed and the largest of its turnover is realized with a minimum level of effective viscosity (lowest viscosity maximum destructed structure). The duration of this phase is defined by the time intervals between the account of the torque “T”. Thus, essential total time for the preparation of liquid sponge was about 200 seconds according to our process conditions.

**Keywords:** cooking time, the indirect method, liquid sourdough, torque.