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EVALUATION OF THE PRODUCTION TECHNOLOGY OF MEAT PASTE
ОЦІНКА ТЕХНОЛОГІЇ ВИРОБНИЦТВА М'ЯСНИХ ПАШТЕТІВ

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Abstract. *The results of technological features, flow lines and modes of sterilization of meat pastes are given. Thanks to the development of a new method of aseptic canning, it became possible to intensify the heat treatment of the product and, as a result, to reduce its harmful effect on the quality of the canned products. Also, the method of sterilization of products in the stream is gaining wide demand. When producing canned goods from products with a uniform structure, it is possible to apply heat treatment of the product in the flow as it moves through the product pipeline. The technological process of sterilization takes place in accordance with general physical, chemical and physico-chemical laws. There is a well-known technology of processing food products with high pressure, which contributes to the successful suppression of the vital activity of vegetative cells of microorganisms, but it is less effective in inactivating bacterial spores and enzymes. In addition, this technology allows processing only small volumes of the product, and its implementation requires expensive installations. Domestic authors proposed a technology for the sterilization of liquid food products, according to which the product is passed between the electrodes of the sterilizer with simultaneous exposure to electric current with alternating pulse polarity. The technology provides electroplasmolysis of cell cultures, removal of products of electrochemical decomposition and preservation of nutritious components of the product.*

Key words: *technology, sterilization, meat, pate, heat treatment, food products.*

The line for the production of pate begins with a complex of equipment for the preparation of meat raw materials, consisting of a defrosting chamber, a table for deboning turkey meat and a capacity for collecting sintered meat. Next is a complex of equipment for grinding raw meat, consisting of a meat grinder. The main one is a set of equipment for mixing and salting meat raw materials, consisting of a mixer, a cutter and a brine mixing unit. One of the most important is the complex of equipment for packing and rolling cans, which includes dispensers, a packing machine, a weighing device and a rolling machine. Next is a complex of equipment for sterilization of canned goods, consisting of a stacker and vertical sterilizers.

The complex is completed by the finishing equipment of the line, which includes a sorting table, a labeling machine, a machine for lubricating cans with vaseline and a packing table. Meat raw materials that arrive in a frozen state are thawed under certain conditions and sent to conveyor 1 for deboning and sinewing. Here the separation of muscle, connective and adipose tissue from the bones occurs, as well as the separation of cartilage, fat, tendons, bones and blood vessels.

Tenderloin meat enters the meat grinder 2, where it is chopped into separate pieces. On tray 3, pieces of meat are sent to the meat dispenser 4, and with the help of salt and pepper dispensers 5 and fat 6, the appropriate ingredients are added in certain proportions. After their control weighing on scales 7, cans filled with all components are fed into a vacuum rolling machine 8, in which the rolling operation is carried out in a vacuum chamber at a vacuum of 58...66 kPa.

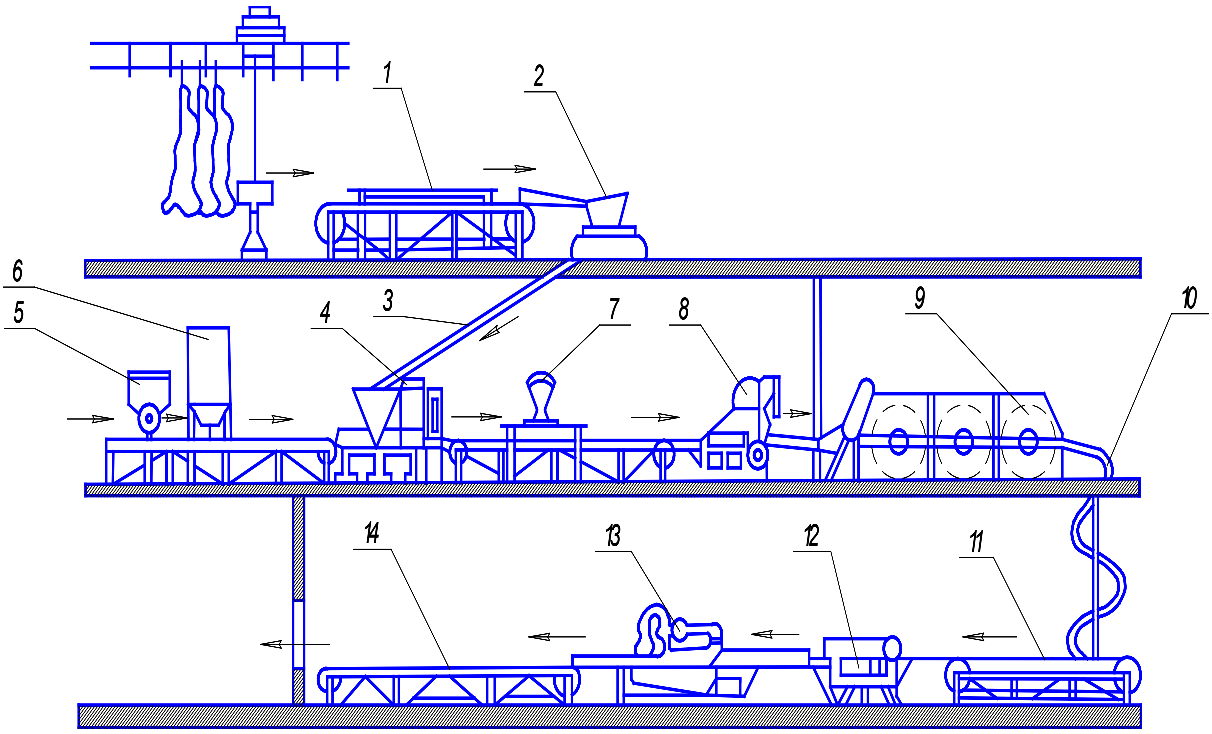

Fig. 1. Hardware - technological scheme for the production of pate from poultry meat

After rolling, the cans are sent to the autoclave 9, where the cans are sterilized under a pressure that exceeds the pressure of saturated steam at a sterilization temperature of 115 °C. With the help of a tray 10, canned goods that have undergone heat treatment are delivered to the sorting table 11 to detect defects and leaks in cans. After cooling, paper labels are pasted on the cans using a labeling machine 12.

Cans intended for further storage, to avoid corrosion, are covered with anti-corrosion grease (technical vaseline) on the machine 13 for lubricating cans and sent to the conveyor table 14. Cans sent directly to sales are not covered with grease.

Depending on the sterilization temperature, the pressure that occurs in the can during heating, and the type of container, canned goods are sterilized either in open devices at atmospheric pressure or in closed devices using excess pressure. To carry out the sterilization process in autoclaves, saturated water vapor and heated water are usually used as a heat carrier, and in pasteurizers and sterilizers of continuous action, water vapor, heated water and high-temperature organic substances (glycerol, ethylene glycol, etc.) are used [10]. The main disadvantages of this method include: significant duration of heat treatment, measured in tens of minutes, and it is different for cans of different sizes; impossibility of sterilizing canned goods in large containers (for example, in cans of 10 liters or more); the periodicity of processing (for autoclaves), which complicates the creation of flow-through automated lines for the production of canned goods; deterioration of the quality of canned goods due to the need to expose the product long heat treatment; inhomogeneity of heat treatment, due to which the outer layers of the product are greatly overheated compared to the inner ones, which leads to a deterioration in the quality of canned goods.

Also known [13] is the "hot filling" method, which is used in the production of some canned goods (mainly of a homogeneous consistency) in large containers (3 liters or more) mainly for the needs of public catering. The method is very simple to implement, but has a number of significant drawbacks. It can practically be used only for products of a homogeneous consistency (natural juices, juices with pulp, tomato products, etc.), packaged in containers with a capacity of more than 3 liters, although there is some information in the literature about the use of this method for heterogeneous products . In addition, for metal containers, the high temperature of packaging the product leads to the occurrence of vacuum deformation of the can body after cooling and the lack of products, and for glass containers, the high temperature threatens the container with thermal damage.

Recently, aseptic canning has become widely in demand. This method [1,3, 11] is based on a new principle of heat sterilization of food products. Thanks to the development of a new method of aseptic canning, it became possible to intensify the heat treatment of the product and, as a result, reduce its harmful effect on the quality of the products being canned. However, although the aseptic method of canning is one of the promising methods, it has not yet gained widespread use in the practice of canning production for various reasons, one of which is the technical difficulty of creating aseptic conditions when packing and sealing the product in a container, as well as the fact that this the method can be used for canned goods of homogeneous consistency.

Also, the method of sterilization of products in the flow is gaining wide demand. In the production of canned goods from products with a homogeneous structure, it is possible to apply heat treatment of the product in the flow as it moves through the product line [7]. Products are heated in various types of heat exchangers (tubular, plate with rotators, etc.). Such heat treatment can be used practically for canned goods of a homogeneous consistency and, moreover, is associated with packaging complications that do not exclude secondary contamination of the product with microflora.

The technological process of sterilization takes place in accordance with general physical, chemical and physicochemical laws. The application of these laws to one or another process allows to create a theory of this process and methods of designing devices for its implementation. The law of conservation of mass in the science of processes and devices takes the form of a material balance: the amount of materials entering the device must be equal to the number of final products obtained as a result of the process. The energy balance is based on the law of conservation of energy: the amount of energy introduced into the process (energy input) is equal to the amount of energy released (output). This refers to thermal, mechanical, electrical and other types of energy. Most often, in practice, they make an energy balance. The heat balance equation usually determines the amount of heat that must be introduced into the process for its implementation. During various technological operations, the main role belongs to transfer processes. In a thermal process, the object of transfer is thermal energy. The efficiency of energy transfer in this process depends on speed.

The speed of the process is the amount of heat transferred in the apparatus through a unit of area per unit of time. The most common heat carrier in food production is water vapor. Its positive property is the practical constancy of heat content with variable pressure. This property of water vapor makes it possible to repeatedly and optimally use its energy in a series of devices with gradually decreasing pressure[2].

Improving the process of thermal sterilization of canned foods is an urgent task of obtaining products of high nutritional and biological value with scientifically based heat treatment regimes [5]. Sterilization of canned foods according to scientifically based regimes is the basis of ensuring high sanitary and hygienic indicators of their quality. Thermal preservation regimes should guarantee the death of pathogenic and toxicogenic microorganisms and microflora, which causes spoilage of products [11].

For any heat exchange device, the indicator of the intensity of the heat process is the value of the heat transfer coefficient, which is determined by the known ratio (for the sterilization device):

$$K = \frac{1}{\frac{1}{a_1} + \frac{\delta_1}{\lambda_1} + \frac{\delta_2}{\lambda_2} + \frac{1}{a_2}}, \qquad (1.1)$$

where a_1 coefficient of heat transfer from the heating medium to the surface of the jar, W/m2·degrees;

δ_1 – thickness of the can wall, m;

δ_2– the thickness of the product or the inner radius of a can for canned goods of a thick consistency in a cylindrical container, m;

λ_1, λ_2– coefficients of thermal conductivity of the material of the can wall and the product, respectively, W/m·degree;

a_2– coefficient of heat transfer from the wall to the product, W/m2·degree.

In the process of sterilization of canned food $\frac{\delta_1}{a_1}$ i $\frac{\delta_2}{a_2}$ can be considered constant, therefore the value of the heat transfer coefficient "K" mainly depends directly proportionally on the values a_1 and a_2. It is known from the literature [12] that the coefficients a1 and a2 are determined by the hydrodynamic regime that occurs near the can wall, i.e., the Reynolds criterion

$$R_e = \frac{V \cdot d \cdot \rho}{\mu}, \qquad (1.2)$$

In addition, it is known that a1 and a2 have the largest values in the turbulent regime. Therefore, a change in the specified values is associated with a change in the value of the speed "V". A change in the flow rate near the heat exchange surface during sterilization of canned goods is achieved by rotation or vibration of the container.

For the first time (1935-36) on increasing the coefficient of heat transfer from rotating tubes of different diameters (d = 8…50мм) into the air during free convection reported [1,9]. The heat transfer from single tubes located parallel to the axis of rotation at a distance was investigated R = 160 i 330 мм, as well as from tubes rotating around their axis during free convection. As a result of these studies [13], the formula was proposed:

$$N_u = 0{,}31 R_м^{0,6} \left(\frac{d}{R} \right)^{0,1}, \quad (1.3)$$

where d– diameter of the tube;

R– turning radius;

Nu– Nusselt's criterion.

A study on determining the influence of vibration on heat transfer by convection was conducted [6]. He used wires through which electric current was passed as heating elements. The wires heated the air. Lemlich's study of the heat exchange process established that the heat transfer coefficient can be increased by almost 4 times with the help of vibration. He established the dependence of heat transfer on the mode of vibration:

$$\frac{a}{a_1} = 0{,}75 + 0{,}0031 \frac{R_e^{0,25} (\beta \cdot \Delta t)}{G_R^{0,41}}, \quad (1.4)$$

where a_1– heat transfer coefficient without vibration;

G_r– Grashoff's criterion;

β– coefficient of linear expansion;

Δt – temperature difference.

The author of [5] investigated the process of heat exchange of a vibrating cylinder with d = 20 mm in a forced gas flow, and established that in this way the heat transfer coefficient can be increased almost 6 times. Buznyk received this dependence in the following form:

$$N_n = 0{,}0436 R_e^{0,815}, \quad (1.5)$$

The issue of intensification of technological processes with the help of vibration was first investigated [8] in 1952 at the Kyiv Technological Institute of the Food Industry, and the influence of vibrations on the intensification of the heat exchange process during the sterilization of milk cans was investigated, where a criterion dependence was established between the coefficient of heat transfer from the wall to the product and the quadratic speed vibrations for canned milk with different thermophysical properties:

$$N_n = 0{,}026 P_c^{0,815} \cdot P_ч^{-0,3}, \quad (1.6)$$

де P_c– the Péclet criterion;

$Pч$– Prandtl criterion.

The researcher [3] established the efficiency of heat treatment when the can is rotated both around its axis and when rotated from the bottom to the lid for the same product under the same conditions. At the same time, one cannot talk about the advantage of one type of rotation of the can without taking into account technological requirements for finished products.

It is proposed to use a five-channel rotary carrier in continuous-acting devices. As a result of the study of the cooling process of tomato paste in can No. 14, it was established that during rotation, uniform cooling is obtained, the temperature difference in the center of the product for different cans is 1...1.5 °C[9].

It is noted that with reverse rotation, the duration of sterilization of canned meat is reduced by 25-40%, and at the same time, the quality of products improves[4].

According to the new method, the influence of the rotation of the can on the heating of its contents was studied. This technique is as follows: the sterilizing effect is determined for one arbitrarily chosen reference mode, according to which the studied products are sterilized, and by comparing the obtained values of A-effects, the efficiency of rotation for a given type of product is judged [1,7].

Also, there is a known technology [34] of processing food products with high pressure, which contributes to the successful suppression of the vital activity of vegetative cells of microorganisms, but it is less effective in inactivating bacterial spores and enzymes. In addition, this technology allows processing only small volumes of the product, and its implementation requires expensive installations.

Effects capable of destroying microflora also include ionizing radiation [1,6], which have high energy and are able to cause ionization of electrically neutral atoms and molecules and stimulate the same type of chemical reactions in irradiated materials. In practice, two types of ionizing radiation are used - X-rays and γ-rays.

Ultraviolet radiation is also used to suppress the vital activity of microorganisms, because due to their high energy, they create a significant chemical (at a wavelength of 400-330 nm) and biological (at a wavelength of 330-200 nm) effect. The region of ultraviolet rays with a wavelength from 295 to 200 nm is called bactericidal, since the rays of this region have the greatest effect on viable cells of microorganisms. Ultraviolet rays are used to sterilize containers and liquid food products, provided they are processed in a thin layer [2].

Microorganisms in food products are also affected by infrared radiation. For this purpose, the flow of liquid and homogeneous food products is processed in pasteurizers equipped with infrared emitters [2,3].

Effects capable of destroying microflora also include the processing of food products with electric discharges [9] and electric alternating current of high and ultra-high frequencies.

Domestic authors proposed a technology for the sterilization of liquid food products, according to which the product is passed between the electrodes of the sterilizer with simultaneous exposure to electric current with alternating pulse polarity. The technology provides electroplasmolysis of cell cultures, removal of products of electrochemical decomposition and preservation of nutritious components of the product.

Ultra high frequency heating is also effective. The electromagnetic field of the microwave range penetrates to a considerable depth into the processed material and thereby creates a power distribution of heat sources. Microwave heating is practically gradient-free and allows obtaining very high rates of temperature increase, which are limited by uneven heating due to the complex composition and properties of the processed products. Research conducted by domestic authors on the impact of a pulsed microwave field on the viability of microorganisms showed that in experimental samples, with a total pulse exposure for 0.8-1.0 seconds and slight thermal heating, the content of microorganisms decreases: at a temperature of 20-22 °C - by 20 %, at 28-33 °C–by 70%, at 42-44 °C the development of microorganisms was not observed. It should be noted that the application of HF and HF processes in practice for preserving food products is limited by the complexity of the equipment, high financial costs for conducting the process, and difficulties in controlling the temperature regime in the container with the product.

Conclusions.

Improving the process of thermal sterilization of canned goods is an urgent task of obtaining products of high nutritional and biological value with scientifically based heat treatment regimes.

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Анотація. *Наведені результати особливостей технологічних особливостей, потокових ліній та режимів стерилізації мясних паштетів. Завдяки розробці нового методу асептичного консервування, з'явилася можливість інтенсифікувати теплову обробку продукту і, в результаті, зменшити її шкідливий вплив на якість продукції що консервується. Також, широкого попиту набуває спосіб стерилізації продуктів у потоці. При виробленні консервів з продуктів, що мають однорідну структуру, можливе застосування теплової обробки продукту в потоці по мірі руху його в продуктопроводіТехнологічний процес стерилізації відбувається відповідно до загальних фізичних, хімічних та фізико-хімічних законів. Відома технологія]обробки харчових продуктів високим тиском, що сприяє успішному придушенні життєдіяльності вегетативних клітин мікроорганізмів, але вона менш ефективна в інактивації спор бактерій і ферментів.Крім того, ця технологія дозволяє обробляти тільки невеликі обсяги продукту, а для її здійснення потрібні дорогі установки. Вітчизняними авторами запропонована технологія стерилізації рідких харчових продуктів, згідно з якою продукт пропускають між електродами стерилізатора з одночасним впливом електричного струму із чергуванням полярності імпульсів. Технологія забезпечує електроплазмоліз клітинних культур, видалення продуктів електрохімічного розкладу і збереження живильних компонентів продукту.*

Ключові слова: *технологія, стерилізація, м'ясо, паштет, теплова обробка, харчові продукти.*