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DEVICES FOR THE DRYING PROCESS OF TOMATO PRODUCTS

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Abstract: This article tomato products drying process main methods and devices about in detail information gives. In the article tomatoes drying different kind methods, including natural drying, heat and vacuum drying technologies such as analysis Also, tomatoes drying in the process applicable modern devices and their efficiency about information The article is about tomatoes. drying process optimization, its quality increase and product far term storage for the most good technologies when choosing help gives.

Keywords: tomato products, drying methods, natural drying, heat with drying, vacuum drying, device efficiency, product storage, technological processes, village farm technologies.

Introduction. The experience of countries around the world in developing a complex network of agricultural products processing shows that the marketing system plays an important role in developing optimal solutions for the storage and processing of fruits and vegetables, as well as energy-efficient designs of equipment. Fruits and vegetables are structurally perishable products. Therefore, guaranteed plans to ensure the timely sale of fruits and vegetables grown by the private and public sectors specializing in fruit and vegetable growing have not been fully developed. In this regard, one of the main problems facing production enterprises for the processing of agricultural products is the introduction of effective technologies aimed at increasing the shelf life of these products. This requires, first of all, research into technologies for the initial dehydration and drying of products, the composition of which consists of 80 ÷ 95% water molecules.

Over the past 15-20 years, leading scientists from abroad and our Republic have conducted scientific research on dehydration and drying of various products, and many technologies have been applied in production. However, the issues of optimal designs of drying technologies in terms of product types, structural structure, and ensuring product safety in the processing system have not been fully resolved.

Extensive scientific research has been carried out by foreign and domestic scientists on the development of theoretical foundations of drying technology using methods of influencing the heat flow generated by alternative and artificial energy sources on the raw materials being dried,

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and the application of drying devices operating on alternative and artificial energy sources.
Research on tomato drying techniques and technologies, and the study of the kinetic laws of the drying process, has been carried out by scientists from Italy (B. Zanoni), Singapore (MNA Hawlader), New Zealand (RK Toor), Greece (MK Krokida), the United States of America (G. Latapi, DM Barrett), Turkey (K. Sacilik), and Spain (A. Heredia).
It is known that fruits and vegetables grown in agriculture differ from each other in terms of chemical composition and structural structure. The changes in the biologically active substances contained in these products during the technological process depend on the drying options and drying methods used. In this regard, theoretical and experimental research on the effect of each drying method on the composition of fruits and vegetables will create a basis for the creation of effective drying technologies.
The IR-drying device proposed by the authors [57; pp. 230–233, 58; pp. 42–49] used IR-lamps with a tungsten spiral, the internal volume of which was filled with gas. The IR-lamps were placed in the device in such a way that only the heat generated by the radiant energy reflected from the reflector was used on the surface of the product being dried. In this case, the limiting values of the heat flux density of the radiant energy falling on the surface of the product were in the range of 2 ÷ 2.5 kW/m^{2}, which led to an increase in temperature and partial burning of the surface of the product.
The laws of influence of IR-ray field on drying intensity based on the method of convective energy supply to tomato fruit slices of appropriate size have been studied by a number of scientists. As objective functions of factors influencing the drying process of tomato fruit, the following quantities were taken: initial moisture content of tomato fruit W_b, kg/kg; thickness of tomato slice δ_b, mm; heat flux density falling on one side of the surface of tomato slice E_q, kW/m^2; temperature K and drying agent velocity ϑ m/c.
Research conducted by leading scientists on the theoretical foundations and kinetic laws of the drying process of agricultural products with a high moisture content shows that insufficient research has been conducted on the development of low-temperature drying methods, energy-saving technologies and devices aimed at preserving the natural properties of dried products and increasing the level of recyclability under the influence of liquids.

It is known that one of the effective technologies for increasing the nutritional value of plant raw materials and preserving their biologically active substances in production sectors is the drying process. The introduction of effective drying technology into production creates the basis for obtaining high-quality finished products and saving energy, including:
- 2 ÷ 2.3 times less energy is consumed in the drying process than in the storage of fresh fruits and vegetables in cold storage [60; pp. 138–143];
- the drying process is considered a waste-free technology, allowing not only the production of dried products, but also the use of substances released as condensate of evaporated moisture during the process in the food and cosmetics industry;
- Dried products are very small in mass and volume, which means low transportation costs and long-term storage;
- preservation of the taste, color, smell, and content of vitamins and other biologically active substances of the product.

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The requirements for drying methods and designs for the production of quality dried products are as follows:
- ensuring an optimal mass fraction of moisture in dried fruits, vegetables and spices to prevent mold and ensure the safety of the finished product;
- selection of drying method and design based on product type and structure;
- minimum energy consumption to remove 1 kg of moisture from the product;
- uniformity of residual moisture throughout the entire volume of the finished dried product;
- organization of a system of periodic and continuous drying of agricultural products.

In order to develop an energy-efficient technology, theoretical foundations and mathematical modeling of low-temperature drying of tomato fruits with a high moisture content, in accordance with the above requirements, heat transfer methods, processing stages, limit values of influencing parameters, and designs of drying devices used were analyzed.

Depending on the shape, size, and structural structure of raw materials in the food and chemical industries, there are devices of various designs for organizing a drying system, including: by the organization of the technological process - periodic, continuous; by the state of the layer of the product being dried - dense, stationary, boiling, etc.; by the type of heating agent - air, gas, steam, flue gases; by the method of heat transfer - convective, conductive, radiation, dielectric; by the pressure created in the drying chamber - atmospheric, vacuum, and sublimation drying methods.

One of the drying methods that allows preserving biologically active substances in agricultural products is sublimation drying - lyophilization. The sublimation drying method is the instantaneous freezing of moisture in various raw materials, dehydration by converting moisture in the ice aggregate state into steam (jumping from the liquid aggregate state) under vacuum. The principle scheme of the sublimation drying equipment consists of a system with a vacuum created in a closed cycle, consisting of a drying chamber (sublimator), a condenser and a vacuum pump (Figure 1).

Figure 1. Principle diagram of a freeze- drying equipment

In sublimation drying, the temperature of the trays on which the product is placed is increased from – 40 ^{0} C to + 20 ^{0} C in order to increase the partial pressure difference and increase the movement of liquid droplets in the product. When the product reaches a temperature above the freezing (eutectic) point, the secondary drying cycle begins. To remove the remaining moisture in the product, the pressure in the chamber is reduced to 1 mbar, in some cases to 10 $^{-3}$ mbar, depending on the structure of the product. At the same time, the temperature of the trays on which the product is placed increases and reaches its maximum value. At the end of the sublimation drying cycle, the pressure in the chamber equals atmospheric pressure. In this case, 2.5 ÷ 3.2% moisture remains in the product (Figure 2).

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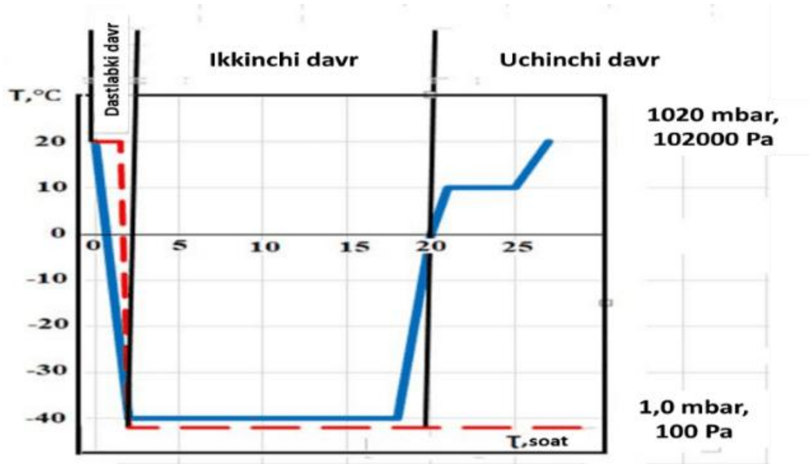

Figure 2. Kinetics of the sublimation drying process by cycles

As can be seen from Figure 2, freeze-drying consists of 3 cycles, in the first cycle the product is frozen from + 20 ^{0}C to - 37 ÷ 40 ^{0}C for 2 hours. In the first stage of the second cycle, freezing is also carried out for 16 hours, and by the end of the cycle it is brought to ^{0}C. In the third cycle, the temperature of the product is gradually increased to 25 ^{0}C, and the moisture content of the product is brought to 2.5 ÷ 3.2% (curve 1). Also, in the first cycle of the drying process, the temperature in the drying chamber also changes proportionally. However, in the remaining cycles, it differs sharply from the product temperature (curve 2). During the first and last minutes of the freeze-drying cycles, the pressure is 1.0 ÷ 1020 mbar.

Another principle of sublimation drying is that if heat is not applied to the product, the heat required to remove the moisture contained in it is released from the product itself. As a result, the product initially cools, and then the free moisture in it freezes, establishing an equilibrium between the vapor pressure on the surface where the moisture is evaporating and the pressure in the volume where the vacuum is created.

Although the preservation of biologically active substances in the product during sublimation drying is an advantage of this method, it is not without a number of disadvantages. The transition of moisture in the product to the vapor phase is very slow, and the drying time of the product is 18 ÷ 20 hours. Also, the complexity of the device, high capital and energy costs

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