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Energy-Saving Method of Drying Products

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ABSTRACT: Modern drying methods are characterized by a significant intensification of heat and mass transfer processes, achieved in various ways: by increasing the contact surface between the dried product and the drying agent; a decrease in the relative humidity of the drying agent; increasing the relative velocity of the reaction phases; using combined energy supply, combining dehydration with various technological processes: freezing, blasting, dispersing, foaming, etc. The choice of drying method depends on the biochemical, physical, structural and mechanical properties of the raw material, its state during dehydration (whole fruits, cut into slices, liquid products), as well as the properties of the final product that it is desirable to obtain, and the efficiency of the process.

KEY WORDS: drying, infrared heating, heat and mass transfer.

I.INTRODUCTION

Using the energy of the electromagnetic field of the infrared range in the drying, heating and heat treatment processes can significantly intensify the internal and external heat and mass transfer in capillary-porous materials [1-2].

The penetration of radiation deep into the material determines the intensification of the processes of mass transfer and phase transformations, has an effect on the structure of the material.

The processing method in the electromagnetic field of the IR range, which is one of the promising physical methods of processing products, is increasingly used in various sectors of the food industry, in particular, in the processing of fruit and vegetable raw materials. IR processing is successfully used for drying fruits and vegetables. The presence of a bactericidal effect, established during microbiological studies of the effect of IR treatment on the tested objects of some cultures, makes it possible to use the IR method for preserving plant materials. It was found that the quality of the final product increases.

Studies carried out during the heat treatment of whole fruits and vegetables in order to obtain new culinary products have shown that, due to the use of high-density infrared radiation, the duration of their preparation is reduced by 24-42% compared to traditional ones. IR energy supply contributes to better preservation of vitamins and minerals, which is the result of a reduction in the duration of heat treatment and improved organoleptic characteristics of the finished product.

Significant advantages of drying fruits and vegetables with IR rays - the simplicity of the design of plants and the high quality of products - lead to the fact that this method is used not only in countries with a temperate, but also with a hot climate.

The best option for drying fruits with IR radiation is a variable irradiation mode, in which the first stage of drying is carried out with strong, and the last with weak exposure. Experimental studies show that the native properties of the products are better preserved under the harsh irradiation regime, which reduces the drying time.

From technological and biochemical evaluations of products dried by infrared rays, it follows that the loss of organic acids and total sugars does not exceed losses under high vacuum (40 kPa) in the radiation drying method, and the appearance of the products improves.
Preliminary calculations show that using infrared heating reduces the cost of 1 kg of dried product by 2 times compared with convective drying.

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Infrared-convective method of drying products in a foamed state. The Bukhara Engineering Institute investigated the drying process of fruit and vegetable pastes by the infrared-convective method. This method includes the following stages: heating the product, introducing a stabilizer, whipping into foam, drying. Drying was carried out to a moisture content of 2-5%, first blowing the foam with air moving at a speed of 4 m / s and heated to 60 °C for 55-65 s, which forms craters and brings the temperature of the product to 60 °C, and then the infrared convective method by periodically exposing the product to the flow of infrared rays and curing the product when blowing air. During drying, the temperature of the foam did not exceed 75 °C.

The intensification of the process of moisture transfer from the lower layers to the upper and uniform heating of the material over the entire thickness occurs due to the formation of craters in the foam layer, which can significantly increase the contact surface of the product with the coolant, as well as due to the air in the pores and facilitating the penetration of rays. The final product has good color and quality indicators.

Vacuum drying has several advantages over atmospheric drying. Firstly, the drying time is shorter and it takes place at a low temperature; however, the color, taste and content of valuable nutrients vary slightly. Secondly, drying proceeds without supplying atmospheric air, therefore, the initial air temperature and its humidity do not affect the drying and the consumption of thermal energy decreases, since air heating is not required.

Based on the above characteristics of IR and vacuum drying methods, it was decided to use the specified combined IR vacuum method to produce fruit and vegetable powder.
When drying tomato paste with an initial humidity of 85%, a layer thickness of 2 mm, a vacuum value of 29.4 kPa, a radiant flux density of 1.5 kW / m2 and a distance from the layer surface to a lamp of 150 mm, the product was dried to a moisture content of 5% in 6 minutes, and the product with a layer thickness of 4 mm with the same process parameters is dried to a final moisture content of 7.9%. With a decrease in the vacuum, a sharp increase in the temperature of the material is observed, which leads to a deterioration in the quality of the final product. With an increase in the distance from the surface of the material layer to the IR emitter to 200 mm, the drying time increases.

II. MATERIALS AND METHODS

Drying using infrared radiation and acoustic waves.Using non-traditional, combined methods of energy supply, including infrared radiation and acoustic energy, when drying fruits and vegetables allows you to get high-quality products.

In this regard, the theoretical and experimental substantiation of the appropriateness of the application of new methods of energy supply, as well as the identification of patterns of moisture and heat transfer through the layers of the studied objects, is of particular relevance.

The feasibility of using promising methods of energy supply in the form of infrared radiation and acoustic waves is due to the high efficiency of drying products. From this point of view, on the basis of the conducted experimental and theoretical studies, the optimal values of heat fluxes and acoustic waves during the processing of fruits and vegetables are determined. The optimal drying mode contributes to a significant intensification of the drying process.

The use of promising physical methods of energy supply during drying provides the opportunity to obtain the following results:
- reducing the drying time, reducing energy costs per unit of finished product by increasing the efficiency of the drying process;
- improving the quality of dried products, the preservation of their valuable components by reducing the temperature of the process.

It should be noted that for carrying out the drying process by the combined method of energy supply, it is necessary to ensure uniform distribution of the energy flow over the surface of the processed products. Proceeding from this, the geometry of the arrangement of IR and acoustic emitters in the drying unit is theoretically justified (the height of the emitters relative to the product, the steps between the emitters, the distance from the reflectors to the surface of the

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product).

An analysis of the calculation results indicates that when the infrared emitters are arranged with the same pitch, the distribution of the radiant flux over the surface of the processed material is not uniform. At the edges of the conveyor, the density of the incident flux is 2.0–2.8 kW / m2, and in the center - about 7.0–7.5 kW / m2.

This indicates that with such radiant flux distributions, during pre-treatment and drying, uneven moisture is removed from the entire surface of the products, as a result of which the process duration is extended, which affects the quality of the dried product.

The capacitor plates have opposite charges, therefore, the electrons and ions move inside the material to one or another plate. When the charge on the plates changes, they move in opposite directions, as a result of which friction inevitably occurs with the release of heat. Dipoles in an alternating electric field will oscillate either in one or in the other direction, trying to occupy a position relative to an alternating field. As a result of such vibrations of asymmetric dipoles, molecular friction also occurs with heat evolution. In polar molecules, consisting of elastic dipoles, in addition to changing the orientation of the molecules, displacements of some parts of the molecule from others are also possible. The resulting effect of deformation is also accompanied by heat generation due to friction. Thus, the energy of electromagnetic waves spent on overcoming these frictions will turn into heat.

If the product is placed in an electric alternating field of ultrahigh frequency, then the electrical energy is absorbed by the structural elements of the product - molecules, electrons, ions, which acquire vibrational motion, which is converted due to internal friction of particles in a viscous medium into heat. Thus, the application of microwave currents is one of the special options for heat treatment of food products. The specificity of this option is that, since the electric energy is absorbed by the entire volume of the product, the product heats up quickly and not from the periphery to the center, as with conventional methods of heat transfer, but also uniformly throughout the volume. We can say that if the usual method of heating canned food requires tens of minutes, then heating in the microwave field occurs within tens of seconds, about 3-6 minutes.

The electromagnetic wavelengths in the centimeter range in the microwave field are small (for example, for a frequency of 2375 MHz the wavelength is 12.6 cm), therefore the use of microwave fields is sometimes called the application of microwave energy.

The most effective application of high-frequency heating when drying piece and lump materials. Under the influence of an electric field with a frequency of the order of 106-107 Hz, the vibrational motion of the molecules intensifies, which leads to the release of heat and uniform heating of the material throughout its thickness. The surrounding air absorbs this heat and cools the surface of the piece. In this case, a temperature gradient arises, directed from the center of the piece to its surface and coinciding in direction with the humidity gradient, i.e. the phenomenon of thermal moisture conduction in this case increases the drying rate.

In addition, the vapor generated inside the piece pushes the liquid through the capillaries to the surface. The liquid also moves to the surface under the influence of an electric field (electroosmosis).

Under the influence of an alternating electric field of high frequency, a controlled heating of the material occurs. Due to the evaporation of moisture, heat and mass transfer with the environment, the surface layers of the material are more dehydrated and give off more heat than with the conductive drying method. In this regard, the temperature and humidity inside the material is higher than outside. Gradients of moisture content and temperature arise, under the influence of which moisture moves from the inside to the surface.

When drying by currents of high and ultrahigh frequencies, evaporation occurs throughout the body and a pressure gradient appears inside the particle, accelerating the transfer of moisture. By changing the field strength, it is possible to smoothly control the temperature of the material during drying.

The lower the permittivity, the deeper the material penetrates the electromagnetic oscillations of the microwave currents.

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The advantages of drying with currents of high and ultra-high frequencies are the ability to control and maintain a certain temperature of the material and significantly intensify the dehydration process, improve the quality of dried products.

To confirm the feasibility of using microwave heating as a drying method and to reduce the degree of contamination by microorganisms, experimental and production data obtained in various regions of Uzbekistan and abroad, at production enterprises and educational institutions can be cited.

One of the relevant drying methods in the processing of plant materials is the microwave method, which ensures the highest degree of preservation of biologically active properties in the resulting product, and also preserves its vitamin composition, taste and aroma, while ensuring high technical and economic indicators by reducing energy costs . To obtain dried fruit and berry products, in which all the valuable components of the feedstock and its native properties are maximally preserved, drying technology and its parameters are important. Promising drying in an electromagnetic field of microwave frequencies, which allows you to heat the material throughout the volume and is characterized by high heating speed, short duration and energy consumption.

An analysis of the results of drying sea buckthorn in the microwave electromagnetic field shows a significant decrease in the level of microflora of the fruits. When drying the fruits of sea buckthorn, vitamins of the feedstock are preserved as much as possible.

The action of the high-frequency and microwave fields on the drying object allows not only to improve the quality of the finished product, but also, most importantly, to obtain products that are environmentally safe. Mushrooms of the genus Fusarium are considered to be difficult to eradicate, which is explained by their undemanding to environmental conditions, the ability to utilize various substrates due to the powerful enzymatic apparatus. The influence of the microwave electromagnetic field on Fusarium infection is effective and can be considered one of the ways to reduce the level of food contamination with Fusariotoxins. When products are heated from 60 ° C, the infection is reduced to zero.

III. CONCLUSION

Thus, the use of ultra-high frequency electromagnetic fields opens up new possibilities for creating environmentally friendly technological processes for the production, processing and storage of food and processing industries.

REFERENCES

[1]. Safarov J.E., Parpiev Z.T., Jumaev B.M. Drying carrots while preserving biologically active substances. Scientific conference of young scientists "Actual problems of the chemistry of natural compounds." Tashkent, 2015.
[2]. Norkulova K.T., Iskandarov Z.S., Safarov J.E., Jumaev B.M. Ways to develop innovative technologies for bulk processing of agricultural products. International Symposium "Microorganisms and the Biosphere" Microbios-2015. Tashkent. November 25-27. S.267-268.