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Improvement Process Drying Product

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Abstract: Currently, agriculture, food production and ensuring its safety are more relevant than ever on a global scale. At the same time, the processing of agricultural products has been and remains a decisive factor affecting the efficiency of agricultural production. Being one of the most important sectors of the agricultural sector of Uzbekistan, the production of dried fruits and vegetables, the level of development of which largely determines the solution to the country's food problem, should be based on the desire to reduce the cost of dried fruit production. By analyzing the achievement of a high effect of the use of infrared radiation, the study of the heating temperature of the emitter is substantiated. The mechanism of the emitted energy of the IR spectrum, the magnitude of its duration and density are described. The cyclical nature of energy transformations, ensuring the maximum efficiency of the process, the effect, including sterilizing when drying fruits (figs and apples), is revealed. The experimentally obtained parameters of the heat treatment processes of figs and apples are presented.

Keywords: drying, infrared rays, heat and mass transfer, fruit and vegetable.

I. INTRODUCTION

In connection with the growing demand for dried natural vegetables and fruits, at present, general ideas about the process of drying them have received significant development. Drying as a process of heat and mass transfer is considered in a broad terms of the laws of physico-chemical, chemical, biochemical transformations.

Recent studies have been aimed at improving drying methods that ensure maximum preservation of nutritional value and taste advantages of the product, as well as high process efficiency.

Modern drying methods are characterized by 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 a combined energy supply, combining dehydration with various technological processes: freezing, blasting, dispersing, foaming, etc.

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The choice of drying method depends on the biochemical, physical and structural-mechanical properties of the raw material, its state during dehydration (whole fruits, cut into slices, liquid products), as well as on the properties of the final product that it is desirable to obtain, and the efficiency of the process.

Most food products, including plant objects, are colloidal in nature and capillary-porous in structure, in which moisture is associated with a solid skeleton.

Drying is a typical non-stationary irreversible process in which the moisture content of the material changes both in volume and in time, and the process itself tends to equilibrium.

We have to make a scientifically based choice of a method for drying potatoes, carrots and onions as components of culinary products.

By the method of heat input, the following types of artificial drying are distinguished: convective - by direct contact of the product with a drying agent, most often air; contact - heat transfer from the coolant to the product through the wall separating them; radiation - heat transfer by infrared rays; dielectric - currents of high and ultrahigh frequency; vacuum and its variety - sublimation.

At present, drying with mixed heat input (combined drying) is widely used. Various options for combining coolants, the possibility of their simultaneous application and application in a certain order are considered [1].

Such special modifications of drying and drying of particles of small sizes as fluidization, vibration, and aero-fountain are further developed. In Uzbekistan, drying of fruits and grapes is widely used in plants with solar energy accumulators [2].

The most common drying methods used in industrial enterprises and recommended for implementation in modern small enterprises by research and educational organizations and institutions.

Drying with infrared rays, its varieties and possible variants of combining coolants. The use of infrared rays for drying materials can significantly intensify the processes due to an increase in the heat flux density on the surface of the material and the properties of short-wave infrared rays to penetrate to a certain depth in the material [3].

Infrared rays include rays with a wavelength of 0.77 to 340 microns. Practical application, in particular for drying, has radiation with a wavelength of 0.77 to 5-6 microns [4].

When IR irradiation in a thick material creates significant (compared with conventional convective drying) temperature differences. In this case, the moisture flow transfers a certain amount of heat into the interior of the material, which also accelerates the internal heat transfer. To intensify thermal radiation drying, it is necessary that the infrared rays penetrate the material to the greatest possible depth. This depends both on the throughput of the material and on the wavelength of the infrared rays.

The smaller it is, the higher the penetrating power of infrared rays. The permeability of edible plant materials increases with decreasing layer thickness and with decreasing moisture content of the material [5-6].

The conversion of radiant energy into thermal energy is due to the optical properties of the product, i.e. its absorption, reflectivity and transmittance. The energy of infrared radiation is converted into heat only if it is absorbed by the irradiated product. For different materials, the degree of absorption and the penetration depth of infrared rays are different. The wavelength in turn depends on the temperature of the IR radiation generator. Thus, the spectral optical properties of the product and the spectral characteristics of the heaters are interconnected and are of paramount importance. With a reasonable choice of the type of emitter and the irradiation mode, infrared radiation penetrates deep into the product, which intensifies the processes of heat and mass transfer [7-8].

II. RESEARCH AND RESULTS PART

Research conditions and description of experimental laboratory facilities. The quality of the dried objects is influenced by preparatory technological operations: the form of slicing and the time of preliminary heat treatment.

In preparation for drying, figs and apples are cut into pieces of various sizes and shapes: columns, mugs, slices, shavings, cubes and plates. The shape and size of the pieces have a great influence on the drying speed, and, consequently, on the performance of the drying unit. With a decrease in the thickness of the slices of the product, the duration of dehydration is reduced and the recovery time of the dried product during cooking is accelerated. If the products are cut into small pieces, surface hardening takes place to a lesser extent.

The intensification of the drying process improves the quality of the dried product and reduces the loss of vitamins and other valuable nutrients. However, the thickness of the piece can be reduced to a certain size (2 mm), since cutting into thinner pieces leads to the formation of a large number of crumbs.

Preference is given to dried fruits, cut into cubes, plates and shavings, since such a product has a large bulk density, mixes evenly in mixtures, is well dosed in soft packaging on machines and has a more attractive appearance.

The content of fines in chopped raw materials should not exceed 5-8%. The increased crumb content worsens the drying conditions and leads to unnecessary losses, since this reduces the yield of the standard dried product and increases the consumption of raw materials.

Uneven cutting in width and thickness, the presence of sticky or incompletely cut particles are also unacceptable, because the correct drying mode is violated, the product is unevenly dehydrated, which requires additional labor for sorting and drying large pieces coming out of the dryer with high humidity. The cut surface should be even, smooth, while the cells of the raw material are destroyed less and the loss of vitamin C is also small.

Currently, among scientists and specialists in the field of drying agricultural products, there are conflicting opinions on the advisability of using pre-heat treatment before drying raw materials.

On the one hand, blanching with steam or hot water is considered to be a prerequisite for preserving color, taste, smell, vitamin activity, accelerating the recovery, mainly, the destruction of oxidative enzymes - oxidases and preventing hydrolysis or oxidation of lipids in order to prevent loss of level product quality during dehydration and especially subsequent storage. On the other hand, numerous studies show that blanching is not particularly necessary.

A negative factor in the heat treatment of fruits before drying is the partial leaching of soluble substances (sugars, minerals, acids, etc.) and the loss of water-soluble vitamins from them.

When blanching sugar, gelatinized starch and gelling pectin substances penetrate into the intercellular space and clog pores, thereby making it difficult to remove moisture during subsequent drying. Also, in the process of preliminary heat treatment, tangible losses of coloring substances are observed, which negatively affects the commercial properties of the finished products. Heat treatment reduces the activity of destructive vitamins, enzymes and preserves the taste, but the loss of vitamins can reach 30%.

Studies show that if pre-treatment with IR heating is used, there is no special need for blanching. Volumetric and deep IR heating in the first stage of drying creates a fairly high temperature (70-80 °C) inside the product particles. Such temperature already gives a blanching effect. As the drying speed decreases, the temperature inside the product and it dries to a characteristic drying crust.

The rationale for the choice of pre-treatment is based on research conducted in the canning and drying industries. Research and development of thermoradiation methods for dehydrating fruits are relevant both from the point of view of improving the quality of dried foods and energy saving in their production.

The technology we developed convective drying with pre-treatment includes processes of convective energy supply at the stage of constant drying speed and infrared energy supply at the stage of decreasing drying speed.

The studies were carried out on a specially designed installation containing IR lamps with a power of 500 W (2 pcs), a thermometer, a barometer, and a vacuum compressor. The research complex allows you to include separately pre-treatment with IR with high power for 90 s, vary the parameters and drying modes.

The determination of the amount of sugars was carried out by high performance liquid chromatography according to GOST 53883-2010, ascorbic acid was determined according to GOST 53693-2009, material moisture and water activity according to GOST 28561-90 in the laboratory of Gosstandart of the Republic of Uzbekistan.

Research Program and Methodology. The objective of the experimental research was to check the theoretical positions, identify a number of physical quantities and values of the coefficients, as well as justify the optimal parameters and operating modes of the proposed dryer.

In accordance with the task, the work was carried out according to the following program:

- study of the influence on the value of the layer resistance of the following factors, the volumetric mass of the layer, the speed and direction of air movement in it, the characteristics of the mass engineer and the parameters of the blown air;

- determination of performance indicators of the technological process.

Moisture content is the ratio of the mass of water to the mass of absolutely dry substance contained in the material.

$$U = 100\frac{M_Б}{M_c}$$

where U - is the moisture content,%; Mв, Mc - mass of water and absolutely dry matter in the material, g.

Humidity is the ratio of the mass of moisture contained in a material to the total mass of the material, i.e.

$$W = 10^2\frac{M_Б}{M} = 10^2\frac{M_Б}{(M_Б + M_c)}$$

where W is the humidity,%; M - mass of material, g.

Moisture content and humidity are interdependent.

$$U = 10^2\frac{W}{(100 - W)};\quad W = 10^2\frac{U}{(1 + U)}$$

The humidity of the object entering the dryer is determined by at least five samples taken periodically for an hour from the conveyor when loading the dryer. Pulp samples in which the particle length exceeds 10 mm are further crushed. At least two pieces of 20 g each are taken from each sample. Humidity is determined by drying the weights in an oven in metal cups for 5 hours at a temperature of (115 ± 2) ° C, then 40 minutes at a temperature of 130 ° C. The moisture content of the pulp W,%, calculated by the formula

$$W = \frac{m_Б - m_c}{m_Б - m_П}$$

where m_v - is the mass of the glass with a sample before drying; m_s - the mass of the glass with a hitch after drying, g; m_p - empty cup weight, g.

Weighing the hinges to determine the moisture content is carried out immediately after sampling the source material.

Determination of material temperature before drying. To measure the temperature of the material, samples are taken in special wooden boxes with a hole in the lid for a thermometer with a capacity of at least 1 dm3 simultaneously with moisture sampling. Measure the temperature with a maximum thermometer for 6-8 minutes, which is moved every 2-3 minutes. In this case, it must be ensured that the mercury ball of the thermometer does not touch the walls of the box. Data is taken at the maximum reading of the thermometer. Measurements are carried out with an accuracy of ± 1 ° C. Calculate the average temperature for the experiment, the maximum deviation. Calculations are carried out to an integer.

Determination of material moisture after drying. The moisture content of the material after drying is determined after a time equal to the exposure of the drying, not less than five samples taken through equal intervals of time during each repetition of the experiment at the outlet of the dryer. Humidity is determined by drying in an oven for 120 minutes at a temperature of 160 ° C. As a result of the processing, the average humidity value, the limiting deviations from the mean value and the standard deviation characterizing the drying non-uniformity are calculated. Calculations are carried out up to a tenth of a percent.

Determination of uneven drying. Unevenness of drying - unevenness of the dried material in moisture.

The drying uniformity for all continuous dryers is determined by time. Moisture samples are taken during operation of the dryer exiting the dryer in accordance with the schemes. Humidity is determined according to GOST 20915. The data is processed to obtain the average humidity value, the maximum deviation from the average and standard deviation. Calculations are carried out up to tenths of a percent.

In each of these sections, the sampling sites should be at points adjacent to the outer and inner cylinders, and approximately in the middle between them. At each point, one sample is taken.

The results are processed to obtain the average, marginal deviations from the mean and standard deviation. Calculations are carried out up to tenths of a percent.

Samples are taken by the area of the heap embankment at nine evenly spaced points and by the height of the embankment at the same points in each layer (in the upper, middle and lower). Humidity is determined by drying to constant weight at a temperature of 105 ° C. Calculations are carried out up to tenths of a percent.

The temperature of the object after drying is determined by mercury thermometers from samples taken at the outlet of the drying device in special boxes.

Determination of uneven heating of the material. The unevenness of heating is characterized by extreme deviations of the temperature of the heating of the material from its average value.

Samples for uneven heating in continuous dryers are taken with a sampler once at the end of the experiment when the dryer is completely stopped from the maximum heating zone specified in the instruction manual. If it is impossible to directly take samples from the maximum heating zone, the main fans are turned off and released from the dryer. After a time equal to the exposure of cooling, samples are taken to heat the outlet every 3-5 minutes (at least six samples).

When processing the data obtained, the unevenness of heating over time is calculated. The coefficient of stability of the drying process to a change in the initial humidity, K_ω is calculated by the formula

$$K_\omega = \frac{\sigma_{\omega_2}}{\sigma_{\omega_1}}$$

where $\sigma_{\omega 1}$ - standard deviation of the moisture content of the material at the inlet to the dryer before drying, %; $\sigma_{\omega 2}$ - standard deviation of material moisture at the outlet of the dryer after drying, %.

III. CONCLUSION

The results analyzing the achievement of a high effect of the use of infrared radiation, the study of the heating temperature of the emitter is substantiated. The mechanism of the emitted energy of the IR spectrum, the magnitude of its duration and density are described. The cyclical nature of energy transformations, ensuring the maximum efficiency of the process, the effect, including sterilizing when drying fruits (figs and apples), is revealed. The experimentally obtained parameters of the heat treatment processes of figs and apples are presented.

The influence of the shape and size of sliced fruits on the drying process, the role of preliminary heat treatment of the dried material on the time of the final drying is experimentally investigated.

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