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MATHEMATICAL AND SOFTWARE TOOLS FOR OPTIMIZING THE GRAPE DRYING PROCESS

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Abstract

One of the current scientific and practical work is the introduction of digital management technologies in the country and society.

Introduction

This will lead to the optimization of the management system and the production process using automated software in all areas of the country, and as a result, the population will receive high-tech processed products. At the same time, the natural conditions of our republic and the opportunity to grow fruits and vegetables are clear and noticeable in the world.

Based on the above, the provision of the population of our country with vitamin-rich fruits, vegetables and melons throughout the year is one of the current problems.

In order to solve this problem, foreign and local scientists are conducting a number of scientific studies on methods such as canning and drying products.

The method proposed by us, we aim to improve the process of obtaining raisins by technological processing of grapes using IR (infrared) rays. This is a method of supplying the population, and when using the method of drying IR-rays and high-frequency power transmission, the ingress of heat into the product has a significant impact on the rate of construction.

The efficiency of this technological process was studied, according to which the result was effective when applied to the drying of agricultural products, and as a result, the formation of a convective drying device, which performs the process of obtaining raisins from grapes by IR-rays [5].

Before conducting the experiment in the laboratory, the grapes and its composition were studied and analyzed, because the grapes are distinguished by their complex compositional structure within the fruit.

Because the vitamins, sugars and other substances in grapes have their own properties. Also, the top coating of the grapes causes a significant reversal of the factors affecting the interior, as well as the effect of temperature.

In the IR-drying method, the temperature is introduced into the product to be dried to remove excess moisture or to absorb substances necessary for human health.

Therefore, it is expedient to study the process of moisture distribution in grapes as a result of exposure to temperature and to apply the optimal temperature effect in the laboratory.

In the process of continuing the research, we also got acquainted with the work of foreign and local

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scientists who have worked and continue to work in this field. Research work on drying of plant products was carried out by A.S.Ginzburg, V.V.Krasnikov, S.G.Ilyasov, I.A.Rogov, A.M.Ostapenkov, K.G.Militser, R.Shtraus, Z.S.Salimov, N.R.Yusupbekov, A.A.Artikov, O.F.Safarov, H.S.Nurmuhamedov, J.M.Kurbanov, H.F.Juraev, K.O.Dodaev and others. They introduced into production the results of developments on the use of IR-convective energy processing in solving the problems of accelerating heat and mass transfer in the processing, drying, cooking, desorption, sorption and other processes of fruits and vegetables.

Also, the study and analysis of the work of scientists in the field revealed that there are traditional and non-traditional methods of drying, such as exposure to natural sunlight, the effect of temperature in non-traditional technological processes.

Under natural conditions, drying of fruits and vegetables, as well as grapes, is carried out in several stages. In it, the fruit is harvested and, after sorting, small cracks are formed in the grape skin by soaking it in sulfur, boiled alkali, etc., and spreading it on the fields to dry.

It will require 10 hundred square meters of land for 1000 kg of grapes of the studied variety and will serve an average of 4-7 workers. They receive a salary of 50,000 to 70,000,000 soums on a day-to-day basis.

In addition to the advantages of the natural drying method, various costs will be required for workforce, exposure to sunlight, and other work.

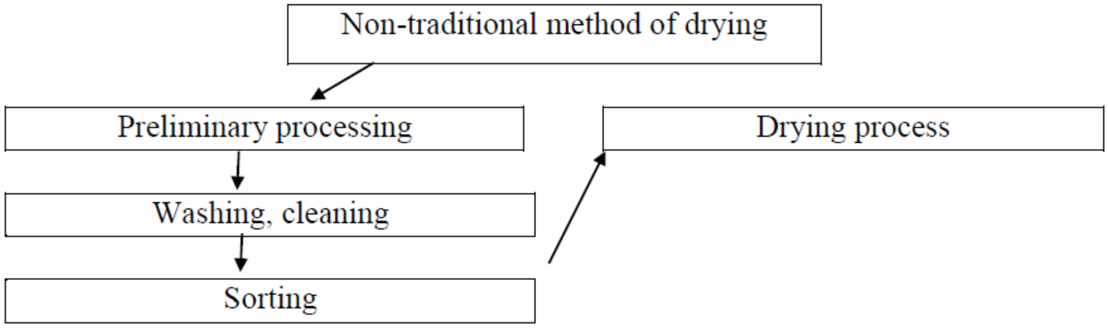
For example, if an error is made during sunlight control, the quality of the product will be impaired. In addition, dust, natural whims, birds and other influencing factors in the natural environment also have a significant impact on it.

This leads to a decrease in the amount of raisins extracted from the product or a deterioration in quality. As a result, the dealers suffer damage.

There are the following types of non-traditional drying of products:

- Biochemical;
- Technological;
- Process-hardware and others.

During the study of the drying process in the non-traditional method of drying grapes, a two-stage processing process was proposed, which are the initial processing and drying processes.



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Preliminary processing is carried out by sorting the grapes, using IR-light, by giving a short pulse to form small cracks in the skin. It is then placed on a tray in a convective dryer and dried.
As mentioned above, a mathematical model of changes in temperature, humidity in the technological process was formed before the implementation of the initial processing and drying process of drying. In the process of forming the mathematical and programmatic model of this process, its composition was divided into fine layers, on the basis of which the following (1) mathematical model was formed.

$$\frac{dX_i}{d\tau} = \frac{1}{\left(\frac{4\pi R^3{}_{\text{ташки}}}{3} - \frac{4\pi R^3{}_{\text{ички}}}{3}\right) * \rho} \left[\left(\left(\frac{2\pi D}{\frac{1}{d_i}-\frac{1}{d_{i+1}}} * (x_i - x_{i+1}) - \frac{2\pi D(x_{i+1}-x_{i+2})}{\frac{1}{d_{i+1}}-\frac{1}{d_{i+2}}}\right)\right)\right] \quad (1)$$

The formed mathematical models were obtained on the effect of temperature and changes in humidity. The obtained results showed that the rational design of drying devices was made by studying the mass, metabolism, distribution of moisture in the product layers under the influence of temperature during the drying process of grapes. This process was studied for changes in the hierarchical pockets of the grapes in layers when creating a computer model. [1,5].
To study the moisture distribution in grapes, the Simulink model in the following MATLAB program was created based on the mathematical expressions obtained above. (Figure 1).

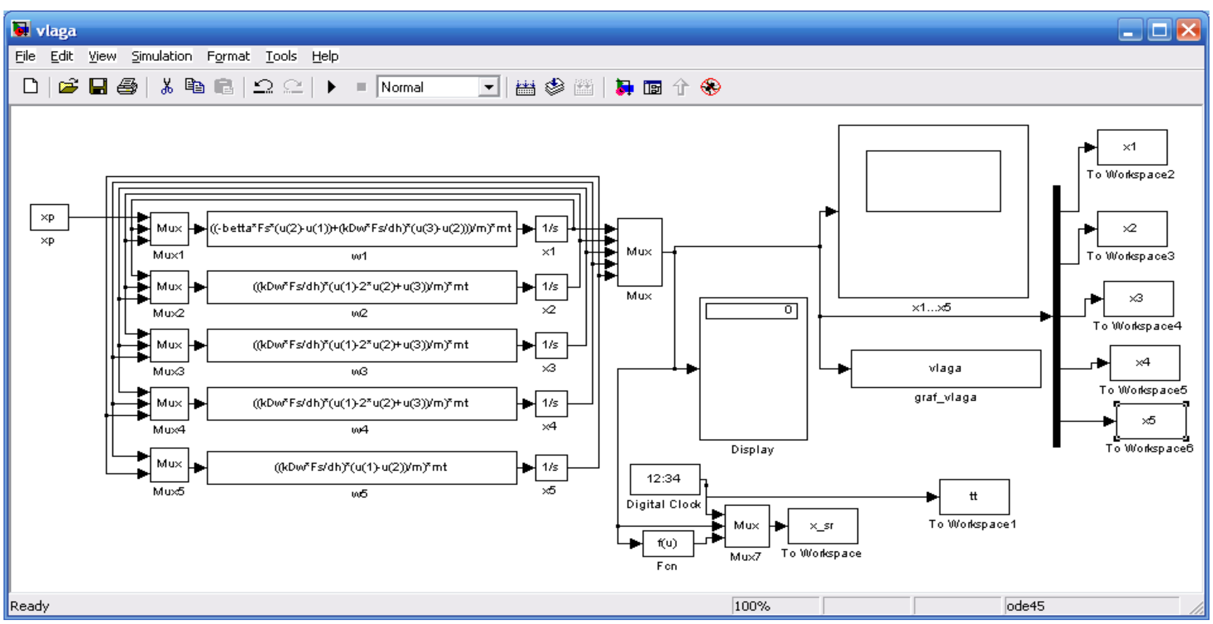

Figure 1. Moisture distribution Simulink model in MATLAB program

The initial value for this model was obtained as follows (Figure 2):

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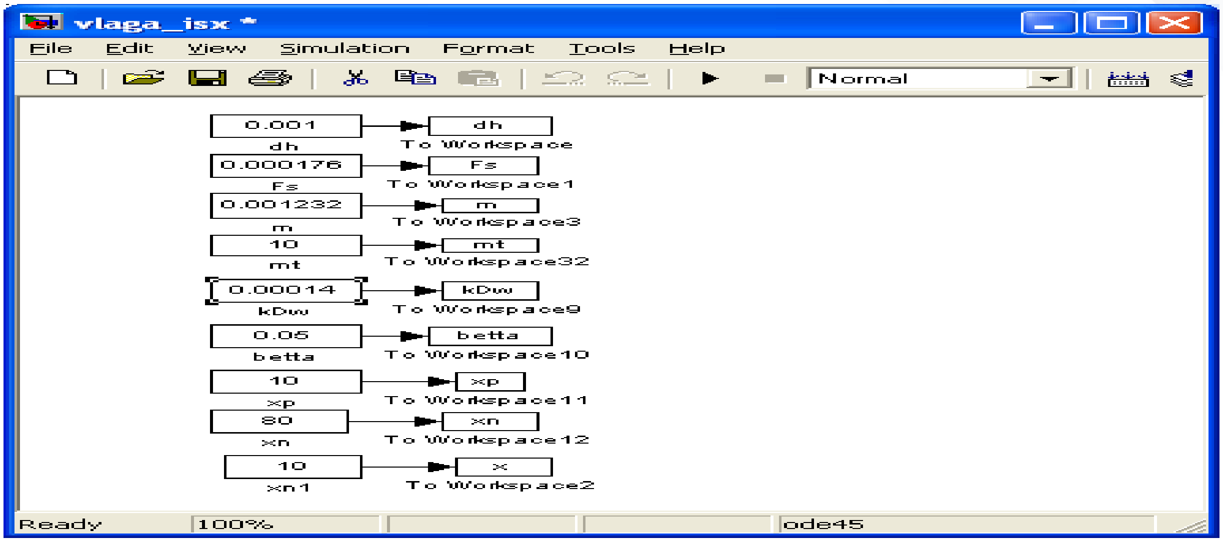

Figure 2. The initial values of the moisture distribution given to the Simulink model in the MATLAB program.

Based on the initial data of the generated moisture distribution given to the Simulink model in the MATLAB program, the following results were obtained for the moisture distribution layers. (Figures 3,4,5,6).

In the next stage, these created models were tested on grapes of different diameters, ie 8-12-16-20 mm (Table 1). Table 1

№.	Diameter (mm)	Low heat flux density, Bt / m2	The standard heat flux density is kBt / m2	High heat flux density. kBt / m2	The average value of the material temperature at the inlet, $t_к$ (°C)			The average value of the material temperature at the outlet, $t_ч$ (°C)			Drying period
					Botto m	The norm	Hight	Botto m	The norm	Hight	Hour
1.	8	q_1=1,12	q_1=1,15	q_1=1,17	69,3	69,5	69,7	69,24	69,26	69,27	24
		q_2=0,52	q_2=0,53	q_2=0,55							
		q_3=0.13	q_3=0.15	q_3=0.17							
		q_4=0	q_4=0,01	q_4=0,03							
2.	12	q_1=1,4	q_1=1,5	q_1=1,57	68,9	69	69,2	69,21	69,24	69,25	48
		q_2=0,5	q_2=0,7	q_2=0,8							
		q_3=2.33	q_3=0.35	q_3=0.37							
		q_4=0.2	q_4=0,05	q_4=0,08							
3.	16	q_1=2.1	q_1=2.3	q_1=2.7	68,32	68.39	68,4	69,22	69,24	69,26	72
		q_2=27.3	q_2=27.5	q_2=27.7							
		q_3=2.33	q_3=0.45	q_3=0.37							
		q_4=0.12	q_4=0,15	q_4=0,17							
4.	20	q_1=2.8	q_1=3	q_1=3.2	68,37	68.39	68,5	68.79	68.81	68,82	292
		q_2=0.7	q_2=0.9	q_2=1.2							
		q_3=0.52	q_3=0.55	q_3=0.57							
		q_4=0.18	q_4=0,2	q_4=0,21							

In developing the description of the dried products, attention was paid to their composition and the interaction of moisture with the product.

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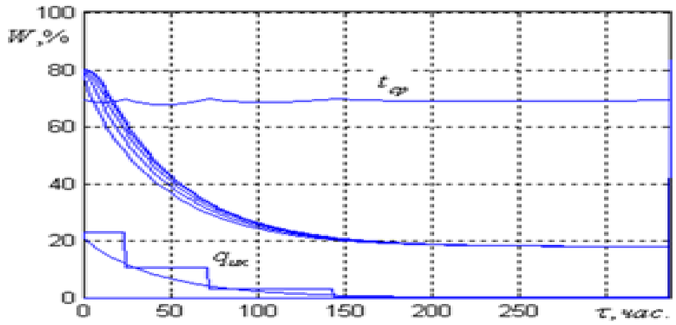
According to the results obtained by computer modeling, the distribution of moisture in the drying process of grapes on the diameters of grapes, along with its diameter, the density of heat flux, the value of temperature at the inlet and outlet, the construction time were obtained.

Table 2

#	Grape variety	Weight in wet condition, (kg)	Dried weight, (kg)	Natural loss, (kg)	Pure dried grapes, (kg)
1.	Black kishmish	10	2.4	0.2	2.2
2.	White kihsmish	10	2.4	0.3	2.1
3.	Oftobi (yellow grapes)	10	2.2	0.4	1.8

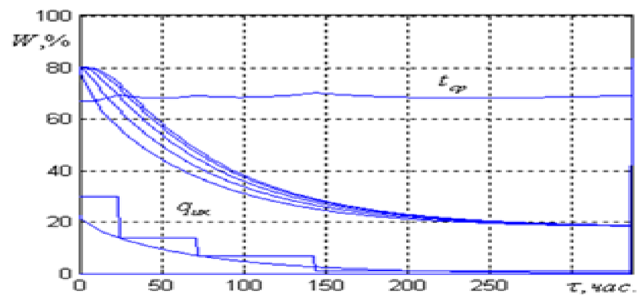
Table 2. The result obtained on the basis of natural drying per 10 kg.

According to it, the results of theoretical research conducted using computer models allow to develop the right decision in this process, as well as to control the process on the device in terms of product diameter and other parameters. [2].



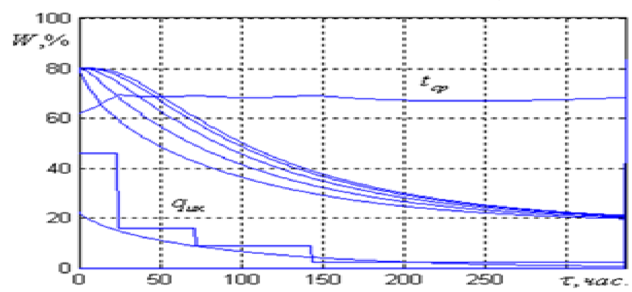
d= 8мм; q_1=1,15кВт/$м^2$; q_2=0,53кВт/$м^2$; q_3=0,15кВт/$м^2$; q_4=0,01кВт/$м^2$; τ_1=24с; τ_2=48с; τ_3=72с; τ_4=292с; $\tau_{чиқ}$=69,5с;

Figure 3. Distribution of moisture on the surfaces during convective drying of grapes under the influence of IR-rays.



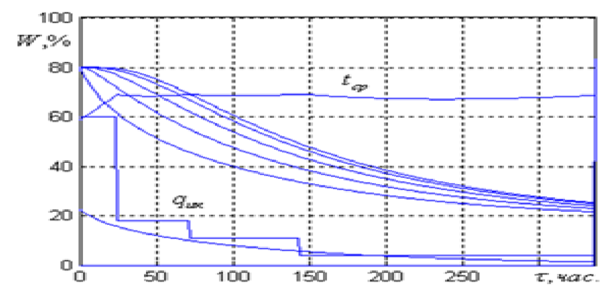
d=12мм; q_1=1,5кВт/$м^2$; q_2=0,7кВт/$м^2$; q_3=0,35кВт/$м^2$; q_4=0,05кВт/$м^2$; τ_1=24с; τ_2=48с; τ_3=72с; τ_4=292с; $\tau_{чиқ}$=69,26с;

Figure 4. Distribution of moisture on the surfaces during convective drying of grapes under the influence of IR-rays.



d=16мм; q_1=2,3кВт/$м^2$; q_2=0,8кВт/$м^2$; q_3=0,45кВт/$м^2$; q_4=0,12кВт/$м^2$; τ_1=24с; τ_2=48с; τ_3=72с; τ_4=292с; $\tau_{чиқ}$=68,39с;

Figure 5. Distribution of moisture on the surfaces during convective drying of grapes under the influence of IR-rays.



d=20мм; q_1=3кВт/$м^2$; q_2=0,9кВт/$м^2$; q_3=0,55кВт/$м^2$; q_4=0,2кВт/$м^2$; τ_1=24с; τ_2=48с; τ_3=72с; τ_4=292с; $\tau_{чиқ}$=68,81с;

Figure 6. Distribution of moisture on the surfaces during convective drying of grapes under the influence of IR-rays.

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The results also show that the time spent on the drying process is significantly reduced.

We have developed a computer model for the case where the drying of grapes is carried out with the help of natural (convective) and the influence of IR rays.

The product shell uses a variety of methods to increase moisture absorption, as well as exposure to short-term IR rays.

Semi-finished devices for drying grapes were created using the recommended methods. Research on these devices demonstrates the reliability of the computer models created and theoretical research [3,4]. In this case, the natural moisture content of the dried product may drop to the moisture content of the finished product. The results of the analysis show that when drying the product, its speed depends significantly on the temperature transfer (α), moisture transfer (β) and (kDn) thermodiffusion coefficients.

As the moisture content increases, the construction time of the product decreases.

An increase in the thermodiffusion coefficient of the product shell ensures an efficient drying process.

In short, the quality of the product is ensured by controlling the moisture content of the grapes.

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