INVESTIGATION OF DRYING APPLE SNACK CONVECTION-TERMORADIATSIYNYM ENERGY TO WRAP DIFFERENT POWER HEATERS

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Summary: During drying apple snacks to obtain high-quality product should vyibraty optimum parameters of drying and rational use of energy, materials and time. The intensity of the convection-drying termoradiatsiynoho largely depends on the capacity of heaters, used for the process. The purpose of the given research is to determine the optimal load heaters.

Keywords: termoradiatsiyne-convective drying, product range, moisture content, the intensification of the drying process, the load heaters, snack.

Introduction

Pressing issue of our time is a healthy lifestyle and healthy nutrition, but the rhythm in which we live is quite difficult to correct and balanced diet and a lot of people at lunchtime prefer snacks, most of which is oily or harmful food (chips, crackers, chocolate bars). So the question before us develop easy and useful food for modern people. In the food are fairly wide range of dried fruit, which can be attributed to safe and nutritious snacks, but along with snacks that attract consumer label bright and cheerful smiles data foods are less able to competitively to the same range of slightly outdated.

Materials and Methods

Developed apple snack recipes with balanced chemical composition and low calorie. This product is safe for virtually all Groom population than those groups who need to use sugar limitations (people suffering from diabetes and others). In Ukraine, a traditional raw apples and presented in a fairly wide range, but based on previous studies (organoleptic and technological properties of apples) was elected several varieties of which the best was the variety "Golden".Advance preparation includes slicing apples of the particles blanching within 90 seconds 30% of th sugar syrup with the addition of organic (citric acid) and antioxidant. When choosing the concentration of sugar syrup, a number of studies. Based on his own experience apple snacks drying temperature was 60 °C [1 - 3]. Power heaters plays an important role in intensifying the drying process, because it affects the quality of the finished product. If heaters power is low, the drying process is energy intensive and long, and the raw material at that time irreversible physical and chemical processes that affect the final product (loses appearance and basic organoleptic properties). If power heaters is quite high, the moisture from deep layers do not have time to defonduvaty outskirts surface snacks and so will burn with that in the middle of the sample is crude, which is also a shortage. To determine the optimal loading of heaters was conducted at 1 kW/h, 1.5 kW/h, 2.5 kW/h and 3 kW/h. Drying was performed in pulsed mode heating-cooling, and the heating was carried out infrared rays for 40-47 seconds with a wavelength in the range of 1,2-4 mm and heat flux density of 5,5 kW / m2, and cooling was performed for 59-82 seconds. Also, in order to intensify the drying process was put in the dryer air recirculation 50/50%.

Results and Discussion

Based on the data of drying curves were constructed (*Fig. 1*), which characterize the change in moisture content W^c integral function of time τ. This shows that the warm-up period for all samples is absent, and moisture removal is directly proportional to the load heaters.

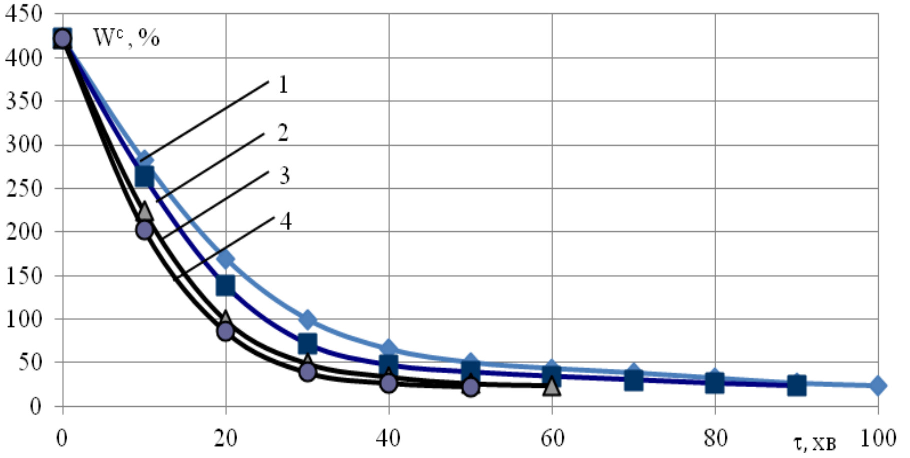


Fig.1. Curves drying blanched apple with workloadheaters:
1- 1 kW/h; 2- 1,5 kW/h; 3- 2,5 kW/h; 4- 3 kW/h.

Data approximating the first period of drying, moisture brought equations depending on the time of exposure and power heaters.

$$W^c = -3{,}9N\,\tau - 10{,}1\,\tau + 423 \text{ при } R^2 = 0{,}99;$$

where W^c – moisture content ,%; τ – time, min; N – power heaters, kW/h; R^2 – the correlation coefficient.

For the second period of drying brought the equation.

$$W^c = (1007N^2 - 3332\,N + 6450)\,\tau^{-0{,}155N+0{,}94} \text{ при } R^2 = 0{,}93.$$

Result in the drying curves obtained depending on the speed of drying apples of moisture particles (*Fig. 2*), which allow you to analyze the dynamics of drying samples. In deriving the equation drying kinetics of experimental dependencies $dW^c/d\tau$ of W^c found that the first stage of drying speed can be considered approximately constant. And since the second period of drying observed growing dependence with varying specificity with increasing load heaters.

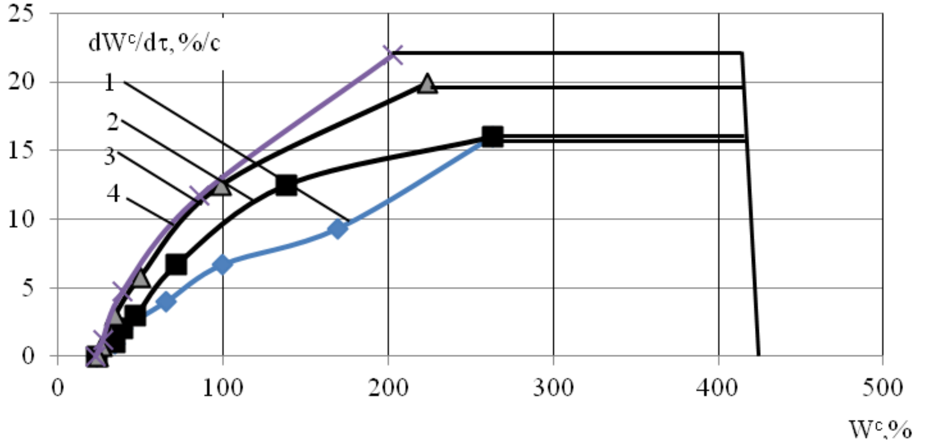
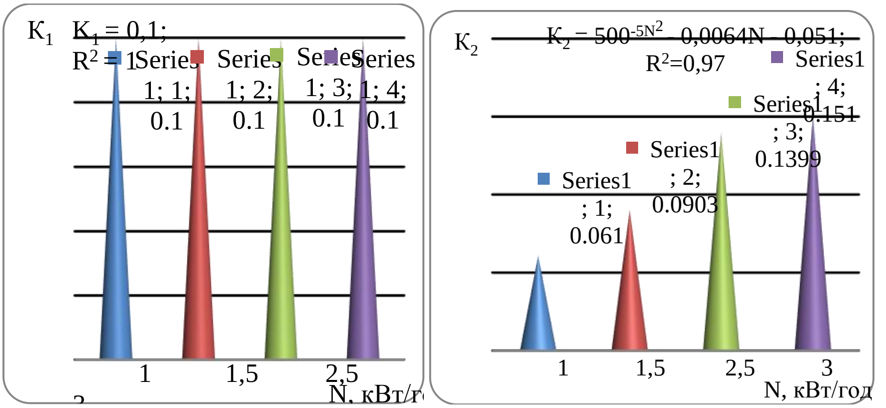


Fig. 2. Curves speed drying of blanched applecapacity heaters:
1- 1 kW/h; 2- 1,5 kW/h; 3- 2,5 kW/h; 4- 3 kW/h.

After analyzing the second period of drying, derived approximation equation for all the samples.

$$dW/d\tau = (1{,}89N+4{,}27)\ ln\ W - 5{,}42N\text{-}15{,}3 \text{ при } R^2 = 0{,}99.$$

Based on graphics drying curves and drying rate coefficients determined depending on the speed of drying the first and second periods and output approximating equation (*Fig. 3*).

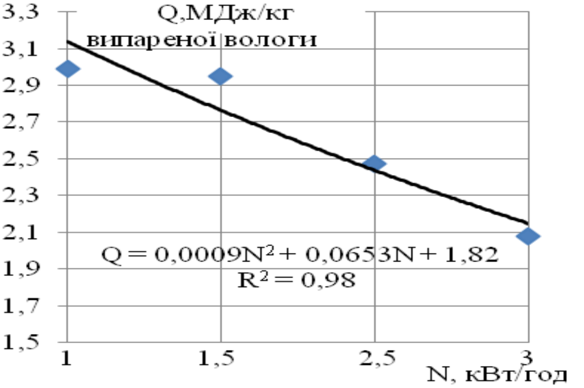


a *b*

Fig. 3 Factors speed drying for snacks in the first (3*a*)and second periods of drying (3 *b*) at different load heaters

After drying, the samples were 4 snacks of apples "Golden", to an objective assessment of our finished products was carried out qualitative analysis of samples. Organoleptic all samples were virtually identical - light cream color, rich aroma and a pleasant sweet-sour flavor in addition to the sample which was dried heaters with a power of 1 kW/h. This sample was slightly darker color due to surface oxidation product oxygen due to significant moisture removal. Physico-chemical analysis also showed that the least vitamin C was also in this sample - 31.75 mg / 100 life-size and 206.98 mg per 100 g dry matter. The highest vitamin C content in the sample was power heaters which was 2.5 kW/h - 64.81 mg / 100 life-size and 422,50 mg per 100 g dry matter. Therefore, based on a qualitative analysis of samples is assumed that the optimum load heaters is 2.5 kW/h. Vitamin C was determined by the method according to GOST 24556-89.

When processing data received drying process energy consumption for all samples snacks in kWh per kg of feedstock (*Fig. 4a*) and MJ /kg evaporated moisture (*Fig. 4b*).



a *b*

Fig. 4. Power consumption of 1 kg of raw materials *(4 a)* and1 kg of evaporated moisture *(4b)* for different load heaters

The figure shows that the highest energy costs accounted for snacks that were drying in the load heaters of 1 kW/h - 7.5 kWh/kg of feedstock, and the lowest costs amounted to 5.4 kWh/kg of feedstock for snacks that dried in the load heaters of 3 kW/h. This phenomenon is explained by the fact that with increasing load heaters reduces drying time. Approximating your energy consumption depending on loading heaters during drying of raw materials (particles blanched apple) brought the equation $Q = 0{,}0023N^2 + 0{,}1745N + 4{,}165$ at $R^2 = 0{,}99$; where N - the loading of heaters during drying samples snacks. These results clearly correlated with the properties and chemical composition of apple snacks.

Treating experiment we obtained dependency ratios masoviddachi at different loads and heaters displayed approximating equation. The results are shown in *Fig. 5*.

$$J = dW^c / d\tau = \beta(x_r - x) = \beta(x_1 - x)$$

where x_r – moisture content of the air (kg/kg) on the verge of a particle that is considered equilibrium; $x_r = x_1$– moisture content of air at a constant rate (first period) drying (kg/ kg). Both numbers are on psyhrometrychnymy data. Matthew Molar mass of water $M_в$=18, air $M_п$=29, humidity φ = 64. The partial vapor pressure *P* at *t* finds the tables and mole destiny m - ratio of $m_1 = Pt_1/(1- Pt_1)$, $Pt_1 = Pt/760$. At temperatures 21 °C $Pt_{21}=18,66/760=0,025$.

Molar share at 21 °C $m_2 = Pt_{21}\ \varphi/(1- Pt_{21})=0,016$. Moisture content $x=(M_в/M_п)(m_2/(1-m_2))=0,01$. Moisture content in the first period is given by $x_1=(M_в/M_п)(m_1/(1-m_1))=0,027$.

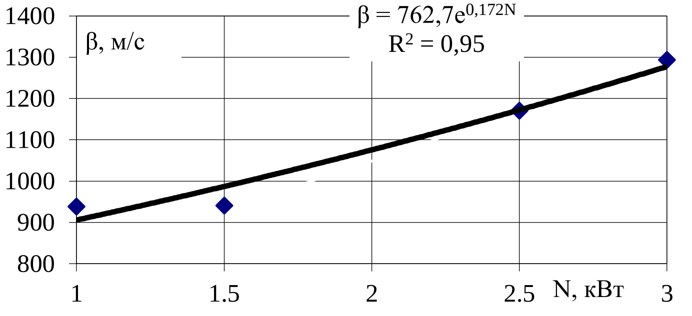


Fig. 5. Dependence of the load masoviddachi heaters

Conclusions

The results showed that the optimal loading of heaters for drying apple snacks is 2.5 kW/h. This is justified as the organoleptic (color, smell, taste) and physicochemical (vitamin C) indicators. In addition, power consumption chart below shows the drying efficiency of heaters of this burden. The drying process also managed to intensify due to pulse input "heating-cooling" and recirculating air.

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