Studying the application of dielectric pretreatment before drying

Mirolim Aripov[1], *Sherzod* Mamatov[1,*], and *Sadriddin* Turobjonov[2]

[1]Tashkent chemical-technological institute, 100010, Navai str. 32, Tashkent, Uzbekistan
[2]Tashkent State Technical University named after Islam Karimov, University street 2, Tashkent, Uzbekistan

Abstract. In this paper, we studied the characteristics of drying red beets that were pretreated using microwaves before convective drying. The results of shortening the drying period using microwave pre-treatment during drying are analyzed. Experimental data were also obtained and the rehydration process of the dried sample was compared.

1 Introduction

Drying is the most common way to remove moisture from solid and paste materials. Depending on the heat transfer method, dryers are classified into convective and contact ones. In convection dryers, the material to be dried is in direct contact with the drying agent (flue gases, heated air).

At present, vegetable-drying enterprises mainly use conveyor steam dryers.

The most powerful of the dryers are convective, air, atmospheric dryers with forced air circulation, continuously operating, conveyor, steam [1-3].

The results of research over the past decade in the field of convective dehydration of food products and the increased demands made by wide circles of consumers on the quality of dried products have served as an incentive for improving the air convective dryer, the scientific development of a number of new methods of drying food products and the introduction of more advanced dehydration methods in practice vegetable drying [4].

One such method is fluidized bed drying. Dryers working on this principle are intended for dehydration of food products in the form of small pieces (cubes) or grains (granules). When drying in a fluidized bed create increased speeds (4 ... 6 m / s) of air, which enters under the dryer grid. By air pressure, the pieces of material are torn off the grid and are kept suspended in the floor during drying. Due to this, the overall evaporation surface increases, convection is enhanced, moisture exchange between the material and the drying agent is improved, which intensifies the process and favors the production of a well-restoring dried product.

The main disadvantage of the convective drying method, leading to its relatively low intensity, is the movement of moisture inside the material to its surface only due to the difference between the humidity in the inner and outer layers of the material. In this case, the temperature in the center is less than on the surface, so the temperature difference has a

* Corresponding author: sherzod_mamatov@mail.ru

© The Authors, published by EDP Sciences. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (http://creativecommons.org/licenses/by/4.0/).

negative effect and inhibits the movement of moisture in the material [5-6].
Studies show that for drying agricultural products, in particular vegetables, it is promising to use combined drying methods (microwave and convective drying).
However, the disadvantage of drying with high frequency currents is the high cost and significant energy consumption. The cost of drying with high-frequency currents is 3-4 times higher than the cost of convective drying, and the electric power consumption in the first method is 2-5 kW * h per 1 kg of evaporated moisture. To reduce costs and save energy, microwave waves should be used in the form of pretreatments.
In this paper, we consider the features of the interaction of microwave energy and provide an overview of the application of microwave processing before convective drying of beets.

2 Objects and research methods

The objects of the research were: - Pablo red beets grown in the Syrdarya region, Uzbekistan were selected. With calories: 23.8 kcal., And also with a caliber of 7 cm. For drying, they are cut in the form of 8x8mm cubes.

For technological purposes, auxiliary materials are used that meet the requirements of regulatory documentation.

To compare the influence of pre-treatment we were prepared at microwave pre-treatment. And we are used conventional microwave magnetron 2450 MHz, wavelength 12.2 cm. Microwave pre-treatment is carried out for 2 minutes, and the temperature is reached up to 100-120 ºC. The weight changes of red beets were measured every 2 hours using a digital balance during the drying.

Samples of red beets were placed in a drying chamber BINDER FD 53 and the operating time is simultaneously displayed on the control panel and operating conditions. Samples were dried until of moisture content of 14%.

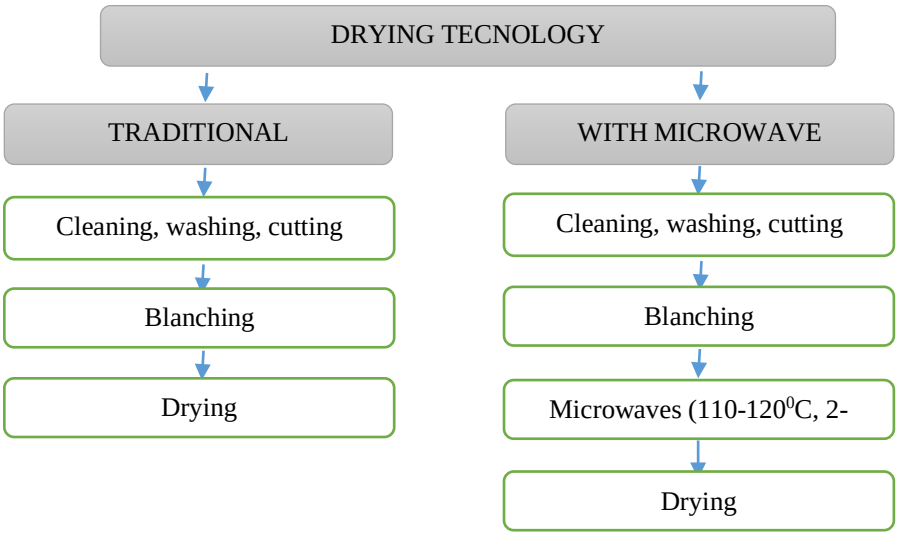

Fig. 1. Drying technology of red beets (traditional and with microwave pretreatment).

- moisture content was determined by oven-drying;
- the dried beets were soaked in 25^{0}C distilled water for 2 h, and then put on the filter paper of a Buchner funnel, which was held on a suction flask evacuated for 30 s to remove free

water on the surface. The sample weighing was performed in triplicate. The rehydration ratio (RR) was estimate as follows:

$$R_R=W_r/W_d$$

Where W_d and W_r were the weights (g) of samples before and after rehydration, respectively.

3 Results and Discussion

At the first stage of the experiment, the beet drying technology was carried out according to the traditional method of the convective method in the BINDER FD53 laboratory unit. The technological parameters of the processes are carried out according to the following indicators: the drying process took place at a temperature of 70 ° C, while the beets lose their mass, that is, they decrease by about 6-7 times. Control of weight indicators, dried samples was carried out each after 2 hours of drying, the total duration of the process is 6-8 hours, to a final moisture content of 14% of the dry sample (Fig.1).

At the second stage of the experiment, exactly the same technology was carried out, only using microwave processing before drying on the BINDER FD53 installation. The process parameters in the microwave form of pre-processing took 2 minutes, with a power of 700 watts, a conventional microwave magnetron 2450 MHz.

At the third stage of the experiment, the dynamics of moisture change during the drying period of the obtained samples was compared.

The results of experimental studies showed that the use of microwaves in the form of pre-treatment for 2 minutes (temperature reaches 110-1200 ° C) reduces the drying period by about 2 hours or 25%. The graph shows the change in mass during drying. That is, the use of microwave pre-treatment in just 2 minutes allowed to reduce the drying time by 2 hours (Fig. 2.). This means that pre-treatment saves energy by 15-20%, which will be spent on drying.

And during the study, we examined the organoleptic characteristics of beets. It should be noted that pre-treatment did not significantly affect the organoleptic characteristics (color, smell, texture) of the samples.

3.1 Moisture contents

Removing moisture during drying without adversely affecting the composition of the raw materials is the main goal. The experiments were confirmed by microwave pre-treatment for 2 minutes, beets lose moisture by about 25-28%. This directly reduces the drying time (about 2 hours when drying at 70 ° C).

3.2 Rehydration coefficient

The rehydration coefficient for dried beet samples was considered one of the important qualitative features. The rehydration coefficient of the dried samples was evaluated as described in the previous section. The ratio of the rehydration coefficient of dried samples with microwave pretreatment and without treatment is shown in Fig. 2.

The maximum water absorption capacity was, on average, for dried samples without preliminary treatment and for dried samples with microwave processing. The degree of recovery during rehydration depends on various drying conditions and the final moisture content, as shown in Fig. 3.

As shown in Fig. 3 Samples of dried beets without pretreatment had the best rehydration

ability, but there was no significant difference between samples dried and without microwave pretreatment.

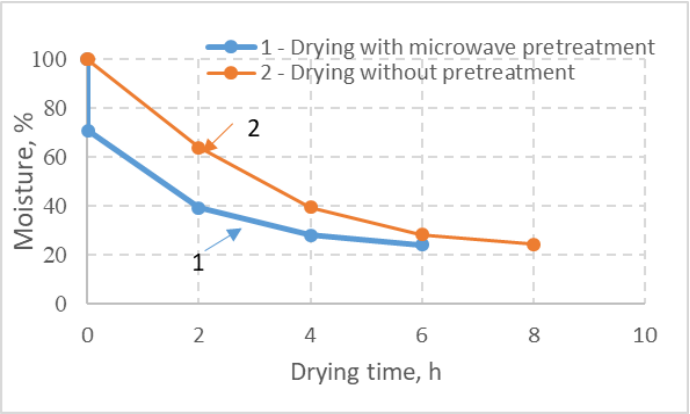

Fig. 2. Drying curves of samples of red beets with microwave pretreatment and without by convective drying

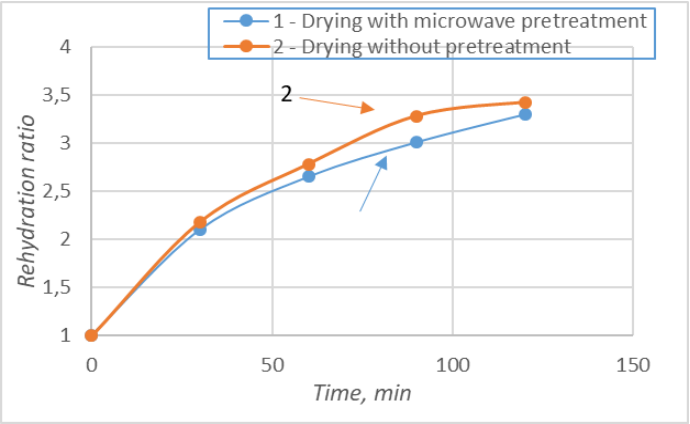

Fig. 3. Relationship the rehydration ratio with microwave pretreatment and without by convective drying of red beets

4 Conclusion

With the method of drying with microwave pre-treatment, it is conducted rather intensively than by a method without pre-treatment with a convective method. Moreover, the drying speed increases by 1.2 times compared with convective drying without pre-treatment, and the energy consumption is 1-1.5 kW * h / kg of moisture.

Based on the results obtained, it can be concluded that microwave pre-treatment of beets before drying reduces drying time by 25%, without violating its organoleptic characteristics. The research results are of great practical importance, since convective drying is the simplest technology today, which is used by almost 80% of Uzbek producers. The above allows us to consider the possibility of using microwave pretreatments suitable for use in the technology of drying agricultural products.

References

1. Mamatov, S., Zhang, M., Jia, A., Liu, X., & Liu, C. (2019). Effect of infrared radiation (IR) pre-treatment on the freeze-drying of sea cucumber. *International Journal of Innovative Technology and Exploring Engineering.* Pp. 475-478. (2009)
2. Nowak, D., & Lewicki, P. P. (2004). Infrared drying of apple slices. *Innovative Food Science and Emerging Technologies*, **5,** 3 (2004)
3. Mujumdar, A. S. Process Heat Transfer. *Drying Technology*. **14** (1996)
4. Mujumdar, A. S. (2014). Handbook of industrial drying, fourth edition. In *Handbook of Industrial Drying, Fourth Edition*. P.1319. (2014)
5. Duan, X., Zhang, M., & Mujumdar, A. S. Studies on the microwave freeze drying technique and sterilization characteristics of cabbage. *Drying Technology*. 25, 10 (2007)
6. Duan, X., Zhang, M., Mujumdar, A. S., & Wang, S. (2010). Microwave freeze drying of sea cucumber (Stichopus japonicus). *Journal of Food Engineering.* 96 (2010)