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Abstract. This article explores the possibility of using microwave processing technology to improve the process of extracting juice from stone fruits. The authors conducted experiments to determine the optimal microwave processing parameters, such as power, processing time and frequency, for each of the considered fruits. The effects of fruit temperature, humidity and initial sugar content on processing efficiency were also studied. The obtained results showed that the treatment with microwave energy before extracting the juice helps to increase the yield of juice and reduce the content of solid residues in the juice. The process of extracting juice from stone fruits can be improved through the use of microwave processing technology, which is an effective method. This is of practical importance for juice producers and consumers, who can receive a better and healthier product. The article also discusses the parameters of microwave processing, such as the power and time of exposure to waves, as well as the temperature of the raw material. Proper selection of processing parameters allows you to achieve the best results in terms of yield and quality of juice. In general, the use of microwave processing of stone fruits before juice extraction is an effective way to increase the yield and improve the quality of the juice. Choosing the right processing parameters is crucial to achieve the best results, as it is necessary to take into account the characteristics of each type of fruit.

1. Introduction

The amount of juice extracted during pressing depends on the structure of the fruit tissue and the pre-treatment technique. The degree of juice release during pressing of different types of fruits can also be different, since it is due to the physiological and anatomical properties of the fruit tissue. The cell permeability of plant tissue is one of the main factors affecting the amount of juice extracted during pressing [1, 2, 3].

To increase the yield of juice, various methods are used that contribute to the destruction of cell walls. Among these methods may be mechanical grinding of fruits, heating, freezing, passing electric current, enzyme preparations, and some others [4, 5, 6].

The release of juice from vegetable raw materials depends on many factors, including the viscosity of the cytoplasm, elasticity and other properties of cells that affect their ability to resist external influences during pre-treatment and pressing. The more cells are destroyed during pre-treatment, the more juice is released during pressing [7, 8].

In production, mechanical methods are most often used, when the fruits are crushed before pressing in order to increase the release of juice by pressing. All kinds of crushers are used for this: two-roller, one- and two-drum [9, 10].

According to the existing technology, mainly juices with pulp are prepared from stone fruit in the following way. After washing, removing the stalks, the fruits are crushed in crushers so that no more than 15% of the seeds are crushed, since crushed seeds in large quantities worsen the taste of the juice due to the transition of bitter substances into the juice. In addition, to increase the yield of juice, plums, cherry plums and apricots, whole or crushed, are heated with steam or water and then rubbed or pressed on belt presses [11, 12].

Pectolytic enzyme preparations are additionally added to the squeezed juice of plums for better clarification. The clarified juice is separated and heated to 90°C and cooled to 30-40°C. Then the juice is filtered through two diatomaceous earth filters (with round and fine-grained diatomaceous earth) [13, 14].

As you can see, the disadvantages of obtaining juices from stone fruits are processing with hot water or steam, crushing, adding pectolic enzymes both to increase the yield of juice and to clarify [15, 16].

Therefore, on the basis of the foregoing, a technology for obtaining juices from stone fruits is attached.

According to the existing technology, we mainly get juices with pulp from stone fruits, i.e. before rubbing, pressing, the fruits are heated with steam, water.

When heated in water, 20-25% of water is added to the fruits of plums and blanched until small cracks appear on the skin. Several batches are blanched in one water, the remaining blanching water in an amount of not more than 10% is added to the plums during pressing.

Steam treatment is carried out in a belt scalder for 3-3.5 minutes. The temperature inside the mass of fruits should be 72-75 °C, and then pressed hot.

Apricots are treated with steam to soften and wiped on a machine with wire whips, which exclude crushing of stones.

According to another scheme, apricots are pitted, heated to 55-60 °C, squeezed juice with pulp.

In this regard, the goal was to create a progressive technology for obtaining juice without pulp from stone fruits.

2. Materials and methods

For the study, fresh stone fruits of various varieties were used, including apricots, plums and cherry plums.

To obtain juices from whole stone fruits, microwave processing was used using the Elektronika microwave oven, which operates at a frequency of 2400 ± 50 MHz using a magnetron to excite an electromagnetic field.

Fundamentally, the microwave apparatus should consist of a number of necessary elements (figure 1): power supply; microwave energy converter; a communication device that provides energy transfer to the product; a device that creates a uniform distribution of energy during heating; own heating chamber with a transport device; microwave traps and insulation systems that prevent radiation into the environment, as well as control systems.

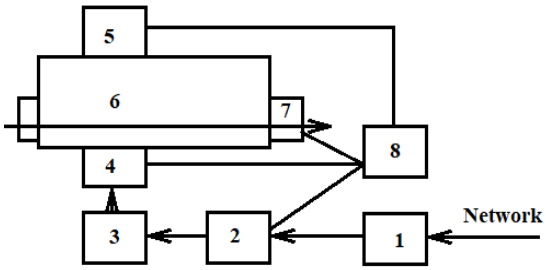

Figure 1. Schematic diagram of the microwave apparatus: 1-power supply; 2- microwave energy converter; 3 - a device for transmitting microwave energy; 4 - transmitter of microwave energy; 5- energy distributor; 6- heating chamber; 7 - system of microwave traps; 8- control system.

The working chambers of microwave devices are made of a closed form with walls made of materials that conduct electricity well. The energy is reflected by the walls of the chamber, which remain cold.

In practice, food products from an electrical point of view are dielectric materials with losses, therefore, products placed in a microwave chamber absorb microwave energy, quickly and efficiently heat up.

The main physicochemical parameters in the analyzed samples of stone fruit juices were determined by the following methods:

Dry matter - refractometer and hydrometer.

The optical density of juices was measured photometrically using a KF-77 photoelectrocolorimeter. The principle of operation of the KF-77 photoelectric colorimeter manufactured by Poland is conventional, i.e. consists in an objective measurement of the absorption value and the transmission value of light close to a monochromatic beam in colored solutions.

3. Results and discussion

The fruits of plums, apricots and cherry plums after washing and inspection, as a whole, are processed in a microwave chamber (resonator) with a frequency of 2400 ± 50 MHz, for various times depending on the type of fruit, and then pressed with a screw press to obtain juice. During processing, the temperature in the center of the fruit reaches 80-90 °C, but the pulp of the fruit remains elastic.

The obtained average values after the processing of fruits (plums, cherry plums and apricots) with microwave energy are presented in tables 2, 3, 4, 5, 6.

As can be seen from tables 2 and 3, processing up to 23-32 seconds, and tables 4, 5, 6 up to 40-45 seconds, does not yet give the desired effect on the output of juice, then we get juice without pulp, and after 32, 50-56 and 60 seconds, respectively, we already get juice with pulp.

As you can see, the first studied method of pre-treatment of whole fruit seeds before pressing to obtain juice will give reason to conclude that this method provides juice yield from cherry plum and plums up to 63-71% and apricot 60-64%.

The juice obtained after pressing the fruits of plums, cherry plums and apricots is light without pulp, having a natural plum, cherry plum and apricot taste, aroma and color.

In addition, it was found that when treating apricots and plums with microwave energy, up to 40-70% of the seeds are removed due to the pressure inside the fruit.

Table 1. The effect of microwave energy on the yield and quality of juice from whole plums of the Hungarian purple variety, treated with an electromagnetic field for 23-25 seconds.

Duration of microwave treatment, seconds	Temperature, °C	Juice yield, %	Dry matter, %	Optical density
23	80.5	65.4	10.2	0.45
25	83.0	67.3	10.6	0.32
28	84.0	67.0	10.6	0.37
30	85.0	66.0	10.5	0.57
32	85.4	64.0	10.6	0.61

Table 2. The effect of microwave energy on the yield and quality of juice from whole plums of the Giant variety, treated with an electromagnetic field for 40-50 seconds.

Duration of microwave treatment, seconds	Temperature, °C	Juice yield, %	Dry matter, %	Optical density
40	85.0	63.3	15.5	0.32
43	86.5	64.1	15.6	0.30
45	87.0	66.4	16.0	0.24
48	88.0	67.2	16.0	0.27
50	90.0	62.6	16.5	0.36

Table 3. Influence of microwave energy on the yield and quality of juice from whole fruits of cherry plum variety Raspberry, processed for 25-32 seconds.

Duration of microwave treatment, seconds	Temperature, °C	Juice yield, %	Dry matter, %	Optical density
25	81.5	67.7	8.7	0.48
26	82.0	69.4	8.8	0.33
28	84.0	71.6	9.4	0.28
30	85.5	71.5	9.6	0.24
32	87.2	70.2	9.8	0.45

Table 4. Influence of microwave energy on the yield and quality of juice from whole cherry plum fruits of the Violet Dessert variety treated with electromagnetic fields for 45-56 seconds.

Duration of microwave treatment, seconds	Temperature, °C	Juice yield, %	Dry matter, %	Optical density
45	81.0	63.2	10.4	0.52
48	84.0	65.2	10.7	0.42
50	85.0	65.8	10.4	0.30
52	86.5	65.1	10.8	0.36
54	87.6	63.7	10.6	0.44

Table 5. Influence of microwave energy on the yield and quality of juice from whole fruits of Isfarak variety apricots treated with an electromagnetic field for 45-60 seconds.

Duration of microwave treatment, seconds	Temperature, °C	Juice yield, %	Dry matter, %	Optical density
48	83.5	60.1	13.1	0.49
50	85.0	61.3	13.5	0.39
52	86.4	62.2	13.3	0.39
54	87.6	63.0	13.6	0.45
56	89.6	64.0	13.4	0.48
58	90.0	63.7	13.8	0.48
60	91.0	62.3	13.7	0.52

It follows from our studies that under the influence of microwave energy on whole bunches of grapes and on whole fruits of stone fruits before pressing, it is possible to increase the yield of juice and improve its quality compared to existing methods for obtaining juices.

We believe that the positive effects - an increase in the yield of juice and an improvement in the quality of juice from fruits and berries - are due to the volumetric absorption of microwave energy inside them, which leads to rapid heating, destruction of the cellular structure and complete yield of high-quality juice during pressing.

4. Conclusions

The possibility of using microwave electromagnetic field energy in technological processes for obtaining stone fruit juices has been scientifically substantiated.

We found that the treatment of fruits and berries with microwave energy at a frequency of 2400 MHz leads to an increase in excess air pressure in pores, capillaries and cells due to water flows and a temperature gradient from the center to the surface, which leads to microexplosions in cells, protein coagulation and an increase in cell permeability. As a result, juice yield and juice yield during subsequent pressing increase: from apricots - up to 60-64% in 48-60 seconds, from plums - up to 63-67% in 23-60 seconds, from cherry plum - up to 63-71% in 25 -56 seconds.

After washing and inspection as a whole, plums, cherry plums and apricots are treated with microwave energy at a frequency of 2400 ± 50 MHz for 23-50 seconds, which leads to a juice yield of 63-67%. When processing plums and apricots with microwave energy, pits are separated from the pulp by 50-70% due to the pressure created inside the fruit. The yield of juice when processed for 25-50 seconds is 63-70%, and when processed for 60 seconds - 60-64%, depending on the variety and maturity of the fruit.

References

[1] Ardestani S B, Sahari M A and Barzegar M 2015 *Journal of Food Biochemistry* **39(5)** 554-65
[2] Matys A *et al*. 2022 *Applied Sciences* **12** 3392
[3] Eshpulatov N *et al*. 2023 *IOP Conference Series: Earth and Environmental Science* **1142** 012017
[4] Eshpulatov N *et al*. 2022 *IOP Conference Series: Earth and Environmental Science* **1112(1)** 012081
[5] Ibragimov M *et al*. 2023 *IOP Conference Series: Earth and Environmental Science* **1142** 012031
[6] Aaby K *et al*. 2018 *Food Chemistry* **260** 115-23
[7] Adams J B, and Brown H M 2007 *Critical Reviews in Food Science and Nutrition* **47** 319-33
[8] Caminiti I M *et al*. 2011 *Food Chemistry* **124** 1387-92
[9] Chandrasekaran S, Ramanathan S and Basak T 2013 *Food Research International* **52** 243-61
[10] Moreira R G 2014 *European Journal of Lipid Science and Technology* **116** 723-34
[11] Noci F *et al*. 2008 *Journal of Food Engineering* **85** 141-6
[12] Patras A *et al*. 2010 *Trends in Food Science & Technology* **21** 3-11
[13] Ibragimov M, Turdiboyev A and Akbarov D 2021 *IOP Conference Series: Earth and Environmental Science* **939(1)** 012004
[14] Turdiboyev A *et al*. 2022 *AIP Conference Proceedings* **2686** 020019
[15] Khaliknazarov U *et al*. 2020 *IOP Conference Series: Earth and Environmental Science* **939(1)** 012020
[16] Turdiboyev A *et al*. 2021 *IOP Conference Series: Earth and Environmental Science* **939(1)** 012021