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APPLICATION OF ULTRASONIC TREATMENT IN PRESSING PROCESS OF GRAPE JUICE

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Abstract. The paper presents the influence of pulp sonication on changes of dry matter content in fruit waste and extract content in raw juice. The materials for investigation were two varieties of grape: Datal and Portugalskie Niebieskie. The experiments were carried out using two ultrasonic generators with the following characteristics: 25 and 40 kHz frequency and 2 W cm^{-2} intensity. The study showed simultaneous increase of dry matter content in fruit waste and extract content in juice after sonication of grape mash.

Keywords: ultrasound, preliminary treatment, raw juice, grapes, pressing

INTRODUCTION

The pressing process is widely used in the food industry for extraction of fruit juices [10]. To increase the yield of pressing different methods are used: heating, freezing, alkaline breakage, enzymatic treatment, pulsed electric field treatment, microwave heating and sonication [1-5,9]. The aim of all the operations is to enhance the degree of raw material plasmolysis, to reduce viscosity of juice and to improve the efficiency of pressing. However, next to the yield there are other factors that influence the efficiency of pressing such as: consumption of energy, extract content in juice, dry matter content in waste, etc.

Extract content in raw juice is of great importance due to the requirements established by the Polish standard (at least 10%). Therefore, high extract content in juice is required. Dry matter content in fruit waste is of some importance, too. This factor shows the degree of juice extraction. Increase of dry matter content in fruit waste indicates high yield of pressing.

Power ultrasound can accelerate heat and mass transport in a variety of food process operations and has been successfully used to improve drying, mixing, filtrating, crystallization, homogenization and extraction [6-8,11-13]. In the case of extraction, ultrasounds provide a greater penetration of solvent into cellular materials and improve mass transfer. They can also disrupt plant cell walls, thereby facilitating the release of extractable compounds and enhancing the yield of the process. But these effects are dependent on the frequency and application time of ultrasounds. Based on the studies it was hypothesized that the application of power ultrasound may improve the process of juice pressing and especially increase dry matter content in juice and fruit waste.

The aim of the study was to evaluate the influence of ultrasonic treatment on extract content in raw juice and dry matter content in fruit waste.

MATERIALS AND METHODS

Raw material

Grapes were purchased from a local shop. The grapes for the pressing were selected to be mature and disease-free. For the experiments, two varieties of grapes, namely Datal and Portugalskie Niebieskie were used.

Ultrasound equipment

Two ultrasonic bath systems, delivered by Polsonic Company, were used. There were composed of an ultrasonic generator, ultrasonic transducer and a stainless steel tank. Power ultrasound was delivered from the bottom to the middle area in the tank. The baths worked at two different frequencies: 25 and 40 kHz. In both cases the intensity of ultrasound was 2 W cm^{-2}. The exposure time varied from 0 (control sample) to 90 minutes.

Juice processing

The grapes were mashed and then pressed according to the flow diagram shown in Figure 1.

The expression process was performed on the pressing system that consisted of an expression chamber (height 15 cm, inner-diameter 10 cm) and an Instron Universal Testing Machine (Fig. 2.)

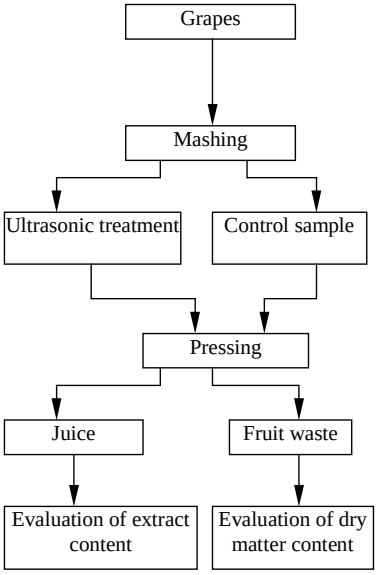

Fig. 1. Flow diagram of juice grape pressing

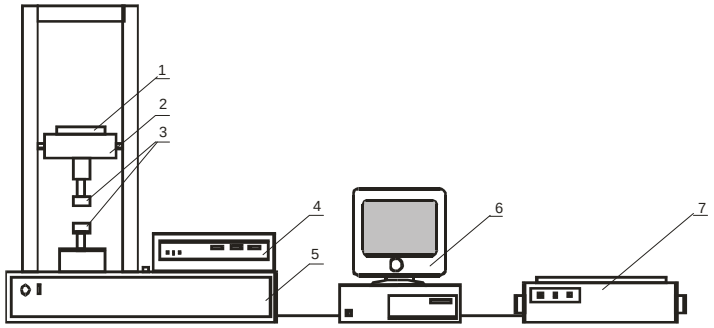

Fig. 2. Schematic of a laboratory stand for testing the process of juice pressing: 1– upper mobile head, 2 – Instron testing machine, 3 – laboratory press, 4 – control desk, 5 – lower stationary machine table, 6 – monitor, 7 – printer

Evaluation of extract content and dry matter content

Extract content in raw juice was determined using Abby's refractometr. The analysis was carried out according to the Polish Standard PN-90/A-75101/02.

The dry matter content in grape waste was determined by thermal drying of samples. The samples were dried at 100°C for 3 hours. The analysis was carried out according to the Polish Standard PN-90/A-75101/03.

Statistical analysis

All measurements were conducted in four replications. The experimental data were analyzed with the help of the Statistica 6.0 software package. Regression analysis was carried out to determine the effect of frequency and ultrasonic time treatment on dry matter content in fruit waste and extract content in juice. For all the equations, coefficients of regression equations are significant at the level of $\alpha = 0.05$.

RESULTS AND DISCUSSION

Effects of time and frequency sonication on extract content in raw juice are presented in Figures 3 and 4.

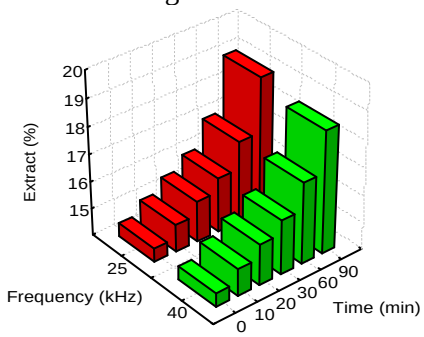

Fig. 3. Effect of mash sonication on extract content in Portugalskie Niebieskie juice

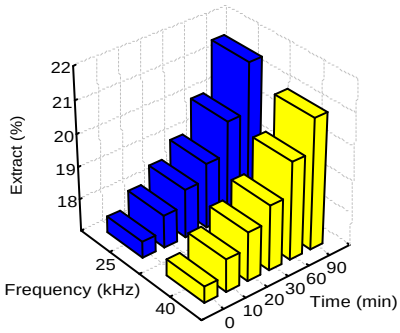

Fig. 4. Effect of mash sonication on extract content in Datal juice

Extract content in juice increased when the mash was sonicated before pressing. Extract content in Datal and Portugalskie Niebieskie juices from sonicated mash was significantly grater then the extract content from untreated mash. In the case of Datal juice, the extract content increased by 4% while Portugalskie Niebieskie juice by 6% for 90 minutes sonication time. Increase of extract content in juice was the result of solid leaching from grape skins during sonication.

Regression analysis showed a strong correlation between the sonication time of mash and the extract content in juice. For Portugalskie Niebieskie equation number 2 expresses the correlation:

$$E = 0.041t + 14.57 \tag{2}$$

and for Datal juice – equation number 3:

$$E = 0.042t + 17.72 \tag{3}$$

where E is the extract content in juice (%) and t is time of pulp sonication (min).

There was no significant difference in extract content between frequencies for both varieties (as shown by the lack of frequency in 2 and 3). A large difference in extract content between varieties was noticed. The Datal variety had a higher extract content than the Portugalskie Niebieskie variety. The observed difference in extract content when the two mashes were sonicated was the result of differences in the initial extract content between the two grape varieties. This is shown by the similar coefficients of 2 and 3 equations (0.041 and 0.042).

For comparison, the influence of sonication on extract content in raw juice dry matter content in fruit waste was determined. The influence of mash sonication dry matter content in grape waste is presented in Figures 5 and 6.

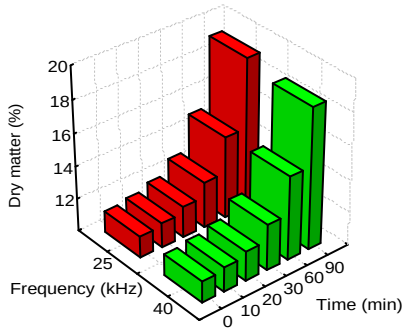

Fig. 5. Dry matter content as a function of frequency and time of sonication for grape variety Portugalskie Niebieskie

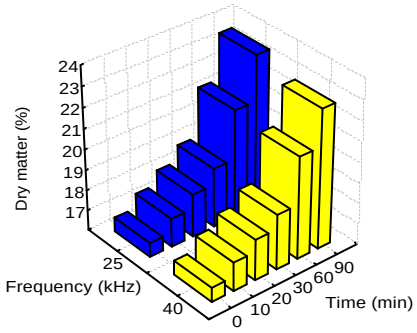

Fig. 6. Dry matter content as a function of frequency and time of sonication for grape variety Datal

Ultrasonic treatment of grape mash increased dry matter content in fruit waste. When the sonication time increased from 10 to 90 minutes, dry matter content of Datal increased by 7.1% for 25 kHz and by 6.3% for 40 kHz. In the case of Portugalskie Niebieskie, dry matter content increased by 8.0% for 25 kHz and by 7.4% for 40 kHz. In general, dry matter content increased with treatment time irrespective of the ultrasonic frequency. Analysis of regression showed linear relationship between sonication time and dry matter content in fruit waste for both varieties. The correlation between the variables may be expressed by equation 4 for Portugalskie Niebieskie fruit waste:

$$S = 0.084t + 11.2 \tag{4}$$

and equation 5 for Datal fruit waste:

$$S = 0.073t + 16.7 \tag{5}$$

where S is the dry matter content in fruit waste (%) and t is time of pulp sonication (min).

There was no significant difference in dry matter content between frequencies for both varieties. The increase of dry matter content did not depend on the variety, either. The Datal variety had a higher value of dry matter content than Portugalskie Niebieskie variety, but the relative increase in dry matter content of the two grape varieties was the same. The differences in dry matter content between the varieties were the result of differences in the initial dry matter content in fruit waste.

CONCLUSIONS

1. In this study juice from two sonic treatments (25 kHz and 40 kHz) of Datal and Portugalskie Niebieskie grape mashes were compared to juice from unsonicated mash. The results demonstrated that sonicating mash increased the extract content in grape juice. Ultrasonic treatment of the mash also enhanced dry matter content in fruit waste. The increase depended on the time of sonication. The highest values were found for the longest exposure time (90 minutes).
2. There was no significant influence of frequency on extract content and dry matter content for both varieties. There were differences in dry matter content and extract content between the varieties. But the differences were the result of initial dry matter content in fruit pulps. Further research should be conducted to determine the effects of ultrasonic treatment on other grape varieties.

REFERENCES

1. **Bazhal M.I., Lebovka N.I., Vorobiev E.:** Pulsed electric field treatment of apple tissue during compression for juice extraction. Journal of Food Engineering, 50, 129-139, 2001.
2. **Chang T., Siddiq M., Sinha N.K., Cash J.N.:** Commercial pectinases and the yield and quality of Stanley plum juice. Journal of Food Process and Preservation, 19, 89-101, 1995.
3. **Gerard K.A., Roberts J.S.:** Microwave heating of apple mash to improve juice yield and quality. Lebensm.-Wiss. U.-Technol. 37, 551-557, 2004.
4. **Jones G.C.:** Cossette pretreatment and pressing. International Sugar Journal, 90(1077), 157-167, 1988.
5. **Li H. Pordesimo L., Weiss J.:** High intensity ultrasound –assisted of oil from soybeans. Food Research International, 37, 731-738, 2004.
6. **Kalmykova I.S.:** Application of electroplasmolysis for intensification of phenols extraction from grapes in the technologies of red table wines and natural juice. Ph. D. Thesis, Odessa Technological Institute of Food Industry, Odessa, Ukraine, 1993.
7. **McClements D.J.:** Advances in the application of ultrasound in food analysis and processing. Trends in Food Science and Technology, 293-299, 1995.
8. **Mason T.J., Paniwnyk L., Lorimer J.P.:** The use of ultrasound in food technology Ultrasonics Sonochemistry, 3, 253-259, 1996.

9. **Ponant J., Foissac S., Esnault A.:** The alkaline extraction of sugar beet. Zuckerindustrie, 113(8), 665-676, 1988.
10. **Schwartzberg H.G.:** Expression related properties in "physical properties of foods". M. Peleg and E. Bagley AVI, Westport, CT 423-471, 1983.
11. **Toma M., Vinatoru M., Paniwnyk L., Mason T.J.:** Investigation of the effects of ultrasound on vegetal tissues during solvent extraction. Ultrasonic Sonochemistry, 8, 137-142, 2001.
12. **Vinatoru M.:** An overview of the ultrasonically assisted extraction of bioactive principles from herbs. Ultrasonics Sonochemistry, 8(3), 303-313, 2001.
13. **Vinatoru M., Toma M., Radu O., Filip P.I., Lazurca D., Mason T.J.:** The use of ultrasound for the extraction of bioactive principles from plant materials. Ultrasonics Sonochemistry, 4(2), 135-139, 1997.

ZASTOSOWANIE OBRÓBKI ULTRADŹWIĘKOWEJ W PROCESIE TŁOCZENIA SOKU WINOGRONOWEGO

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S t r e s z c z e n i e. W pracy przedstawiono wpływ sonifikacji miazgi winogronowej na zmiany zawartości suchej masy w wytłokach i ekstraktu w moszczu. Badania przeprowadzono na owocach dwóch odmian winorośli: Datal i Portugalskie Niebieskie. Doświadczenia zrealizowano przy użyciu dwóch generatorów ultradźwiękowych wytwarzających fale o częstotliwości 25 i 40 kHz i natężeniu 2 $W \cdot cm^{-2}$. Wykazano równoczesny wzrost zawartości suchej masy w wytłokach i zawartości ekstraktu w soku po sonifikacji miazgi winogronowej.

S ł o w a k l u c z o w e: ultradźwięki, obróbka wstępna, sok surowy, winogrona, tłoczenie