Optimal Drying Conditions for Valorization of Industrial Apple Pomace: Potential Source of Food Bioactive Compounds (Optimal Drying of Apple Pomace)

HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE SCIENCES

Faraja Deo Gonelimali*, Beatrix Szabó-Nótin, Mónika Máté

***fgonelimali@gmail.com**
Department of Vegetable and Fruit Processing Technology
Institute of Food Science and Technology
Hungarian University of Agriculture and Life Sciences
H-1118, Budapest, Villányi street 29-43. , Hungary

Introduction

Apple pomace are the solid waste products from processing of apples into juice, wine and cedar. They include skin, seeds, stem and flesh tissues left after obtaining the juice from squeezing the apples. About 25% of an apple's composition and weight is the pomace. Thus, for every amount of the apples that are processed, an estimate of 25% is waste, and most of these are thrown away to the environment, however there are attempts to utilize them as animal feed ingredients. Recently, it has been proved that these substances contain huge amount of bioactive compounds especially pectin and polyphenols. polyphenols from the pomace have also been used to enhance antioxidant activity in production of functional foods that can help to fight inflammation and cancer diseases. In addition to that, extracts from apple pomace have a potential to be used as natural food preservatives due to its antimicrobial activity. In order to properly obtain these bioactive compounds, proper handling of the pomace immediately after being produced is very important. One of the key step in early handling of the pomace is drying.

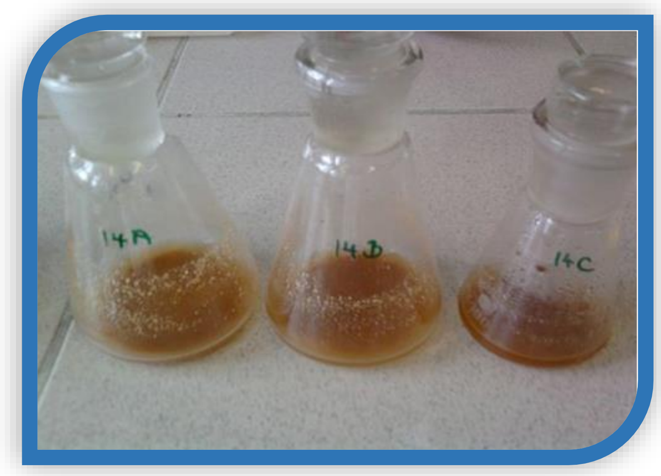
Drying of the pomace is essential process in order to remove excess water that can cause spoilage prior to its utilization. Usually, fresh apple pomace contain high moisture content and water activity, about 70% and 0.84 respectively. These conditions are ideal for the growth of microorganisms especially fungi that can lead in spoilage and production of toxins. Moreover, drying facilitate proper storage since less space and storage materials are required to store dried pomace as compared to fresh pomace. In addition to that, drying of the pomace is an important technical step that is required during extraction process where most of the bioactive compounds are extracted better on dried pomace rather than fresh. In order to protect important bioactive compounds from degradation, attention to proper drying methods should be under consideration.

Materials and methods

Apple pomace from industrial juice production were obtained from Agrana Juice Ltd (Hungary). Drying using the conventional oven (LP 232/1, Hungary), 200g of the pomace were spread in a drying tray with a depth of 0.5 cm. Trays were then taken to the oven and dried at 60°C and 80°C and the moisture content was being monitored every hour. For a vacuum oven drying, samples were first dried by a conventional oven to a moisture content of about 10 percent at 80°C and 60°C. Thereafter, samples were dried in the vacuum dryer at a temperature of 60°C and a pressure of 65 mb, moisture content was monitored every hour until reached 3 – 4 %. Dried samples were ground into fine powder using a "PRINCESS" multi chopper and grinder were vacuum packaged till the day of extraction.

Ultrasound assisted extraction was performed as the following: briefly, 15g of the pomace were mixed with 450 ml of 80% ethanol (1:30 w/v) in a flask. There after the flasks were placed in the sonication bath, 35 kHz for 1 hour (Bandelin, RK 52). Obtained solution was filtered using Whatman filter paper No.1, using vacuum pump. Solvent from the obtained filtrate was removed using rotary evaporator (IKA, RW 10C S99) and further removed on circulating air oven (60°C) in a petri dishes. Weight of the obtained extracts was determined and diluted accordingly with distilled water to obtain a final extract solution with a concentration of 200mg mL^{-1}.

Total phenolics were determined according to the Folin–Ciocalteu colorimetric method as described by Singleton and Rossi 1965. Antioxidant capacity was determined using Ferric Reducing Ability of Plasma (FRAP) assay (Benzie and Strain, 1996). Colour was determined according to C.I.E.LAB system using a tristimulus colorimeter (Konica Minolta CR 410, Minolta Canada Inc.). Statistical analysis was performed using one factor complete randomized ANOVA.



Results and discussion

The data of fresh apple pomace drying using atmospheric oven at different temperatures and atmospheric oven combined vacuum oven is shown in **Fig.1.**

Raw apple pomace had an initial moisture content of 69.37%, and drying procedure was continued till the moisture content of the sample reach final wet content (2.94-4.28%; 3 and 6 h) (Table 1.). In case of atmospheric drying at 80°C during the first 2 h (to 11.67-17.17%) the moisture content of apple pomace decreased quickly, after that, the moisture content decreased slightly.

Table 1. Shows time, final weight and recovery after drying the pomace using a conventional oven and a combination of a conventional oven with vacuum drying to reach a moisture content of approximately 4%. The final weight was the highest in case of using 60°C atmospheric drying, and the smallest weight was obtained in case of 80°C atm+ Vacuum drying method. The recovery shows similar tendency. The highest recovery % was achieved using 60°C atmospheric drying, and the smallest recovery was in case of 80°C atm+ Vacuum drying method.

After extraction method, the water soluble dry material content of the extracts were between 13.77-15.81%. According to the ANOVA results, the drying method had significant effect on the water soluble dry material content (p=0.000).

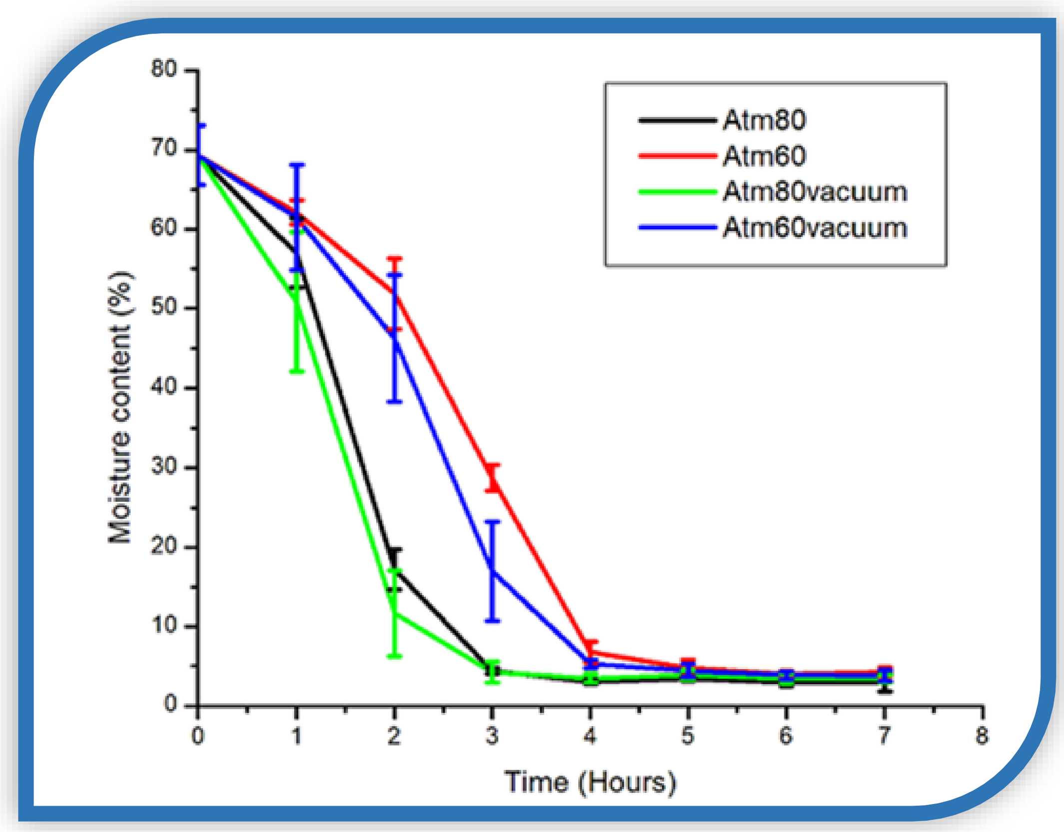


Fig. 1. Drying curves of apple pomace using different drying mode

Table 1. Time, final weight and recovery of the pomace using different drying method

Drying method	80°C atm.	60°C atm.	80°C atm. + Vacuum	60°C atm. + Vacuum
Time (hours)	3	6	3	6
Final Moisture conten (%)t	2.94	4.28	3.42	3.82
Final weight (g)	41.92 ± 2.42	45.25 ± 1.26	39.97 ± 2.84	40.98 ± 2.34
Recovery (%)	20.96	22.63	19.99	20.49

Table 2 contains the TPC content and FRAP values of the apple pomace extracts. The TPC of the final apple pomace extract was the highest (1075 μg mL-1) in case of atmospheric drying at 80 °C+vacuum drying, and was lower when atmospheric 60°C and vacuum drying methods were used (at 60°C atm + vacuum 874 μg mL-1. The effect of drying method and the TPC content of the extracts was evaluated by one-way analysis of variance (ANOVA). The drying method had significant effect on TPC content of the extracts (p value at 95% confidence: 0.043).

The highest antioxidant capacity were measured the sample was dried 60°C atmospheric, and the lowest value was determined in case of the sample was dried 800C atmospheric. Between atmospheric 80°+vacuum and atmospheric 60°C +vacuum there was no difference. According to the statistical analysis, drying method has significant effect on the antioxidant capacity (p values at 95% confidence: 0.000).

Table 2. TPC content anf FRAP values of the extract

	Atm_80	Atm_60	Atm_80_vac	Atm_60_vac
TPC±SD (μg mL^{-1} extract)	1000±184	944±106	1075 ±79	874±47
FRAP value ±SD (μg AS mL^{-1} extract)	471±21	744±52	576±20	588±106

Conclusion

Our results showed that apple pomace similarly to the grape seeds, a by-product of apple juice producing, might be another potent source of antioxidants.

Further purification of the apple pomace, identification of phenolic fractions and examination of their stability are necessary and apple pomace should be regarded as a valuable product and has potential as a value-added ingredient for functional foods as natural antioxidants and functional food ingredients (jams, juices, biscuits etc.)

References

Benzie, I.I.F.; Strain, J.J. (1996) The ferric reducing ability of plasma (FRAP) as a measuring of "antioxidant power". The FRAP assay. Anal Biochem. 239: 70–76.
Jung. J., Cavender, G., Zhao, Y. (2015) Impingement drying for preparing dried apple pomace flour and its fortification in bakery and meat products. *J. Food Sci. Technol*. 52(9):5568–5578 DOI
Lyu, F., Luiz, S.F., Denise, D.R.P., Cruz. A.D., Ajlouni, S., and Ranadheera, C.H. (2020) Apple Pomace as a Functional and Healthy Ingredient in Food Products: A Review. *Processes*. 8(3): 319; https://doi.org/10.3390/pr8030319
Sadh, P. K., Duhan, S., Duhan, J.S. (2018) Agro-industrial wastes and their utilization using solid state fermentation: a review. *Biores. Bioproc*. (5)1: https://doi.org/10.1186/s40643-017-0187-z
Singleton, V.L.; Rossi, J.A. (1965) Colorimetry of total phenolics with phosphomolybdic phosphotungstic acid "reagents". *Am. J. Enol. Vitic*. 16: 144–158.
Virot, M., Tomao, V., Le Bourvellec, C., Renard, C.M. & Chemat, F. (2010) Towards the industrial production of antioxidants from food processing by-products with ultrasound-assisted extraction. *Ultrason. Sonochem*. 17 (6): 1066-1074.

Acknowledgements

This work was supported by EFOP-3.6.3-VEKOP-16-2017-00005.
The authors acknowledge the University of Agriculture and Life Science's Doctoral School of Food Science for the support in this study.