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DRYING PARAMETERS INFLUENCE IN ORGANIC APPLES QUALITY

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Abstract. The organic dried fruits market is in a growing demand in Romania, especially due to the important amounts of nutrients for human health that the fruits bring. In this study we aimed to test the influence of different pre-treatment and drying temperatures on physical and biochemical characteristics in two organic apple varieties ('Topaz' and 'Dalinette'). Both varieties were washed, cored, sliced and hot-water blanched in order to inactivate the enzymes that produces the browning reaction. As control, untreated apple slices were dried in the same conditions as those pre-treated. Two temperature were used in order to assess the drying conditions, 40 °C and 70 °C. Results shown that different drying periods are required for organic apple 'Topaz' and 'Dalinette'. When control samples were dried, 18 hours where necessary for 'Dalinette' variety to reach 95 ± 3 % dry matter, compared to 14 h for 'Topaz' variety. The drying period was dependent of both applied pre-treatments and temperatures. After drying, it was observed an increase in phenolic content and antioxidant activity for both pre-treated organic apple varieties. Both pre-treatment and higher temperatures (70 °C) affected the ascorbic acid content for 'Dalinette' apple slices.

Key words: Apples; Drying; Hot-water blanching; Fruit chips; Titratable acidity; Dry matter content; Antioxidant activity.

INTRODUCTION

The apples (*Malus domestica* Borkh.) are considered one of the most appreciated (Musacchi & Serra, 2018) and consumed fruits in the world (Jaeger, S.R. et al. 2018) due to their high content of vitamins, antioxidant, minerals (Bezdadea-Cătuneanu, I. et al. 2019), fibre content, and their effect on human health, especially if they are obtained from organic horticulture (Persic, M. et al. 2017). In Romania, in 2019 the apple and pear production was estimated at approximately 350 000 tons (Mihăescu, C., Neagu Frăsin, L. 2020). Fruit quality is dependent on the environmental conditions, production area, growing technology, ripening stage, harvesting time (Asănică, A. 2018), processing technology, and storage conditions after harvest. Consumers demand for minimally processed organic fruits with high nutritional quality is growing and for this, the organic processing technologies becomes highly relevant (Stan, A. et al. 2020).

At international level, drying can be classified as one of the most used technologies in the fresh product processing, due to prolonged availability and multiple applications, such as: fruit bar, simple or mixed cereals with nuts, and other various food products (Sulistyawati, I. et al. 2020; Sadler, M.J. et al. 2019).

Drying refers to water removal from fresh products using sun or mechanical technologies (Chang, S.K. et al. 2016) with the aim of reducing product packaging, storage and transportation costs, due to, the volume and mass loss (Omolola, A.O. et al. 2017). By using new and modern technologies in fruit drying, the manufacturers can obtain products with high nutritional value (Sun, Y., Liang, C. 2020; Ullah, F. et al. 2018). The dried fruits are an important source of antioxidants, vitamins, and fibres, which are in higher amounts compared with fresh fruits (Cinar, G. 2018; Bennett, L.E. et al. 2011) when reported to the mass of the final product.

The aim of this study was to assess the influence of different pre-treatment and drying temperatures on physical and biochemical characteristics of two organic apple varieties 'Topaz' and 'Dalinette'.

MATERIALS AND METHODS

Chemicals

Solvents and chemical substances used in analysis were of analytical grade, acquired as follows: gallic acid from Carl Roth; trolox from Acros Organics, Fisher Scientific (Geel, Belgium); DPPH (1,1-diphenyl-2-picrylhydrazyl) and Folin Ciocalteu's reagent from Sigma-Aldrich Chemie GmbH (Riedstrasse, Steinheim); anhydrous sodium carbonate from Lach-Ner, (Neratovice, Czech Republic); sodium hydroxide 0,1 N from Cristal R Chim S.R.L. (Bucharest, Romania); methanol from Honeywell (Riedel-de Haën, Seelze, Germany) and ultrapure water produced in laboratory with Milli-Q water equipment (Millipore, Bedford, MA).

Samples

Organic apples from 'Topaz' and 'Dalinette' varieties were harvested in October 2020 and stored at 2 ± 0.5 °C and 90 ± 5 % relative humidity (RH) at the Research Institute for Fruit Growing (Pitesti, Romania) until they were shipped to the Research Center for Studies of Food Quality and Agricultural Products. After receiving the apple sample in the Postharvest Technologies Laboratory, they were stored at 1 ± 0.5°C and 85 ± 5 % RH until processing. Processing consisted in washing, coring, slicing (approx. 5 mm) and hot-water blanching (30 s at 95 °C) in order to inactivate the enzymes that produces browning reaction, then drying at 40 °C and 70 °C until apple slices reach an approximate 95 ± 3% dry matter.

Quality parameters and bioactive compounds

Quality parameters analyzed after drying period were pH, total titratable acidity (TTA) and dry matter content (DM). The pH and TTA was realised using an TitroLine automatic system, equipped with pH electrode. Samples (5 g) were mixed with distillate water (25 mL) and titrated up to 8.1 pH with 0.1N NaOH solution (AOAC Official Method 942.15). The results were expressed as g malic acid/ g DM similar with Stan et al. (2020). Dry matter content was realized with a MAC 50 PARTNER termobalance using 1 g of sample and a temperature of 105°C (Ticha, A. et al. 2015).

TPC (total polyphenol content) measurement was based on Folin–Ciocâlteu protocol, using Bădulescu et al. (2019) method. Briefly, 0.2 g of sample was extracted with 10 mL of 70 % methanol, and incubated at room temperature overnight. After incubation, the samples were homogenized for 1 h with a speed of 500 rpm, and centrifuged for 5 min at 7000 rpm. The extraction procedure was repeated for two more times, reaching a final volume of 30 mL. For TPC quantification, 0.5 mL of sample extract was mixed with 2.5 mL of Folin–Ciocâlteu reagent and 2 mL of 7.5% sodium carbonate solution and incubated for 15 min at 50 °C. Spectrophotometric measurements were performed using a Specord 210 Plus UV-VIS equipment (Analytik Jena, Jena, Germany) at 760 nm, and expressed as mg GAE /100 g product.

AA (antioxidant activity) method was realised using the protocol described by Bujor et al. (2016). The extraction protocol of samples was similar with TPC and for spectrophotometric measurements 0.2 mL of extract was continuous homogenising with 2 mL of 0.2 mM DPPH in methanol and incubated for 30 minutes in the dark. Spectrophotometric measurements were performed using a Specord 210 Plus UV-VIS equipment (Analytik Jena, Jena, Germany) at 515 nm, and expressed as mM equiv Trolox/ 100 g product. All experiments were performed as three independent replicates.

RESULTS AND DISCUSSIONS

The drying period at 40 °C for organic apples 'Topaz' blanched for 30 seconds at 95 °C was with more than 2 hours longer than those untreated, reaching to a total duration of 16.5 hours. For organic apples 'Topaz' dried at 70°C the necessary period to reach 95 ± 3 % dry matter was similar for both treated and untreated experimental variants. When organic apples 'Dalinette' were analysed from drying period point of view it was observed that untreated apple slices require a longer period than those treated (Figure 1).

The dry matter content varied between 92.89 ± 1.14 % and 97.97 ± 0.47% for all samples dried at 40°C and 70°C, as can be seen in Figure 2. Higher dry matter content was observed when a 70 °C drying temperature was used, for both apple varieties.

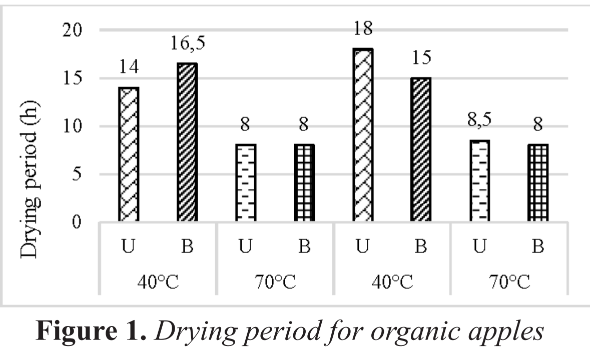

Figure 1. *Drying period for organic apples (U – untreated, B – blanched 30 s at 90 ºC)*

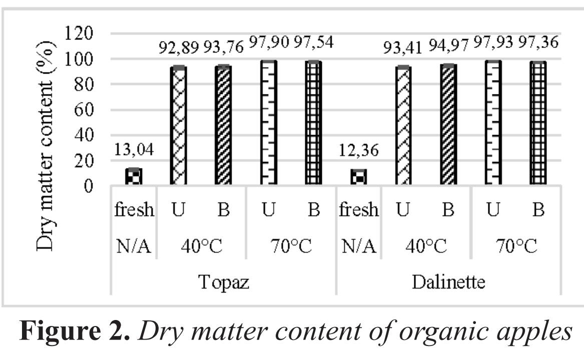

Figure 2. *Dry matter content of organic apples fresh and dried (U – untreated, B – blanched 30 s at 90 ºC)*

The variation of total acidity before and after drying was similar for both apples varieties, ’Topaz’ and ’Dalinette’ treated and untreated, died at 40 ºC and 70 °C (Table 1). pH was also not influenced by the drying pre-treatment and drying temperatures.

Table 1. *Total titratable acidity of dried apple slices*

Variety	Pre-treatments applied	Drying temperature	pH	Total titratable acidity (mg malic malic/g DM)
\`Topaz\`	fresh	N/A	3.54 ± 0.15	0.022 ± 0.001
	untreated	40 °C	3.83 ± 0.21	0.017 ± 0.000
	blanched 30 sec at 95 °C		3.88 ± 0.04	0.020 ± 0.001
	untreated	70 °C	3.50 ± 0.12	0.020 ± 0.001
	blanched 30 sec at 95 °C		3.77 ± 0.07	0.018 ± 0.001
\`Dalinette\`	fresh	N/A	3.62 ± 0.11	0.026 ± 0.001
	untreated	40 °C	5.06 ± 0.30	0.018 ± 0.001
	blanched 30 sec at 95 °C		3.73 ± 0.15	0.020 ± 0.001
	untreated	70 °C	4.03 ± 0.09	0.017 ± 0.001
	blanched 30 sec at 95 °C		3.99 ±0.18	0.021 ± 0.000

The ascorbic acid content (Figure 3) decreased after drying for ’Dalinette’ organic apples. The lowest values were registered for both untreated and treated samples dried at 40 ºC due to longer necessary for drying period (18 h and 15 h, respectively). The treated ’Dalinette’ organic apples dried at 70 ºC registered the smallest decrease (8.78 ± 0.96 mg ascorbic acid/100 g product) compared to the fresh product (9.06 ± 0.96 mg ascorbic acid/100 g product), while the untreated ’Dalinette’ organic apples registered a decrease to a value of 6.99 ± 0.23 mg ascorbic acid/100 g product (representing 22.85 % of the fresh value). For ’Topaz’ organic apples, the ascorbic acid content registered decreases for untreated and treated variants dried at 40 ºC, while for those dried at 70 ºC a small increase of 10 % was observed for untreated slices, due to the fast water loss and a lower time exposing to oxidizing agents.

The total phenolic content was 178.6 ± 4.0 mg/100 g sample for fresh ’Topaz’ organic apples, and 167.4 ± 4.3 mg/100 g sample for fresh ’Dalinette’ organic apples. Following the dehydration process, was observed an increase of total phenolic content for all organic apple samples, a phenomenon that occured due to the loss of water content and the concentration of bioactive compounds (Figure 4).

The antioxidant activity recorded values of 11.80 ± *1.01* mM equiv Trolox/100 g for fresh ’Topaz’ organic apples and 10.83 ± *0.05* mM equiv Trolox/100 g for fresh ’Dalinette’ variety. Following the drying process, an increase in antioxidant activity was observed for all samples of organic apples of ’Topaz’ variety (Figure 5). ’Dalinette’ organic apple also recorded increases in antioxidant activity, with the exception of untreated sample dried at 40 °C where the value of antioxidant activity decreased with 50 % compared to the fresh sample, which may be due to the very long time of drying (18 hours).

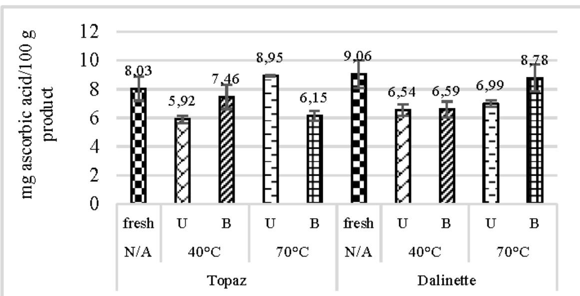

Figure 3. *Ascorbic acid content variation after organic apples drying (U – untreated, B – blanched 30 s at 90 ºC)*

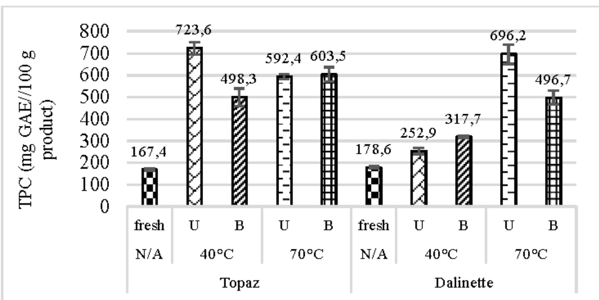

Figure 4. *Total phenolic content variation after organic apples drying (U – untreated, B – blanched 30 s at 90 ºC)*

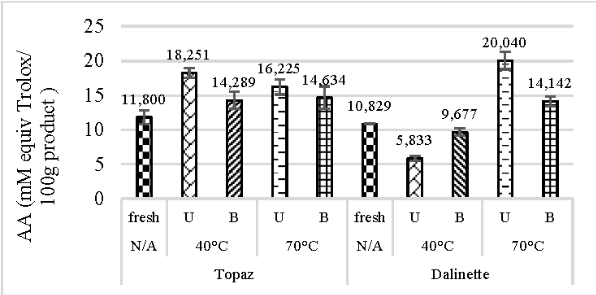

Figure 5. *Antioxidant activity variation after organic apples drying (U – untreated, B – blanched 30 s at 90 ºC)*

CONCLUSIONS

The required time for drying differs from one species to another, from one variety to another, and is influenced by pre-treatments and applied temperature. Due to the organic apples growing conditions, there may be changes in physical and biochemical processes, depending on the variety, over the entire period of dehydration. The total titratable acidity presented small variations for all analysed samples and remain similar with fresh samples. After drying, the total phenolic content registered increases for all organic apple samples, due to water loss and nutrients concentration. An increase in antioxidant activity was observed for all ’Topaz’ organic apples samples after drying. Further the studies and trials are required in order to evaluate the impact of drying on the bioactive compounds and for a better understanding of the pre-treatment and temperature effect on the overall quality of organic apple slices.

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