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STORAGE LIFE UNDER CONTROLLED ATMOSPHERE OF JONATHAN AND BELLE OF BOSKOOP APPLES, TRADITIONALLY PRODUCED IN BRAN-ZĂRNEȘTI AREA

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Abstract

This study is part of the extended research focused on the identification of local fruit varieties, on their nutraceutical properties in order to be promoted on the market both as fresh fruits or processed products with added value. Among the South-East Transylvanian fruits, the old apple varieties Jonathan and Belle of Boskoop are cultivated in traditional orchards of Bran-Zărnești area. This article aims to present the results of a detailed analysis of the physical and biochemical transformations undergone in controlled atmosphere storage by the two apple varieties. Fruits were harvested from a traditional orchard from 40-50 years old trees, planted at 15 x 15 meters. The soil was maintained covered with multispecies grass and the vegetation was mown twice a year for hay production. Fruits were stored in controlled atmosphere cells of 1m^3 capacity and determinations were done on monthly bases. Dry matter content, total soluble sugars and total acidity were significantly different at the two varieties. Similar values for the ascorbic acid content were registered. Belle of Boskoop had a low storage life and correlations between parameters were detailed.

Key words: *M. domestica, total soluble sugar, dry matter, ascorbic acid, total acidity*.

INTRODUCTION

Healthy food is more and more promoted as an answer to the massively increasing number of illnesses, particularly digestive, that are very difficult to treat. In this context, the nutritive value of some natural products like fruits is considered for use. Fruits represent the essential component of the daily diet helping to balance the nutritive value and eliminating the monotony of meat-and cereal-based diets.

As they stimulate the secretion of digestive juices and have a distinct nutritive and gustative value, fruits are the food that must not be absent from the everyday diet. Carrying essential mineral salts, fruits contribute to the neutralization of the body's acidity, which can occur because of the excessive intake of animal products explosively present in the population's daily menu (Râpeanu, 2010; Ticha et al., 2015).

Research focuses as much as possible on native fruits, which are within the population's reach and should replace a large part of its animal proteic diet.

Apples prevail in the researched area (Bran-Zărnești). These are grown in traditional orchards with 40-50-year trees. The orchards floor is maintained with a grass cover, the vegetation being mowed for hay twice a year. The most representative local apple cultivars are Jonathan, Boskoop Gel and Boiken.

The qualitative appreciation of a cultivar is based on its content in water, total sugars, minerals, ascorbic acid, pectic substances as well as the fruits' physical characteristics: size (weight, height, diameter), the proportion between the edible and waste parts. Firmness is influenced by fruit size during the post-harvest period (Saei et al., 2011).

It is known that drying is the oldest and most healthy method of preserving fruits and vegetables, more suitable than cold room storage (Bujdei et al., 2019). During dehydration, the fruits undergo certain transformations, such as structure transformation; volume reduction; turbulence

by losing water from the structure; color transformations (color change depending on the oxidative process, time and duration of drying); flavor transformations (the warm air entails some of the aromas resulting in their diminution); loss of some vitamins; increases of the energy value of dried products.
The aim of this study was to present the results of an analysis of the physical and biochemical transformations undergone in controlled atmosphere storage and respectively through drying by the two apple cultivars.

MATERIALS AND METHODS

Jonathan cultivar, created in 1880 at Ulster, USA, has medium-sized fruits, red color skin and white-yellowish color pulp. The cultivar is very sensitive to mildew (Cimpoieș et al., 2001). It is one of the most appreciated apple cultivars for fresh consumption in Romania (Hoza, 2000; Ghena and Braniște, 2003; Stănică and Braniște, 2011).
Belle of Boskoop (sin. Reinette von Monfort), created in the Netherlands, has large-sized fruits and green-yellowish color of skin. The cultivar is scab sensitive (Braniște and Uncheașu, 2011).
For this study, Jonathan and Belle of Boskoop cultivars fruits were harvested from a traditional orchard from Brașov county, Sub Măgura area, Predeluț village, Bran commune, Nicolae Boș Street. The trees were 40-50 years old, planted at 15 x 15 meters. The soil in the orchard was maintained covered with multispecies grass and the vegetation was mown twice a year for hay production.
After harvesting, the fruit samples were kept in controlled atmosphere cells at 2°C temperature, 90% humidity, 2% oxygen and 3% CO_2.
The average fruit weight, diameter and firmness determined with a digital penetrometer were registered monthly.
The water and dry substance content were determined through oven drying at 105°C, 24 hours, following the sample's weight loss through water evaporation, the total dry extract being derived by deduction (100-water).
The total titratable acidity in the analyzed sample was determined through the titration of the fruit extract with NaOH 0.1N in the presence of phenolphthalein as an indicator.
The ascorbic acid (vitamin C) was determined through the iodometric method by titration with potassium iodate.
The sugar concentration was determined with the help of the ABBE-PULFRICH refractometer.
Obtaining apple chips by hot air drying
Apples from Jonathan and Boskoop cultivars were used, after being washed and sliced. Immediately after slicing, the slices of about 0.5 cm thick, after been immersed in a lemon juice mixed with water to avoid oxidation, were placed in the dryer, in layers, on trays. The sliced fruits were kept for one, two and three hours respectively at 80°C. After each hour of drying, the humidity was determined. The same parameters were determined for 67°C and three, six and nine hours.
Data statistical analysis was performed with Excel (MS Office). For correlation between two data sets Excel statistical functions with a significance level $p < 0.05$ were used.

RESULTS AND DISCUSSIONS

Belle of Boskoop had a higher average fruit weight (162.3 g) comparing with Jonathan's cultivar. At the initial moment of the research, the average flesh firmness was 4.0 kg f/cm^2 at Belle of Boskoop comparing with 3.5 kg f/cm^2 at Jonathan (Figure 1).

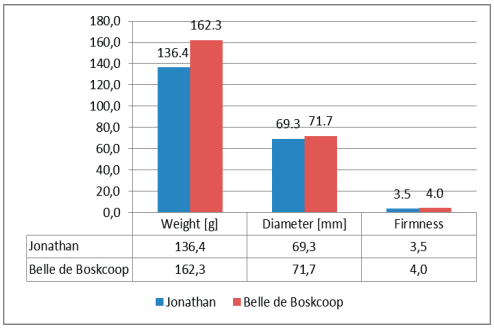

Figure 1. Apples physical parameters

Ancient apple cultivars were studies also by Iordănescu et al. (2019) in the Banat region. Jonathan cultivar in the Bran area presented higher weight compared with the Banat region (93.65 g). Oltenacu and Oltenacu (2013) presented higher physical parameters for Jonathan cultivar cultivated in the Ilfov area (171.05 g/fruit harvested at 3.47 kg f/cm^2). In Table 1 are presented data about the fruits' weight modification and the waste occurring during the controlled atmosphere storage period, October 2016 - January 2017.

Table 1. The behavior of the Jonathan and Belle of Boskoop cultivars grown in traditional orchards in controlled atmosphere storage

Cultivar	October	November	Waste	Weight loss
Jonathan	9415.78 g	9225 g	190.78	-
Boskoop	9181.65 g	8890 g	186.65	105
	December		**Waste**	**Weight loss**
Jonathan	8867.83 g		357.017	-
Boskoop	8763.68 g		126.32	-
	January		**Waste**	**Weight loss**
Jonathan	8438.83 g		429	-
Boskoop	8442.08 g		321.6	-

The weight variation in the four months period beginning with October, when they were harvested, until processed as chips was mostly due to damages. Similar results regarding fruit depreciation were observed at Ivan et al. (2019), where organic apples, after four months of storage at 1°C and 90% humidity, were affected by postharvest diseases, predominantly caused by fungal pathogens. Paul and Pandey (2014) presented an estimation for apple postharvest losses to 14% in developing countries. For both analyzed cultivars total losses were significantly lower than other similar researches with different storage conditions (Oltenacu and Oltenacu, 2013) where average total losses were at 16.33% compared with 9.18%. At Jonathan cultivar, total losses were 19.28% compared with 10.37% and damage losses 11.87% compared with 10.37%. Comparable results for the organic apple in a modified atmosphere were obtained by Chira et al. (2014).

Table 2 presents the fruit biochemical characteristics of the studied apple cultivars.

Table 2. The fruit biochemical composition of the Jonathan and Boskoop cultivars.

The apple cultivar	Water %	Total dry substance %	Sugar concentration %	Total acidity %	Ascorbic acid %
Jonathan	80.89	19.11	16.00	0.1009	97.20
Boskoop	89.22	10.78	11.00	0.2570	93.10

The obtained results showed that water, the fruits' main component, varied according to the cultivar, a higher content of water, 89.22%, being recorded at Boskoop cultivar.

The results of water content were similar with Bezdadea-Cătuneanu et al. (2019) for some cultivars of organic apples at the initial moment of storage (79.52%-87.25%) and similar for some cultivars studied by Bujdei et al. (2019) were water content for organic apple cultivars varied from 69.07% to 84.98%. Chira (2008) estimated an apple water content between 83-89%.

For Jonathan cultivar, Mureșan et al. (2014) registered significantly differences for water content (85.34%), total acidity (0.29%) and total soluble content (23.25% Brix) in the Reghin area. Similar, Oltenacu and Oltenacu (2013) for the Ilfov area.

Dry substance determination was an important analysis, which revealed apple quality. The fruit of the Johnathan cultivar was the richest in dry substance (19.11%), while of the Boskoop cultivar had a lower content (10.78%).

The total titratable acidity was recorded in a higher percentage, double even, with the Boskoop cultivar, being 0.2570% as compared to Jonathan's 0.1009%.

As for the sugar content, there were also notable differences, as the above table showed, the Johnathan apples being sweeter than the Boskoop ones. The ascorbic acid content was on about the same level: 93.1 and 97.2 (Figure 2).

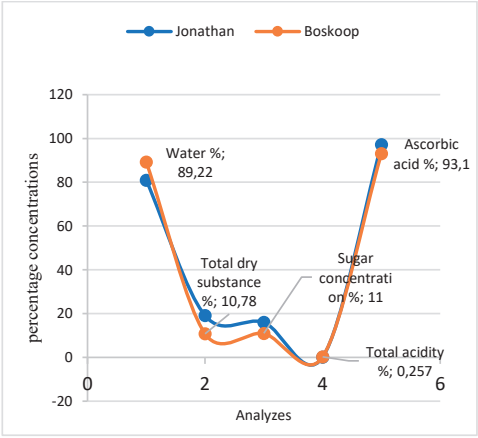

Figure 2. Structural analysis of Jonathan and Boskoop fruits

Obtaining apple chips by hot air drying

In order to determine the optimum time for apple drying at 80°C, after each hour the apple humidity was measured (Table 3).

Table 3. Determination of apple chips humidity

Time h	Temperature ^{0}C	Jonathan u %	Boskoop u %
1	80	16.271	17.024
2	80	14.494	15.671
3	80	12.744	14.194

For drying at 67° C, different time periods were necessary (Table 4) in order to obtain de necessary humidity.

Table 4. Determination of apple chips humidity after drying for a period of 3, 6 and 9 hours

Time h	Temperature ^{0}C	Jonathan u %	Boskoop u %
3	67	14.131	14.924
6	67	13.264	13.261
9	67	11.864	12.984

The apple chips humidities are represented after dehydration in different periods of time. At 80° C (Figure 3), Jonathan chips were more dehydrated than those in Boskoop apples, which leads us to conclude that the chips in Jonathan are drier, have a lower percentage of moisture and thus become more crunchy.

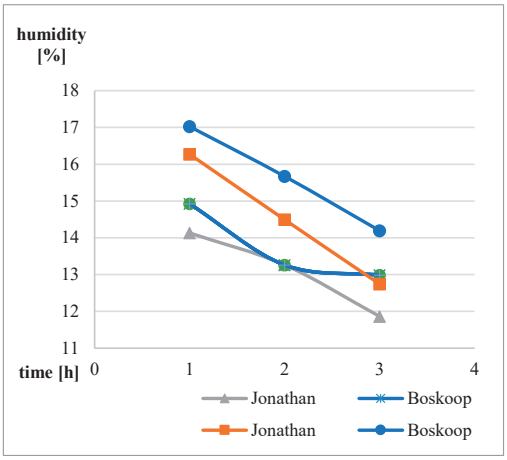

Figure 3. Variation of apple chips humidity on drying at 67^{0}C and 80^{0}C

Drying at 67^{0}C, after six hours was obtained for these apple cultivar samples the same value of the humidity (13.26%).

Different parameters after drying could be obtained according to apple cultivars, being important in the production process. Moura et al. (2005) presented also the differences in water loss during dehydration between apple cultivars according to several time units.

Determination of vitamin C content in dried chips

Ascorbic acid (vitamin C) content in the dried apple chips was lower than in fresh products due to the used temperature (Tables 5 and 6).

Table 5. Vitamin C content in dried apple chips at 80^{0}C

Time (h)	Temperature ^{0}C	Dry sample mass	Jonathan mg C vitamin	Boscoop mg C vitamin
1	80	100	61.070	58.163
2	80	100	54.963	52.347
3	80	100	48.856	46.530

Table 6. Vitamin C content in dried apple chips at 67^0C

Time (h)	Temperature ^{0}C	Dry sample mass	Jonathan mg C vitamin	Boscoop mg C vitamin
3	67	100	58.463	55.063
6	67	100	53.201	50.107
9	67	100	49.693	46.804

From the experimental data obtained from the samples of chips at a lower temperature, the quantitative values of vitamin C are higher for Jonathan cultivar at the same humidity and similar at Belle of Boskoop.

CONCLUSIONS

Jonathan and Belle of Boskoop, apple cultivars produced in a traditional organic orchard in Bran (Brașov) area, presented good post-harvest qualities.

For apple drying, the working temperature should be between 67^0C and 70^0C, in order to maintain their quality parameters, ascorbic acid presented a higher value at similar dry matter content and cultivar.

REFERENCES

Bezdadea-Cătuneanu, I. L., Stan, A., Zugravu, M., Frîncu, M., Bădulescu, L. (2019). Physiological parameters of some pomological species, for the initial moment before storage period – preliminary data. *Scientific Papers – Horticulture Series*, 62(1/2), 1-9.

Branişte, N., Uncheaşu, G. (2011). *Determinant of apple varieties*. Bucharest, RO: Ceres Publishing House.

Bujdei, A., Stan, A., Dobrin, A., Bădulescu, L., Stănică, F. (2019). Apples quality indicators variation during storage in controlled atmosphere conditions. *Scientific Papers. Series B, Horticulture*, LXIII (1), 91-96.

Chira, L. (2008). *Controlul calităţii fructelor [Fruits quality control]*, Bucharest, RO: Ceres Publishing House.

Chira, L., Chira, A., Delian, E., Alexe, C., Marin, L. (2014). Research concerning the influence of different storage conditions on the preservation capacity of some new apple varieties. *Scientific Papers. Series B. Horticulture*, LVIII, 29-31.

Cimpoieș, Gh. (2012). *Apple culture*. Kishinev, MD: Bons Offices Publishing House.

Cimpoieș, G., Bucarciuc, V., Caimacan, I. (2001). *Soiuri de măr [Apple cultivars]*, Chișinău, MD : Science Publiching House.

Clayden, G., Warren, W. (2001). *Organic Chemistry*. Oxford University Press.

Ghena, N., Branişte, N. (2003). *Cultura Specială a Pomilor [Special fruit tree cultivation]*. Bucharest, RO: Matrix Rom Publishing House.

Hoza, D. (2000). *Pomologie [Pomology]*. Prahova, RO: Prahova Publishing House.

Iordănescu, O. A., Călin, C. C., Becherescu, A., Camen, D., Scedei, D., Bala, M. (2019). Research concerning the quality of fruits of some ancient apple tree varieties in conditions of western part of Romania. *Scientific Papers. Series B, Horticulture*, LXIII (1), 129-136.

Ivan, E. S., Ciceoi, R., Jerca, I. O., Nițu, O. A., Stan, A. (2019). Postharvest pathology of organic apples from Romania. Preliminary study. *Scientific Papers. Series B, Horticulture*, LXIII (1), 81-84.

Moura, C. P., Masson, M. L., Yamamoto, C. I. (2005). Effect of osmotic dehydration in the apple (*Pyrus malus*) varieties Gala, Gold and Fuji. *Thermal Engineering*, 4(1), 46-49.

Mureșan, E. A., Muste, S., Borșa, A., Vlaic, R. A., Mureșan, V. (2014). Evaluation of physical-chemical indexes, sugars, pigments and phenolic compounds of fruits from three apple varieties ar the end of storage period. *Bulletin UASVM Food Science and Technology*, 71(1), 45-50.

Oltenacu, N., Oltenacu, C. V. (2013). The influence of the drip irrigation on the physical and chemical apple characteristics. *Scientific Papers. Series B. Horticulture*. LVII, 99-103.

Paul, V., Pandey, R. (2014). Role of internal atmosphere on fruit ripening and storability - A review. *Journal of Food Science and Technology*, 51(7), 1223-1250.

Râpeanu, G. (2010). Control of food falsification. *Laboratory techniques and analyses*. Bucharest, RO: Didactic and Pedagogical Publishing House.

Saei, A., Tustin, D. S., Zamani, Z., Talaie, A., Hall, A. J. (2011). Cropping effects on the loss of apple fruit firmness during storage: The relationship between texture retention and fruit dry matter concentration. *Scientia Horticulturae*, 130, 256-265.

Stănică, F., Branişte, N. (2011). *Ghid pentru pomicultori [Guide for fruit growers]*. Bucharest, RO: Ceres Publishing house.

Ticha, A., Salejda, A. M., Hyspler, R., Matejicek, A., Paprstein, F., Zadak, Z. (2015). Sugar composition of apple cultivars and its relationship to sensory evaluation. *Zywnosc. Nauka. Technologia. Jakosc*, 4(101), 137-150.