Scientific Papers. Series B, Horticulture. Vol. LXV, No. 2, 2021
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

INFLUENCE OF PRE AND POST-HARVEST CONDITIONS ON QUALITY INDICATORS AND MICROBIOTA OF ORGANIC *ARONIA MELANOCARPA*

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Abstract

Organic chokeberries (Aronia melanocarpa L.) are plants with unique health-promoting properties, due to its high content of antioxidants in fruits. The present study focuses on the incidence of fungal pathogens and the quality parameters of organic chokeberry in different storage conditions. Two organic chokeberry varieties, 'Nero' and 'Nero Eggert', were harvested in August 2020 from the University of Agronomic Sciences and Veterinary Medicine of Bucharest experimental orchard, stored in normal and controlled atmosphere conditions, and analysed during the storage period. In pre-harvest field, for both varieties of chokeberry it were performed two different fertilization scheme: control (untreated) and treated variant with organic fertilizers applied on soil or by foliar sprays. Aronia melanocarpa L. fruits were monitored in terms of: shape index, firmness, total soluble solids, total titratable acidity, dry matter content, total phenolic content, antioxidant activity and fungal fruit pathogens during storage. Total phenolic content and antioxidant activity showed similar behaviour during storage period for all samples. Penicillium, Botrytis and Alternaria were the main fungal pathogens identified on organic chokeberry fruits.

Key words*: chokeberry, controlled atmosphere, DPPH, fungal pathogens, storage condition.*

INTRODUCTION

Black chokeberry (*Aronia melanocarpa*) is a plant native to North America and was transferred to Europe about a century ago (Chrubasik & Li, 2010) and is a member of *Rosaceae* family, *Maloideae* subfamily (Howard et al., 2013).

The cultivation of *Aronia* for the food industry started in Russia in 1900s in the cold areas of Siberia and, afterwards the crops spread all over Russia. In the first half of the 20th century, the plant was introduced also to the other European countries like Poland, Germany, Finland, Sweeden and Norway (Jannick et al, 2008). At the beginning of cultivation in Europe, chokeberry was used for domestic production of juices and jams, but in the recent years, *Aronia* berries was cultivated more as an industrial crop (Hardin, 1973; Strigl et al., 1995).

Previous studies show that chokeberry is one of the richest fruits in phenolic compounds, they have antioxidant potential, bringing multiple health benefits for the consumers (Denev et al., 2012). However, due to its astringent taste and high tannin content, chokeberries is not a very popular table fruit, despite its qualities. (Chrubasik et al., 2010)

Recent studies have shown, regarding the maximum reach levels of fruits anthocyanin content and weight, the optimal harvest period is at the end of August, beginning of September (Andrzejwska et al., 2015).

Postharvest environmental conditions have a major impact on visual and compositional quality of fruits. The most important component of postharvest environmental is temperature that has a great impact on the quality of fresh fruits (Cheng et al., 2013). It is estimated that about 25% of the harvested fruits are decayed by pathogens during postharvest (Droby, 2006).

During the early stages of growth, the pathogens remain in the fruit tissues and remain there for all the maturation period. After harvesting, the diseases will be visible during the storage period (Passey et al., 2017).

MATERIALS AND METHODS

Samples

Two varieties of organic chokeberry, 'Nero' and 'Nero Eggert', were harvested in 2020 from the experimental field of the University of Agronomic Sciences and Veterinary Medicine of Bucharest. For both varieties of chokeberry it were performed two different fertilization scheme: control, untreated (noted with M) and treated variant (noted with TR) with organic fertilizers applied on soil or by foliar sprays. They were stored at 1° C and 95% relative humidity (RH) for one day, after which they were transported to Postharvest Technologies Laboratory from Research Center for Studies of Food Quality and Agricultural Products**.**

After the initial analyses were performed, the fruits were evenly distributed and stored in three different conditions: 1) normal atmosphere (NA) with 1°C and 95% RH, 2) controlled atmosphere conditions with 1˚C, 95% RH, 3% and 5% CO_2 (CA 5% CO_2), and 3) controlled atmosphere conditions with 1°C, 95% RH, 1.5% O_2, and 10% CO_2 (CA 10% CO_2).

Organic chokeberries samples were analysed in 5 different moments, initial (noted with 0-zero), after 1, 3, 6, 7 months of storage (noted with 1, 3, 6, 7).

Chemicals

To determine antioxidant activity, DPPH (1,1-diphenyl-2-picrylhydrazyl) and Folin & Ciocalteu's reagent were purchased from Sigma-Aldrich Chemie GmbH (Riedstrasse, Steinheim).

Methanol used was bought from Honeywell (Riedel-de Haën, Seelze, Germany).

Gallic acid was purchased from Carl Roth and Trolox (6 - hydroxy - 2, 5, 7, 8 - tetramethylchroman - 2 - carboxylic acid) from Acros Organics, Fisher Scientific (Geel, Belgium). Sodium hydroxide 0.1N was from Cristal R Chim S.R.L. (Bucharest, Romania) and anhydrous sodium carbonate was purchased from Lach-Ner, s.r.o. (Neratovice, Czech Republic).

Ultrapure water used it was made with a Milli-Q equipment (Millipore, Bedford, MA).

Potato dextrose agar (PDA) used in microbiological analyses was purchased from Scaharlau S.A. (Germany).

Quality indicators

Quality parameters were represented by firmness, total titratable acidity (TTA), pH, dry matter (DM) and total soluble solids (TSS), methods of analysis being described forward.

Firmness results were obtained and expressed in N/cm² using a digital penetrometer (53205 TR Italy) equipped with a 3 mm piston.

TTA and pH analysis were realised using the TitroLine automatic titrometer, equipped with pH electrode. The analysis consist in mixing 5 g of fresh homogenized sample with 25 mL of distilled water, measuring the initially pH values and then titration with 0.1N NaOH until the final pH is 8.1° T according with AOAC Official Method 942.15. For TTA, results were expressed in g malic acid /100g of fresh fruit similar with Stan et al. (2020).

Dry matter results were obtain using UN110 Memmert oven and drying approximately 1 g of sample at 105°C (Stan et al., 2020) until constant weight. The analysis of total soluble solids (TSS) were performed using Kruss DR301-95 digital refractometer (Cătuneanu et al., 2017).

Phenolic content and antioxidant activity

For total polyphenol content (TPC) quantitative determination was used the Folin–Ciocâlteu method adapted after Georgé et al., (2005) protocol. Samples extraction consist in trituration of 1 g fresh sample with 10 mL of 70% methanol and incubated overnight at room temperature (aprox. 22°C) and dark. Extraction continue next day through 500 rpm homogenization for 1 h and, then centrifugation for 5 min at 4°C and 7000 rpm. The supernatant was recovered and the residue re-extracted two more times and the final volume of extract was 30 mL. By mixing 0.5 mL of extract with 2.5 mL of Folin-Ciocâlteu reagent and incubated for 2 minutes at room temperature (aprox. 22°C) is the first step in total polyphenol content determination. Second step is represented by adding 2 mL of 7.5% sodium carbonate solution (Na_2CO_3) and incubate the obtained mix for 15 minutes at 50°C. The final step is based on the absorbance read at Specord 210 Plus UV-VIS spectro-photometer (Analytik Jena, Jena, Germany) at the 760 nm wavelength. Results are expressed in mg GAE/100 g fresh weight and Gallic. Gallic acid is used as standard solution.

Antioxidant activity determination was used the DPPH (2,2-diphenyl- 1-picrylhydrazyl) method, similar as Bujor et al. (2016) with modifications presented forward. Mixing 0.4 mL of extract with 2 mL of 0.2 mM solution of DPPH in methanol and incubated for 30 minutes, in dark with continuous homogenising. The absorbance was measured at 515 nm wavelength. Results were expressed as mg Trolox/100 g FW. The blank reference was realised with methanol.

Pathogens identification

The experiments were realised in the Plant Protection Diagnostic Laboratory. Organic chokeberries were analysed in 3 different moments: after 3, 6 and 7 months of storage in all 3 conditions. The samples were incubated at 22°C for 48 hours on PDA (potato-dextrose agar) culture medium, followed by macroscopic identification of pathogens.

The preparation of PDA culture in the pathogen development was made by following the existing literature (Hulea et al., 1969). Petri dishes with 65 mm diameter were used.

Statistical analysis

Statistical analysis of obtained data was performed using Microsoft Excel for standard deviation, represent the average of three replicates with independent sample preparation.

RESULTS AND DISCUSSIONS

Quality indicators

Both varieties of chokeberries registered quality indicators variation for all of the three storage conditions.

Experiment were performed during 7 months of storage, but physiological disorders appears after 3 months of storage in NA conditions, and 5 months of storage in CA conditions (1.5% CO_2, 16% O_2, 1°C, 95% RH and 1.5% CO_2, 16% O_2, 3°C, 95% RH).

The initially TTA values of 'Nero' variety untreated 0.97 ± 0.07 g malic acid/100 g FW (Table 1), after 6 months of storage, the TTA values decrease to 0.86 ± 0.01 g malic acid/100 g FW, which means the acidity of chokeberries increases after 6 months of storage.

Table 1. Variation of pH, total titratable acidity (TTA), total soluble solids (TSS), and dry matter (DM) content during storage of 'Nero Eggert' variety

Variety/ Treatment	Storage conditions	Analysis moment (months)	pH	TTA (g malic acid/100 g FW)	Total soluble solids (%)	Dry matter (%)	Firmmnes (kg/cm²)
Nero/ untreated	NA with 1°C, 95% RH	0	3.51 ±0.03	0.97 ±0.07	16.45 ±2.45	22.07 ±0.46	0.33 ±0.07
		1	3,43 ±0.06	1.11 ±0.02	18.87 ±1.05	23.94 ±1.43	0.453 ±0.098
		3	3.29 ±0.00	1.08 ±0.01	19.79 ±0.94	24.15 ±0.21	0.315 ±0.047
		6	3.69 ±0.01	0.86 ±0.01	19.95 ±1.60	27.46 ±0.76	0.393 ±0.063
		7	3.73 ±0.01	0.91 ±0.01	22.17 ±1.41	26.38 ±1.02	0.410 ±0.106
	CA 1.5% CO_2, 16% O_2, 1°C, 95% RH	1	3.41 ±0.02	1.03 ±0.01	17.89 ±2.10	24.44 ±1.42	0.403 ±0.061
		3	3.37 ±0.05	1.01 ±0.01	18.85 ±0.65	23.34 ±0.27	0.405 ±0.064
		6	3.73 ±0.01	0.88 ±0.03	20.69 ±1.92	30.57 ±1.22	0,388 ±0,051
		7	3.64 ±0.02	0.94 ±0.01	23.44 ±1.39	29.09 ±2.08	0.422 ±0,089
	CA 1.5% CO_2, 16% O_2, 3°C, 95% RH	1	3.37 ±0.05	1.07 ±0.01	19.14 ±2.30	23.64 ±1.83	0.450 ±0,094
		3	3.38 ±0.07	1.03 ±0.04	20.45 ±0.99	23.12 ±1.32	0,391 ±0,049
		6	3.72 ±0.01	0.88 ±0.03	19.39 ±2.56	22.46 ±2.11	0412 ±0.062
		7	3.70 ±0.03	0.87 ±0.02	21.25 ±1.77	27.19 ±1.45	0.355 ±0.051
Nero/ treated	NA with 1°C, 95% RH	0	3.47 ±0.02	1.11 ±0.004	18.21 ±1.20	22.75 ±0.46	0.37 ±0.05
		1	3.36 ±0.05	1.09 ±0.01	19.65 ±1.42	23.55 ±0.68	0.415 ±0.043
		3	3.40 ±0.07	1.04 ±0.04	20.49 ±0.98	26.11 ±0.51	0.357 ±0.075
		6	3.74 ±0.02	0.80 ±0.01	21.48 ±0.77	27.10 ±0.89	0.376 ±0.064
		7	3.77 ±0.01	0.87 ±0.001	21.88 ±1.77	28.57 ±0.00	0.396 ±0.086
	CA 1.5% CO_2, 16% O_2, 1°C, 95% RH	1	3.39 ±0.08	1.06 ±0.03	19.50 ±1.12	25.21 ±1.09	0.442 ±0.052
		3	3.31 ±0.02	1.03 ±0.03	18.97 ±0.87	21.68 ±0.20	0.341 ±0.045
		6	3.66 ±0.01	0.95 ±0.01	21.11 ±1.18	27.88 ±1.42	0.408 ±0.048
		7	3.68 ±0.06	0.94 ±0.01	20.82 ±2.89	27.69 ±2.22	0.442 ±0.089
	CA 1.5% CO_2, 16%O_2, 3°C, 95% RH	1	3.37 ±0.06	1.06 ±0.01	19.21 ±0.67	25.36 ±0.51	0.349 ±0.086
		3	3.41 ±0.07	1.05 ±0.01	20.05 ±1.26	23.28 ±0.27	0.414 ±0.088
		6	3.66 ±0.09	0.95 ±0.01	22.01 ±1.41	27.41 ±0.39	0.410 ±0.084
		7	3.63 ±0.03	0.90 ±0.02	22.38 ±1.09	27.20 ±1.50	0.443 ±0.054

Nero treated variety show similar variation of TTA after 6 months of storage. Similar behavior were observed at 'Nero Eggert' variety (Table 2), both treated and untreated, in all 3 storage conditions.

TSS values showed constant increases to all samples, in all storage conditions, fruits dehydrating considerable after 3 months of storage, which increase the concentration of total soluble solids. During the storage period, the value of TSS for the fruits stored in NA with 1°C, 95% RH increase much more compared to the fruits stored in CA 1.5% CO_2, 16% O_2, 1°C, 95% RH and CA 1.5% CO_2, 16% O_2, 3°C, 95% RH. Dry matter values showed significant increases for all samples, in all storage conditions, after 6 months of storage.

The firmness values of 'Nero' variety, both treated and untreated showed an increase after 1 month of storage, in all storage conditions. After 3 months of storage the firmness showed a small decrease to all samples.

'Nero Eggert' showed a constant decrease of firmness values (Table 2) after one month of storage, with exception of untreated sample stored in NA with 1°C, 95% RH, variation being similar to Nero variety.

Table 2. Variation of pH, total titratable acidity (TAA), total soluble solids (TSS), and dry matter (DM) content during storage of 'Nero Eggert' variety

Variety/ Treatment	Storage conditions	Analysis moment (months)	pH	TAA (g malic acid/100 g FW)	Total soluble solids (%)	Dry matter (%)	Firmmnes (kg/cm²)
Nero Eggert/ untreated	NA with 1°C, 95% RH	0	3.49 ±0.01	0.97 ±0.01	17.78 ±2.06	24.7 ±0.80	0.343 ±0.045
		1	3.44 ±0.03	0.96 ±0.02	19.26 ±2.06	25.08 ±0.81	0.442 ±0.067
		3	3.32 ±0.02	0.92 ±0.012	19.51 ±1.53	24.14 ±0.19	0.338 ±0.064
		6	3.80 ±0.01	0,61 ±0.011	20.82 ±1.12	26.59 ±0.53	0.300 ±0.083
		7	3.71 ±0.01	0.89 ±0.004	19.77 ±2.27	27.45 ±0.38	0.567 ±0.085
	CA 1.5% CO_2, 16% O_2, 1°C, 95% RH	1	3.42 ±0.03	0.96 ±0.002	17.43 ±1.63	24.25 ±0.94	0.407 ±0.064
		3	3.42 ±0.11	0.90 ±0.03	19.19 ±1.83	22.54 ±0.15	0.374 ±0.067
		6	3.73 ±0.01	0.78 ±0.003	17.91 ±2.61	26.84 ±1.25	0.376 ±0.105
		7	3.69 ±0.01	0.80 ±0.01	21.50 ±1.91	28.50 ±0.66	0.342 ±0.087
	CA 1.5% CO_2, 16% O_2, 3°C, 95% RH	1	3.44 ±0.03	0.93 ±0.01	18.15 ±1.15	23.55 ±0.68	0.359 ±0.081
		3	3.36 ±0.03	0.91 ±0.02	19.44 ±1.26	24.17 ±1.04	0.374 ±0.067
		6	3.72 ±0.02	0.78 ±0.003	21.51 ±1.23	25.24 ±1.00	0.338 ±0.077
		7	3.71 ±0.01	0.78 ±0.02	20.27 ±0.84	26.92 ±0.90	0.407 ±0.057
Nero Eggert/ treated	NA with 1°C, 95% RH	0	3.50 ±0.01	1.00 ±0.02	20.36 ±1.42	23.19 ±0.72	0.408 ±0.05
		1	3.42 ±0.06	1.00 ±0.006	18.47 ±1.34	23.46 ±0.72	0.416 ±0.067
		3	3.36 ±0/02	0.93 ±0.02	19.03 ±1.60	23.32 ±0.25	0.348 ±0.055
		6	3.71 ±0.01	0.81 ±0.02	20.90 ±0.74	25.66 ±0.01	0.371 ±0.067
		7	3.71 ±0.02	0.79 ±0.01	19.61 ±1.25	26.97 ±0.43	0.442 ±0.086
	CA 1.5% CO_2, 16% O_2, 1°C, 95% RH	1	3.43 ±0.03	1.02 ±0.02	18.90 ±0.81	22.86 ±0.49	0.414 ±0.070
		3	3.37 ±0.02	0.99 ±0.01	18.90 ±1.87	22.64 ±0.43	0.367 ±0.065
		6	3.74 ±0.04	0.85 ±0.02	20.63 ±1.42	27.81 ±0.42	0.388 ±0.051
		7	3.71 ±0.01	0.87 ±0.004	22.63 ±1.42	30.03 ±0.35	0.418 ±0.073
	CA 1.5% CO_2, 16% O_2, 3°C, 95% RH	1	3.46 ±0.03	1.00 ±0.03	18.68 ±1.19	21.26 ±0.15	0.416 ±0.047
		3	3.38 ±0.04	0.96 ±0.01	18.73 ±1.26	22.59 ±0.52	0.341 ±0.060
		6	3.70 ±0.01	0.85 ±0.02	19.97 ±1.96	24.12 ±1.37	0.375 ±0.066
		7	3.68 ±0.04	0.82 ±0.01	22.05 ±2.31	26.43 ±0.67	0.395 ±0.099

Phenolic content and antioxidant activity

Total phenolic content were determined from whole fruit and showed similar behavior for both varieties in all tested storage conditions. For Nero variety, initially TPC values was 1274.5 mg GAE/100 g FW, results similar with those obtain by Catană et al. (2017), which demonstrate important increases during storage after 3 and 6 months of storage, up to 1667.1, respectively 1812 mg GAE/100 g FW for fruits stored in NA with 1°C, 95% RH. The increases are similar to the samples stored in CA 1.5% CO_2, 16% O_2, 1°C, 95% RH and CA 1.5% CO_2, 16% O_2, 3°C, 95%.

TPC was better preserved in CA 1.5% CO_2, 16% O_2, 1°C, 95% RH during storage period, for all varieties (Figure 1).

All samples present a high antioxidant activity, initially value being registered at 699.78 mg Trolox Eqiv/100 g FW for 'Nero' variety untreated, 742.84 mg Trolox Eqiv/100 g FW for 'Nero' variety treated, 682,675 mg Trolox Eqiv/100 g FW for 'Nero Eggert' variety untreated and 723.59 mg Trolox Eqiv/100 g FW for 'Nero Eggert' variety treated, results similar to Kapci et al. (2013). After 1 month of storage all samples stored in all condition have showed important increases of antioxidant activity, but after 3 months, chokeberries stored in NA with 1°C, 95% RH, showed the higher increase of antioxidant activity. After 6 months, all samples stored in all condition showed a high increase of antioxidant activity, up to 1002.11 mg Trolox Eqiv/100 g FW on 'Nero' variety treated stored in NA with 1°C, 95% RH (Figure 2).

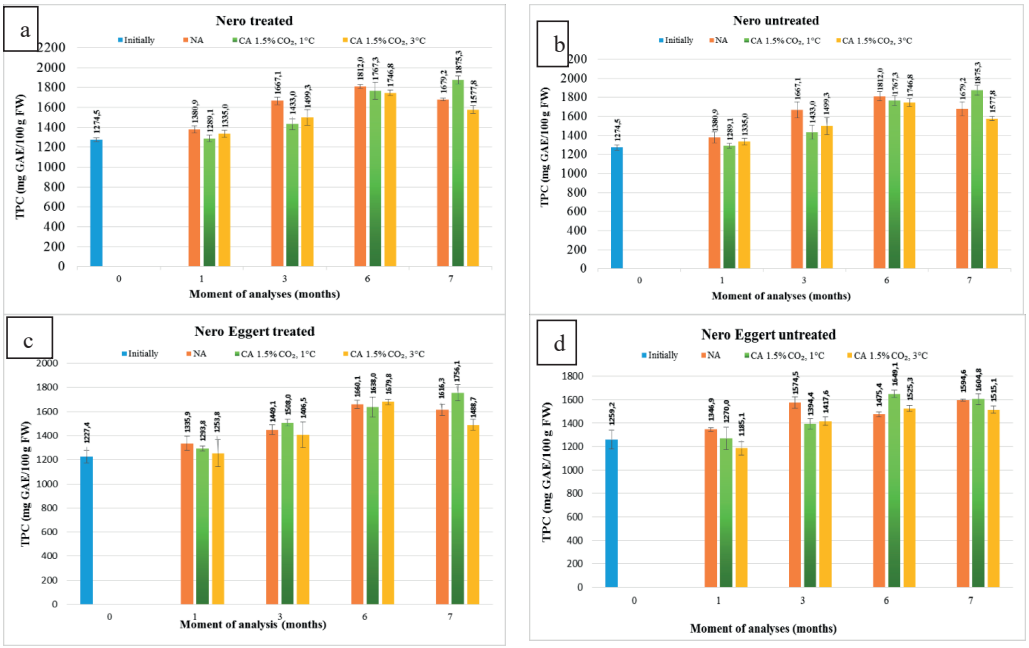
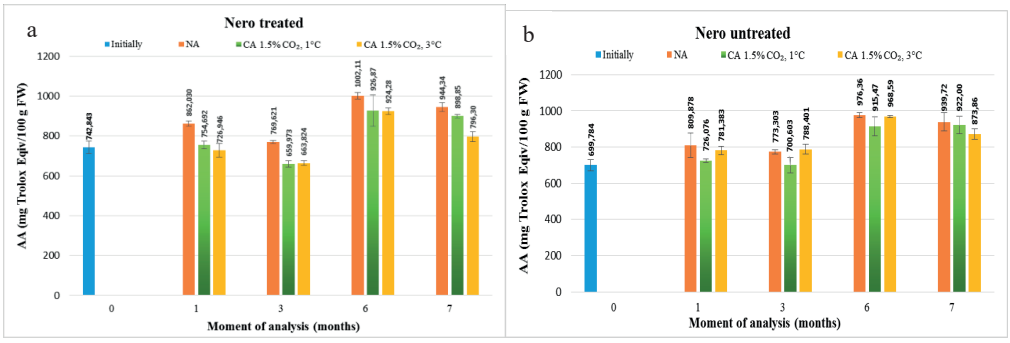


Figure 1. Total phenolic content variations for organic 'Nero' and 'Nero Eggert' chokeberries, registered during storage period (a-'Nero' variety treated; b-'Nero' variety untreated; c-'Nero Eggert' variety treated; d-'Nero Eggert' variety untreated)



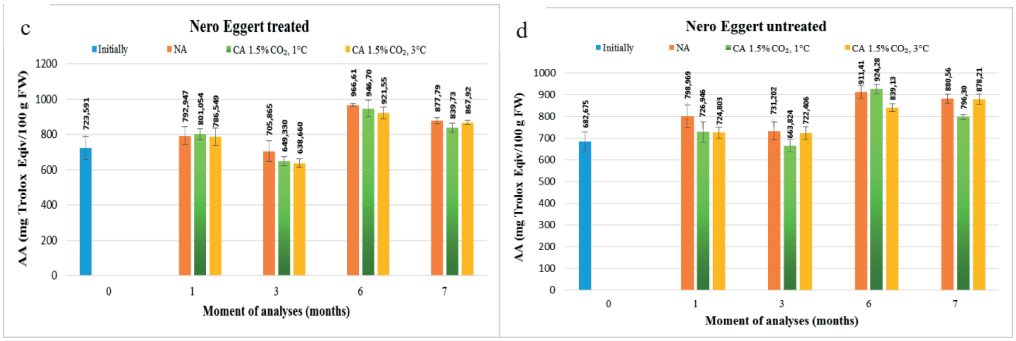


Figure 2. Antioxidant activity variations for organic 'Nero' and 'Nero Eggert' chokeberries, registered during storage period (a-'Nero' variety treated; b-'Nero' variety untreated; c-'Nero Eggert' variety treated; d-'Nero Eggert' variety untreated)

Pathogens identification

Studying the pathogens found on the harvested fruits, it was found that the microflora present in the samples consisted of genus fungi species like *Fusarium* spp., *Penicillium* spp., *Cladosporium* spp. and *Alternaria* spp. After 3 months of storage, *Penicillium* spp. were found on all the samples, exception being 'Nero' variety untreated stored in CA 1.5% CO_2, 16% O_2, 3°C, 95% RH (Tables 3, 4).

High incidence of *Alternaria* spp. were observed on untreated samples, comparative with treated samples, in all storage conditions, in all moments of analyses. *Botrytis* spp. incidence were higher in NA with 1°C, 95% RH than in both CA 1.5% CO_2, 16% O_2, 1°C, 95% RH and CA 1.5% CO_2, 16% O_2, 3°C, 95% RH. *Cladosporium* spp. was detected only on samples stored in CA 1.5% CO_2, 16% O_2, 1°C, 95% RH and 'Nero Eggert' variety treated stored in NA with 1°C, 95% RH. *Fusarium* spp. was only detected on 'Nero Eggert' variety untreated stored in NA with 1°C, 95% RH.

Table 3. Identification of fungal pathogens in 'Nero' variety

Variety/ Treatment	Storage conditions	Analysis moment (months)	*Peniciullium* spp.	*Fusarium* spp.	*Alternaria* spp	*Cladosporium* spp.
Nero/ Untreated	NA with 1° C, 95% RH	3	+	-	-	-
		6	+	+	-	-
		7	+	+	-	-
	CA 1.5% CO_2, 16% O_2, 1°C, 95% RH	3	+	-	-	+
		6	+	-	-	+
		7	+	-	-	+
	CA 1.5% CO_2, 16% O_2, 3°C, 95% RH	3	-	-	-	-
		6	-	-	-	+
		7	-	-	-	+
Nero/ Treated	NA with 1°C, 95% RH	3	+	-	-	-
		6	+	-	-	-
		7	+	-	-	-
	CA 1.5% CO_2, 16%O_2, 1°C, 95% RH	3	+	-	+	+
		6	+	-	+	+
		7	+	-	+	+
	CA 1.5% CO_2, 16% O_2, 3°C, 95% RH	3	+	-	-	+
		6	+	-	-	+
		7	+	-	-	+

Table 4. Identification of fungal pathogens in 'Nero Eggert' variety

Variety/ Treatment	Storage conditions	Analysis moment (months)	*Peniciullium* spp.	*Fusarium* spp.	*Alternaria* spp	*Cladosporium* spp.
Nero Eggert/ Untreated	NA with 1° C, 95% RH	3	+	-	-	-
		6	+	-	-	-
		7	+	-	-	-
	CA 1.5% CO_2, 16% O_2, 1°C, 95% RH	3	+	+	-	-
		6	+	+	-	-
		7	+	+	-	-
	CA 1.5% CO_2, 16% O_2, 3°C, 95% RH	3	-	-	-	+
		6	-	-	+	+
		7	-	-	+	+
Nero Eggert/ Treated	NA with 1°C, 95% RH	3	+	-	-	-
		6	+	-	-	-
		7	+	-	-	-
	CA 1.5% CO_2, 16% O_2, 1°C, 95% RH	3	+	-	-	+
		6	+	-	+	+
		7	+	-	+	+
	CA 1.5% CO_2, 16% O_2, 3°C, 95% RH	3	+	-	-	+
		6	+	-	-	+
		7	+	-	-	+

CONCLUSIONS

Organic fertilization did not significantly influence the properties of chokeberry fruits, all quality indicators are similar between treated and untreated fruits.

The results show that the fruit retains its firmness better in both controlled atmosphere conditions comparative to normal atmosphere storage.

The longest storage period had the varieties stored in CA 1.5% CO_2, 16% O_2, 1°C, 95% RH, but to keep the antioxidant capacity at higher values, it is recommended to store the fruits for a maximum 6 months.

RECOMMENDATIONS

'Nero' variety stored in NA with 1°C, 95% RH, had the highest concentration of TPC after 6 months of storage, which is the maximum storage period, to keep the phenolic content at the optimal level.

'Nero' variety stored in CA 1.5% CO_2, 16% O_2, 1°C, 95% RH, showed constant firmness values during storage, being the most performing variety of chokeberries.

ACKNOWLEDGEMENTS

This work was supported by a grant of the Romanian Ministry of Research and Innovation, CCCDI - UEFISCDI, project number PN-III-P1-1.2-PCCDI-2017-0662, within PNCDI III.

REFERENCES

AOAC. (2000). Official method 942.15 Acidity (Titrable) of fruit products read with A.O.A.C official method 920. 149. Preparation of test sample.

Chrubasik,, G., Li, G., Chrubasik, S. (2010). The clinical effectiveness of chokeberry: a systematic review. *Phytotherapy Research*, 24, 1107-1114.

Andrzejewska J., Sadowska, K., Klóska L., Rogowski L. (2015). The effect of plant age and harvest time on the content of chosen components and antioxidative potential of black chokeberry fruit. *Acta Sci. Pol. Hortorum Cultus*, 14, 105-114.

Bujor, O.C., Le Bourvellec C., Volf, I., Popa, V.I., Dufour, C. (2016). Seasonal variations of the phenolic constituents in bilberry (*Vaccinium myrtillus* L.) leaves, stems and fruits and their antioxidant activity. *Food Chemistry*, 213, 58-68.

Catană, L., Catană, M., Iorga, E., Asănică. A. C., Lazăr, A. G., Lazăr, M. A., Belc, N. (2017). Vitamin C and total polyphenol contentand antioxidant capacity of fresh and processedfruits of aronia melanocarpa. *Scientific Papers. Series B, Horticulture*. Vol. LXI, 2017.

Cătuneanu, I., Bădulescu, L., Dobrin, A., Stan, A., Hoza, D. (2017). The influence of storage in controlled atmosphere on quality indicators of three blueberries varieties. *Scientific Papers. Series B, Horticulture.* Vol. LXI, 2017.

Cheng, C., Gao. X., Feng, B., Sheen, J., Shan, L., He, P. (2013). Plant immune response to pathogens differs with changing temperatures. *Nat. Commun,* 4, 25-30.

Denev, P. N., Kratchanov, C. G., Ciz, M., Lojek, A., Kratchanova, M. A. (2013). Bioavailability and Antioxidant Activity of Black Chokeberry (*Aronia*

melanocarpa) Polyphenols: *in vitro* and *in vivo* Evidences and Possible Mechanisms of Action: A Review. Comprehesive *Reviews in Food Science and Food Safety*, 11, 471-489.

Droby, S. (2006). Improving quality and safety of fresh fruits and vegetables after harvest by the use of biocontrol agents and natural materials. *Acta Horticul.*, 709, 45-51.

Georgé, S., Brat P., Alter P., Amiot J. M. (2005). Rapid determination of polyphenols and vitamin C in plant-derived products. *J. Agric. Food. Chem.*, 53, 1370-1373.

Hardin, J. W. (1973). The Enigmatic Chokeberries (Aronia, Rosaceae). *Bulletin of the Torrey Botanical Club,* 100, 178-184.

Howard, L. R., Brownmiller, C., Prior, L. R., Mauromoustakos, A. (2013). Improved Stability of Chokeberry Juice Anthocyanins by β-Cyclodextrin Addition and Refrigeration. *Journal of Agricultural and Food Chemistry*, 61, 693-699.

Hulea, A. (1969). Ghid pentru laboratorarele de micologie și bacteriologie. Bucharest: RO, Ed. Agrosilvica.

Jannick, J., Bayogan, E., Paull, R (2008). Soursoup Annona muricata. The Encyclopedia Fruit and Nuts.

Kapci, B., Neradova, E., Čížková, H., Voldřich, M., Rajchl, A., Capanoglu, E. (2013). Investigating the antioxidant potential of chokeberry (*Aronia melanocarpa*) products. *Journal of Food and Nutrition Research*, 52, 219-229.

Passey, T. A. J., Robinson, J. D., Shaw, M. W., Xu, X. M. (2017). The relative importance of conidia and ascospores as primary inoculum of *Venturia inaequalis* in a southeast England orchard. *Plant Pathology*, 66(9), 1445-1451.

Stan, A., Butac, M., Ion, V. A., Cătuneanu, I., Frîncu, M., Bădulescu, L. (2020). Post-harvest technologies influences in organic 'tita' plums quality. *Scientific Papers. Series B, Horticulture*. Vol. LXIV, No. 2, 2020.

Strigl, A. W., Leitner, E., Pfannhauser, W (1995). Qualitative und Quantitative Analyse der Anthocyane in Schwarzen Apfelbeeren (*Aronia melanocarpa* Michx. Ell.) mittels TLC, HPLC und UV/VIS-Spektrometrie. *European Food Research and Technology*, 201, 266-268.