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PHYSICO-CHEMICAL AND ANTIOXIDANT PROPERTIES OF COLD-PRESSED ARONIA JUICE

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ABSTRACT

Aronia, as a berry fruit rich in nutrients, represents a suitable raw material for obtaining cold-pressed juices. The chemical composition of aronia indicates the presence of a large amount of polyphenolic compounds and anthocyanins, which contribute to its antioxidant and antimicrobial properties. This study describes the process of producing cold-pressed juice from organically grown aronia (Organic Control System certified), which is frozen immediately after pressing without pasteurization and the addition of additives. Physico-chemical analyses included determination of acidity, pH value, dry matter content, and pectin content. Based on the analysis results of antioxidant properties, which involved determination of total phenols, flavonoids, FRAP, DPPH, and ABTS tests, the study showed that cold-pressed aronia juice has high antioxidant properties. Considering that aronia juice is cold-pressed, aimed at reducing the effects of elevated temperatures on the quality of aronia juice, without the addition of additives, preservatives, colors, sweeteners, etc., it can be said that its good antioxidant properties originate from the raw material, i.e., aronia berries.

Keywords: aronia, cold-pressed juice, antioxidant activity.

INTRODUCTION

The deciduous black-fruited shrub aronia (lat. *Aronia melanocarpa* L.) belongs to the rose family (lat. *Rosaceae*) and originates from eastern North America, including eastern Canada. Today, it is also cultivated in Eastern Europe (Bilić 2017). Aronia is grown both as an ornamental plant and for the high nutritional value of its berries, as well as their antioxidant properties and distinctive flavor. Aronia cultivation initially focused on its strong purple pigment resulting from high anthocyanin content, leading to its use as a natural coloring agent in the food and pharmaceutical industries. In the food industry, aronia is commonly processed into juices and syrups, while the fruit can be consumed raw, dried, or used in compotes, jams, wines, and liqueurs (Šnebergová et al. 2014).

The chemical composition of aronia varies significantly and depends on numerous factors, including genotype, degree of ripeness, climate conditions, harvest time, and fertilizer use. Aronia contains B-group vitamins, vitamin C, β-carotene, and significant amounts of dietary fibers, minerals, carbohydrates, and organic acids (Šnebergová et al. 2014).

Berry fruits represent a rich source of phenolic compounds and other bioactive components. Isolated bioactive components from aronia can contribute to human health. Aronia contains various polyphenols (proanthocyanidins, anthocyanins, flavonoids, phenols, and phenolic acids) with anti-inflammatory and antiviral properties (Bataraga and Valkovska, 2020).

The aim of this study was to produce cold-pressed juice from aronia grown in the Republic of Srpska and to investigate its physical-chemical and antioxidant properties.

MATERIAL AND METHODS OF WORK

For the production of cold-pressed juice, aronia grown in the area of the city of Prnjavor, located in the northwest part of the Republic of Srpska, was used. The aronia production at this household holds an organic production certificate (OCS - Organic Control System). Aronia berries were harvested at the stage of technological maturity. After harvest, all fruits that did not meet satisfactory quality standards were discarded, the berries were washed, and then cold-pressed to extract the juice. The obtained juice was packed into 0.5 L plastic bottles and frozen at -20°C. The juice was not pasteurized, and no sugar, preservatives, or any other additives were added. During analysis, after opening, the juice was stored in a refrigerator at 4°C.

Analysis of physico-chemical properties: Determination of dry matter content was performed refractometrically using a Leica Mark II Plus ABBE refractometer. pH value was measured using a pH meter Hanna Instruments HI-1122. Acidity and pectin content were determined according to the Regulation on Sampling and Methods of Chemical and Physical Analysis for Quality Control of Fruit and Vegetable Products, Official Gazette of the SFRY 29/83.

Antioxidant activity determination: The total phenolic content was determined using the modified method of Folin-Ciocalteu (Wolfe et al. 2003), and the content of flavonoids was determined using the method of Ordenez et al. (2006). The testing of antioxidant activity using the Ferric reducing/Antioxidant power (FRAP) assay was carried out in accordance with Banzie and Strain (1996); the 2,2′-azinobis(3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt (ABTS) assay using the modified method of Re et al. (1999) and the 2,2- diphenyl-1-picryl-hydrazyl (DPPH) assay using the method of Brand-Williams et al. (1995) with some modification. A 0.1 mM solution of DPPH (1,1-diphenyl-2-picrylhydrazyl) in methanol was prepared. 1 mL of aqueous honey solution was mixed with 1 mL of DPPH solution. The mixture was left to stand for 30 min in the dark and absorbance was read spectrophotometrically at 517 nm. The results were expressed as µg of gallic acid (GA) /mg honey. All the chemicals and reagents used were of analytical grade.

RESULTS AND DISCUSSION

Table 1 shows the results of the analysis of the physico-chemical properties of cold-pressed aronia juice: acidity, pH value, dry matter content, and pectin content. The measured acidity in aronia juice was 10.29 g/L. Since the cold-pressed aronia juice was analyzed without any additions, it can be concluded that the acidity in the juice originates from the aronia berries. Aronia berries naturally contain about 1 to 1.5% organic acids, with the most prevalent being malic, tartaric, and citric acids (Šnebergová et al. 2014). Organic acids are a crucial component after sugars because their presence and composition affect sensory properties (Denev et al. 2018). Sosnowska et al. (2016) reported organic acid content ranging from 12.27 to 21.87 g/L in aronia juice, which are higher values compared to those obtained in this study.

Table 1. Physico-chemical analysis of cold-pressed juice.

Parameter	Aronia juice
Acidity (g/L)	10,29 ± 0,02
pH value	3,33 ± 0,02
Dry matter content (%)	19,23 ± 0,01
Pectin content (%)	0,16 ± 0,00

Aronia juice is an acidic product with a low pH value influenced by the content of organic acids. The measured pH value in cold-pressed aronia juice was 3.33, similar to the results reported by Bolling et al. (2015) measured pH values ranging from 3.15 to 3.45. Slightly higher values than those measured are reported by Tolić et al. (2017), who measured pH values ranging from 3.77 to 3.96, and Tolić et al. (2018), who reported pH values ranging from 3.54 to 3.92, as well as Sosnowska et al. (2016), who reported pH values from 3.42 to 3.72. Such low pH values indicate that aronia juice is an acidic product which, combined with its low sugar content, affects its consumer acceptability negatively (Tolić et al. 2018).

The dry matter of aronia fruits consists mainly of sugars, proteins, amino acids, and lipids (Sidor and Gramza-Michałowska 2019). The dry matter content in aronia juice was measured at 19.23%. Tolić et al. (2018) reported dry matter content ranging from 7.96% to 22.55%, while Tolić et al. (2017) reported values from 19.22% to 26.94%, which are similar to the measured results. Sidor and Gramza-Michałowska (2019) indicated dry matter content in aronia fruits from 17.9% to 26%, and in juice from 11.1% to 17.4%. Ochmian et al. (2012) reported dry matter content in fruits from 15.3% to 19.5%, of which soluble matter ranged from 14.2% to 18.7%. The dry matter content in aronia depends on the variety, fruit maturity, climatic conditions (Sidor & Gramza-Michałowska 2019), and soil composition where aronia is cultivated (Trenka et al. 2020).

Aronia fruits are moderately rich in pectins, with content ranging from 0.30% to 0.75% (Trenka et al. 2020). Adam and Versini (1996) note that pressing fruit juice removes most of the pectin substances, which are predominantly located in the fruit pulp. The pectin content in the analyzed juice is 0.16%, which is lower compared to the literature data reported for aronia fruits.

Table 2. Results of antioxidant activity.

Parameter	Aronia juice
Total phenolic content (mg GAE/L)	3468,80 ± 28,28
Total flavonoids content (mg GAE/L)	2786,19 ± 3,26
FRAP (mmol Fe^{2+}/mL)	30,78 ± 0,06
DPPH (μg TE/mL)	1548,33 ± 11,23
ABTS (mg TE/mL)	0,89 ± 0,01

Table 2 presents the results of the antioxidant activity of aronia juice, where it can be seen that the content of total phenols in aronia juice was 3468.80 mg GAE/L. Tolić et al. (2017) state that the content of phenolic compounds in aronia depends on the harvesting season and climatic conditions, reporting values ranging from 8563.8 to 12055.7 mg GAE/L. Efenberger-Szmechtyk et al. (2020) report the content of total phenols in aronia fruit to be around 8615 mg GAE/L. These literature data indicate slightly higher values of total phenol content compared to the result obtained in this study. The reason for this could be the loss of certain components during fruit processing into juice. Jurikova et al. (2017) measured the content of total phenols in aronia juice ranging from 690 to 2560 mg GAE/L, which represents slightly lower values compared to the value obtained in this study. The high content of phenolic compounds in aronia juice is important as research confirms their significant impact on reducing plasma lipid peroxidation, scavenging free radicals, and replenishing antioxidant enzymes (Jurikova et al. 2017).

The content of flavonoids in aronia juice was 2786.19 mg GAE/L (Table 4.2). Tolić et al. (2017) measured flavonoid content in aronia juice ranging from 6994 to 9710 mg GAE/L and found significant differences depending on the harvest season. They also state that flavonoids represent the most abundant group of phenolic compounds in aronia, specifically from 79.2 to 87.5%. A large number of literature sources indicate that quercetin is the most abundant flavonoid in aronia (Denev et al. 2012).

The FRAP value for aronia juice is 30.78 mmol Fe2+/mL. Tolić et al. (2017) report FRAP values in aronia juice ranging from 128.2 to 179.5 mmol Fe2+/mL, which are higher compared to the values obtained in this study. The DPPH value in aronia juice is 1548.33 μg TE/mL, and ABTS is 0.89 mg TE/mL. There are few literature results for DPPH and ABTS expressed in the units used in this study, thus making comparison difficult.

CONCLUSIONS

Aronia represents a raw material increasingly used to produce various products, among which cold-pressed juices are often found. Based on the results presented in this study, it can be seen that aronia has extremely strong antioxidant properties and contains large amounts of phenolic compounds

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DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

LITERATURE

Adam, L., & Versini, G. (1996). *A study on the possibilities to lower the content of methyl-alcohol in eaux-de-vie de fruits*. European commission. Directorate-general 12. Science, research and development.

Bataraga, A., Valkovska, V. (2020). Phytochemical Profile of Chokeberry (*Aronia melanocarpa*). *Key Engineering Materials*, *850*, 184-189.

Benzie, I. F. F., Strain, J. J. (1996). Ferric reducing ability of plasma (FRAP) as a measure of antioxidant power: the FRAP assay. *Analytical Biochemistry, 239*(1), 70-76.

Bilić, D. P. (2017). *Utjecaj načina ekstrakcije na prinos bioaktivnih spojeva iz praha aronije* (*Aronia melanocarpa* L.). Master rad. Zagreb, Hrvatska: Univerzitet u Zagrebu, Poljoprivredni fakultet.

Bolling, B. W., Taheri, R., Pei, R., Kranz, S., Yu, M., Durocher, S. N., Brand, M. H. (2015). Harvest date affects aronia juice polyphenols, sugars and antioxidant activity, but not antocyanin stability. *Food Chemistry*, *187*, 189-196.

Brand-Williams, W., Cuvelier, M. E., Barset, C. (1995). Use of a free radical method to evaluate antioxidant activity. *LWT – Food Science and Tehnologie*, *30*(7), 748-753.

Denev, P. N., Kratchanov, C. G., Ciz, M., Lojek, A., Kratchanova, M. G. (2012). Bioavailability and Antioxidant Activity of Black Chokeberry (*Aronia melanocarpa*) Polyphenols: *in vitro* and *in vivo* Evidences and Possible Mechanisms of Action: A Review. *Food Science and Food Safety*, *11*(5), 471-489.

Denev, P., Kratchanova, M., Petrova, I., Klisurova, D., Georgiev, Y., Ognyanov, M., & Yanakieva, I. (2018). Black chokeberry (Aronia melanocarpa (Michx.) Elliot) fruits and functional drinks differ significantly in their chemical composition and antioxidant activity. *Journal of Chemistry*, *2018*(1), 9574587.

Efenberger-Szmechtyk, M., Nowak, A., Czyżowska, A., Kucharska, A. Z., Fecka, I. (2020). Composition and Antibacterial Activity of *Aronia melanocarpa* (Michx.) Elliot, *Cornus mas* L. and *Chaenomeles superba* Lindl. Leaf Extracts. *Molecules, 25*(9), 2011.

Jurikova, T., Mlcek, J., Skrovankova, S., Sumczynski, D., Sochor, J., Hlavacova, I., Snopek, L., Orsavova, J. (2017). Fruits of Black Chokeberry *Aronia melanocarpa* in the Prevention of Chronic Diseases. *Molecules, 22*(6), 944.

Ochmian, I. D., Grajkowski, J., & Smolik, M. (2012). Comparison of some morphological features, quality and chemical content of four cultivars of chokeberry fruits (Aronia melanocarpa). *Notulae botanicae horti agrobotanici cluj-napoca*, *40*(1), 253-260.

Official Gazette of the SFRY 29/83. (1983). Regulation on Sampling and Methods of Chemical and Physical Analysis for Quality Control of Fruit and Vegetable Products.

Ordonez, A. A. L., Gomez, J. D., & Vattuone, M. A. (2006). Antioxidant activities of Sechium edule (Jacq.) Swartz extracts. *Food chemistry*, *97*(3), 452-458.

Re, R., Pellegrini, N., Proteggente, A., Pannala, A., Yang, M., Rice-Evans, C. (1999). Antioxidant activity applying an improves ABTS radical cation decolorization assay. *Free Radical Biology and Medicine*, *26*(9-10), 1231-1237.

Sidor, A., & Gramza-Michałowska, A. (2019). Black chokeberry Aronia melanocarpa L.—A qualitative composition, phenolic profile and antioxidant potential. *Molecules*, *24*(20), 3710.

Sosnowska, D., Podsędek, A., Kucharska, A. Z., Redzynia, M., Opęchowska, M., & Koziołkiewicz, M. (2016). Comparison of in vitro anti-lipase and antioxidant activities, and composition of commercial chokeberry juices. *European Food Research and Technology*, *242*(4), 505-515.

Šnebergová, J., Cižková, H., Neradová, E., Kapci, B., Rajchl, A., Voldřich, M. (2014). Variability of Characteristic Componentes of Aronia. *Czech Journal of Food Sciences*, *32*(1), 25-30.

Milijaš, M., & Cvetković, D. (2025). Physico-chemical and antioxidant properties of cold-pressed aronia juice. *STED Conference 14*(2), 247-251.

Tolić, M. T., Krbavčić, I. P., Vujević, P., Milinović, B., Jurčević, I. L., Vahčić, N. (2017). Effects of Weather Conditions on Phenolic Content and Antioxidant Capacity in Juice of Chokeberries (*Aronia melanocarpa* L.). *Poland Journal of Food Nutrition Science*, *67*(1), 67-74.

Tolić, M. T., Marković, K., Vahčić, N., Samarin, I. R., Mačković, N., Krbavčić, I. P. (2018). Polyphenolic profile of fresh chokeberry and chokeberry products. *Croatian Journal of Food Technology, Biotechnology and Nutrition, 13*(3-4), 147-153.

Trenka, M., Nawirska-Olszańska, A., & Oziembłowski, M. (2020). Analysis of selected properties of fruits of black chokeberry (Aronia melanocarpa L.) from organic and conventional cultivation. *Applied Sciences*, *10*(24), 9096.

Wolfe, K., Liu, R. H. (2003). Apple peels as a value added food ingredient. *Journal of Agricultural Food Chemistry, 51*(6), 1676-1683.