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SEASONAL VARIATION OF THE PHYSICAL AND CHEMICAL PARAMETERS OF WILD GENOTYPES OF CORNELIAN CHERRY (*Cornus mas L.)*

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Abstract

The paper reports the physical and chemical characteristic in fresh fruit from two populations of cornelian cherry (Cornus mas L.) wild genotypes originated from Bosnia and Herzegovina during the two years 2012 and 2013. Fruits were assayed for physical properties (fruit and stone weight, fruit length, width, thickness, and stone length and width) and soluble solids, total acidity, reducing sugar, ascorbic acid, total phenol and anthocyanin contents. The cornelian cherries weighed from 1.6 g (Bugojno area, 2012 year) up to 2.1g (Konjic area, 2012 year). Ascorbic acid content ranged from 253.62 (Bugojno area, 2012) up to 440.60 (Konjic area, 2013) mg 100g^{-1} fresh weight. Anthocyanin content ranged from 389.10 (Konjic area, 2012) up to 398.92 (Bugojno area, 2012) mg cyanidin-3- glucoside equivalents 100 g^{-1} fresh weight whereas phenol content ranged from 2158.55 (Konjic area, 2012) up to 2750.38 (Konjic area, 2013) mg gallic acid equivalents 100 g^{-1} fresh weight.

Key words: *cornelian cherry, ascorbic acid, anthocyanins, phenols, growing region*

1. INTRODUCTION

The entire genus of Cornelian cherry originates in Europe from where it has spread throughout the world (Bosancic 2009). The Cornelian cherry has been utilized by the people in the Balkans for many thousands years. In Bosnia and Herezegovina, Cornelian cherry fruits are mostly gathered from bushes growing in the wild. Currently this plant is less known and this new source can be potential as a functional food or value added ingredients in future in our dietary system. Cornelian cherry fruits have unusual flavors and qualities with sour and sweet tasting juice. These fruits represent a rich source of nutrients for humans such as vitamins C, dietary fiber, antioxidants, tannin, anthocyanins etc. (Ercisli 2011; Ersoy *et al*. 2011; Seeram *et al*. 2002; Yilmaz *et al*. 2009, Demir and Kalyoncu 2003). Anthocyanins are the red and blue pigments present in a large number of plant tissues including leaves, flowers, and fruit and therefore are consumed as normal components of the diet (McGhie *et al.* 2003). Anthocyanins are known for their antioxidant and anti-inflammatory effects. (Tural 2008). The antioxidant properties of cornelian cherry have been documented in the literature and cornelian cherry has some of the highest ascorbic acid, anthocyanin, phenolic and antioxidant activity among the many other fruits (Pantelidis *et al.* 2007; Pawlowska *et al.* 2010). Therefore, fruits of Cornelian cherry are valuable for fresh consumption and for processing to produce jams, juices, syrups, spirits and other traditional products.

Cornelian cherry fruits don't capture enough attention nor from fruit breeders nor from food producers in B&H (Begic-Akagic *et al,* 2013; Drkenda *et al,* 2014). Therefore, more evidences about technological properties as well the health-promoting components of wild Bosnian cornelian cherry genotypes are highly neccessary. Information like these could lead to a better understanding and an increased consumption of this fruit and related products, including theirs use in functional foods and as ingredients in pharmaceuticals, nutraceuticals, and medicine.

The objectives of this study were:

1. Determination of fruit weight, stone weight, flesh/stone ratio, fruit length, fruit width, fruit thickness of Bosnian Cornelian cherry genotypes
2. Determination of soluble solids, total acidity, reducing sugar, ascorbic acid, total phenol and anthocyanin content of Bosnian Cornelian cherry genotypes

The overall aim of the study was to examine the influence of seasonal variations (harvesting years: 2012 and 2013) and growing regions (Konjic and Bugojno) at the physical and chemical properties of Cornelian cherry fruit.

2. MATERIAL AND METHODS

2.1. Plant material

Cornelian cherry (*Cornus mas L.*) wild genotypes fruits were collected in Bosnia and Herzegovina, from two growing regions: Konjic (altitude = 1200m) and Bugojno (altitude = 875 m). Konjic and Bugojno regions are one of the most important and famous regions for uncultivated cornelian cherry production in Bosnia and Herzegovina. Soil and climate characteristics of selected regions are as follows: Konjic has an average annual air temperatures of 8,5^{0}C, annual precipitation of 1234 mm; the soil type on this site is dystric cambisol on phyllites. This is a deep, skeletal soil with shallow humus-accumulative horizon; Bugojno has an average air temperatures 8,8^{0}C and annual precipitation of 814 mm; soil types are ranker and dystric cambisol on phyllites, which are well-aerated and with pH range from slightly acidic to neutral. The fruits were harvested on October 7th 2012 from Bugojno region and on October 16th 2012 from Konjic region. In 2013, the harvesting time was on 18th of September for both Konjic and Bugojno region. The main criteria for the determination of harvest maturity was skin colour and fruit soluble solids content were. All fruit were harvested at the technological maturity stage (dark red colour of skin and more than 16 % of total soluble solids. Fruits were harvested from seven trees of each growing region (each year in 5 replications). The amount of 30 randomly chosen fruits from each tree was used for analyses (210 fruit per each growing region). Harvested fruits were poured in a mixer and the average sample was obtained by means of quantitation. Each parameter was measured in five replications from the fruit taken from each tree of particular cultivars (n = 35). After the harvest, samples were immediately transferred to the laboratory of Agriculture and Food technology, at the University of Sarajevo and storaged at -20° C until the analysis.

2.2. Physico- chemical analyses

Fruit and stone weigth was measured by an electronic balance with an accuracy of 0.01 g. The width, length and thickness of the fruits and stone were measured by using digital vernier caliper with a sensitivity of 0.01 mm and fruit flesh ratio was calculated using (fruit weigth – stone weight)*100/fruit weight formula. From each location 30 fruits were taken for physical analysis. The skin colour variables were measured immediately after harvesting. The CIELAB colour system (CIE, Commission Internationale de l'Eclairage 1986) with its values L*, a* and b* were measured with a Konica Minolta CR- 400 Chroma Meter (Minolta, Japan) on the site opposite to the fruit suture to describe the colour of the cornelian cherry fruits. The general parameters were measured following official methods (AOAC 2000); total soluble solids content was measured by extracting and mixing one drop of juice, measured by digital hand refractometer with an accuracy of 0.1, (EUROMEX). Total acidity was measured with 0.1 M NaOH, with a bromothyimol blue as indicator, and expressed as percentage of malic acid. The reducing sugar content was determined following the Luff- Schoorl method (Lees 1975). Ascorbic acid concentration was determined by a redox titration using iodine and results were expressed in mg ascorbic acid equivalent as mg per 100 g fresh weight. The amount of total phenolics was measured at 765 nm by the Folin- Ciocalteu reagent (Dewanto et al. 2002). Samples were homogenized at homogenizer (IKA, GERMANY) and extraction was performed with solution methanol, water and formic acid in a ratio 60:37:3. Total phenolic content was expressed in mg gallic acid equivalents (GAE) 100 g^{-1} fresh weight (mg GAE/100 g).

Total anthocyanin content was measured with the pH differential absorbance method, as described by Wrolstad et al. (2001). Briefly, absorbance of the extract was measured at 510 and 700 nm in buffers at pH 1.0 (potassium chloride, 0.025 M), and 4.5 (sodium acetate, 0.4 M). Results were expressed in mg cyanidin 3- glucoside equivalents 100 g -1 fresh weight.

2.3. Statistical analysis

Two-way analysis of variance (MANOVA) was used to determine the effect of growing season and growing region) at the physical and chemical properties of Cornelian cherry fruit and the determined differences were tested by the Tukey test at a significance level of 0.05 (using the SPSS 16 program).

3. RESULTS AND DISCUSSION

3.1.Physical properties

The results obtained for physical properties of Cornelian cherry fruits during 2012 and 2013, for Konjic and Bugojno region are shown in Table 1. During the 2-years study, a significant influence of the season was

observed on all parameters, except fruit flesh ratio parameter. Growing region showed significant impact on these 3 parameters: fruit weight, fruit length and stone length. The interaction between region and season was recorded on parameters: fruit and stone weight, fruit and stone length. Fruit weight was higher in 2012 as compared with the data in 2013, both for Konjic and Bugojno region. Our results for fruit weight were higher than those in the study of Tural and Koca (2008) and were in accordance with the study of Demir and Kayloncu (2003). If compared with some other studies (Bijelic et al. 2011; Ercisli et al. 2011; Yilmaz et al. 2009; Gunduz et al. 2013) our results were lower than the results presented in these studies. Stone weight was constant during 2012 and 2013 for Konjic area and for Bugojno area stone weight was higher in 2012 as compared with the data in 2013. When comparing to previous studies (Bijelic et al. 2011), our results for stone weight were lower than results presented there. Fruit width was significantly higher in 2013 as compared with the data in 2013, for both Konjic and Bugojno area.

Table 1. Physical properties of cornelian cherry fruits

Growing Region		Konjic		Bugojno	
Growing Season		2012	2013	2012	2013
Fruit weight	(g)	2.02 ± 0.18 b	1.90 ± 2.21 bc	2.57 ± 0.19a	1.74 ± 0.20c
Stone weight	(g)	0.37 ± 0.05b	0.37 ± 0.03 b	0.44 ± 0.09 a	0.32 ± 0.04 c
Fruit width	(mm)	6.81 ± 0.38 b	11.55 ± 0.77 a	6.94 ± 0.41b	11.57 ± 1.36 a
Fruit length	(mm)	12.51 ± 0.59b	15.04 ± 0.64a	15.2 ± 0.65b	15.60 ± 0.83 a
Fruit thickness	(mm)	7.50 ± 0.18 b	12.53 ± 0.86 a	7.45 ± 0.15b	12.20 ± 1.15a
Fruit flesh ratio	(%)	81.70 ± 1.71a	80.47 ± 2.21a	82.58 ± 3.69 a	81.53 ± 1.99 a
Stone width	(mm)	4.40 ± 0.22 b	6.11 ± 0.43 a	4.35 ± 0.22b	5.96 ± 0.40a
Stone length	(mm)	7.74 ± 0.27 c	11.90 ± 0.62 b	7.71 ± 0.22c	15.66 ± 0.83 a

Different letters in rows from a to c for each parametar indicate significantly different values among growing reagion and season $P<0.05$

Data for fruit width in 2013 were in accordance with the previous studies (Tural and Koca 2008) and at the same time quite lower in relation to data reported by other authors (Nalbandi et al. 2009; Gunduz et al. 2013). Fruit length was higher in 2013 as compared with the data in 2012, for both Konjic and Bugojno area. Our results for fruit length were slightly lower than those presented in previous studies (Tural and Koca 2008; Nalbandi et al. 2009; Gunduz et al. 2013). Fruit thickness was significantly higher in 2013 as compared with the data in 2012, both for Konjic and Bugojno region. Data for fruit thickness in 2013 were in accordance with previous studies (Nalbandi et al. 2009) and higher (Demir and Kayloncu 2003). Fruit flash ratio was higher in 2012 than in 2013. Our results for fruit flesh ratio were in agreement with Begic-Akagic et al. (2013) who reported a fruit flesh ratio of 77.46-83.96%. Stone width and length were higher in 2013 as compared to 2012. Compared with previous studies (Demir and Kayloncu, 2003) our results for stone width were higher.

3.2. Chemical properties

Results for chemical properties of cornelian cherry fruits during 2012 and 2013, for Konjic and Bugojno region are shown in Table 2. During the 2-years study, a significant impact of the season was observed on all chemical parameters, except total anthocyanin content. Growing region showed significant impact on all chemical parameters except total phenolics and total anthocyanin content. The interaction between region and season was recorded on all chemical parameters, except total phenolics and total anthocyanin content. Total soluble solids content was higher in 2012 as compared with the data in 2013 for both Konjic and Bugojno region. Obtained results for total soluble solids were in accordance to the previous studies (Tural and Koca 2008; Demir and Kayloncu 2003; Yilmaz et al. 2009; Gunduz et al. 2013). Total acidity was higher in 2013 as compared with the data in 2012. Our results for total acidity were in accordance with the results in previous studies (Tural and Koca 2008; Demir and Kayloncu 2003; Gunduz et al. 2013). Many factors affect soluble solids and acidity in fruit

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species including the cultivar, altitude, environmental conditions, etc. (Guleryuz et al. 1998; Ercisli and Orhan 2007). Reducing sugars were higher in 2012 as compared to the data in 2013. If compared with other authors (Demir and Kayloncu 2003; Yilmaz et al. 2009) reducing sugars in our study are in accordance with their results. Ascorbic acid content was higher in 2013 as compared to the data in 2012. Our results for ascorbic acid content were higher in relation to previous studies (Tural and Koca 2008; Demir and Kayloncu 2003; Yilmaz et al. 2009; Ercisli et al. 2011). Total phenolics were higher in 2013 as compared with the data in 2012. Total phenolics content was in range of the results in previous studies (Tural and Koca 2008; Demir and Kayloncu 2003). Total anthocyanin content was higher in 2013 as compared with the data in 2012 for Konjic region, but for Bugojno region it was on contrary. Our results were higher in relation to other authors (Tural and Koca 2008; Yilmaz et al. 2009).

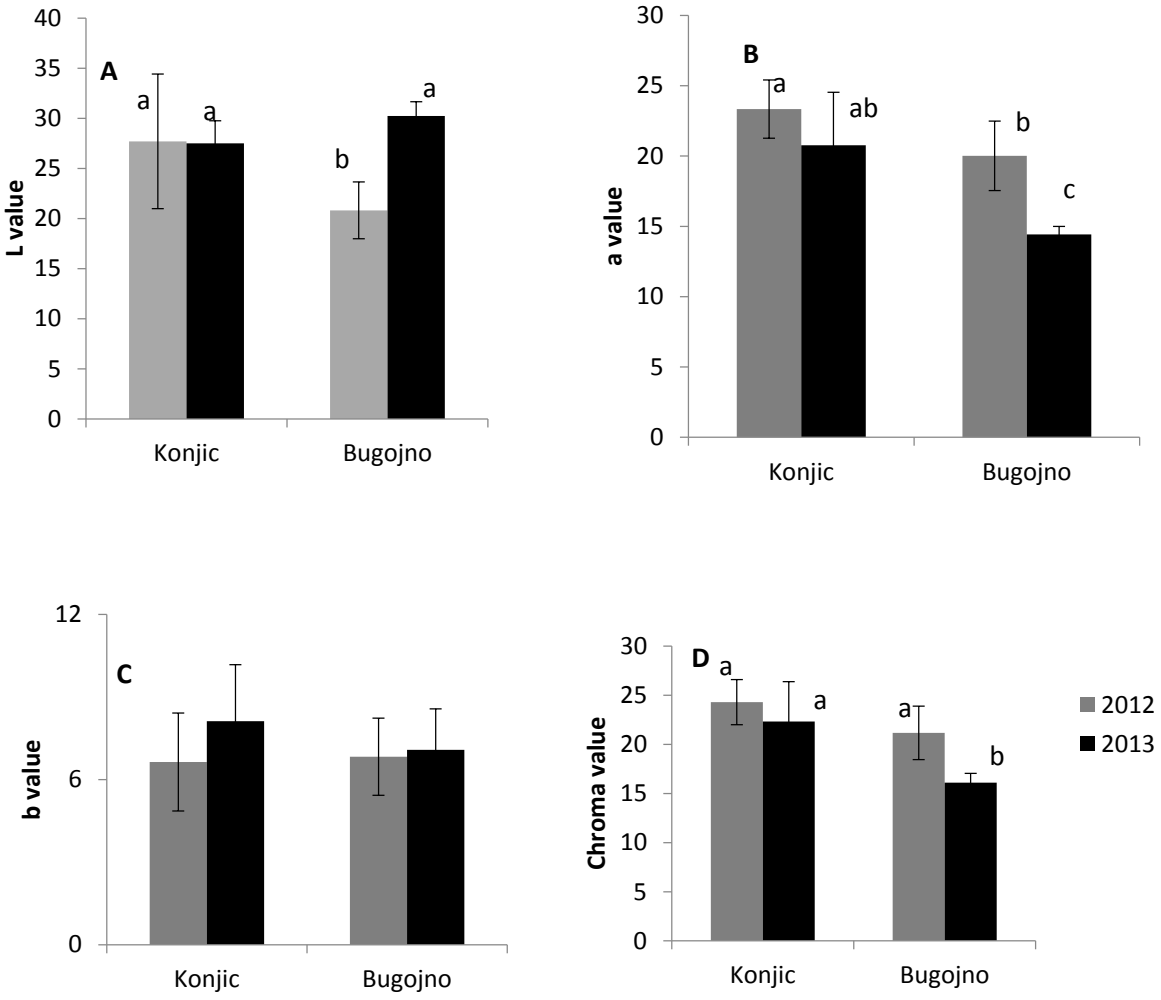
Table 2.: Chemical properties of cornelian cherry fruit

Growing region		Konjic				Bugojno			
Growing season		2012		2013		2012		2013	
Soluble solids content	(°Brix)	21.1	± 0.1 a	16.95	± 0 .01c	20.9	±0.1 a	18.21	± 0 .07b
Total acidity	(g/100g)	1.99	± 0 a	2.72	± 0.07 b	2.05	± 0 a	2.07	± 0.02 a
Reducing sugars (g/100 g fw)		12.04	± 0.03 a	7.95	± 0.02c	12.03	± 0 a	8.45	± 0.16 b
Ascorbic acid (mg/100 g fw)		428.24 a	± 43.69	440.60 a	± 10.40	253.62	± 10.2b	410.61	± 10.48 a
Total phenolics (mg GAE/100 g fw)		2158.55 b	± 111.39	2750.38 a	± 22.23	2218.21	± 46.97b	2691.42	± 14.58 a
Total anthocyanin content(mg/100 g fw)		389.10	± 3.81 a	397.20	± 0.39 a	398.92	± 1.79 a	390.05	± 15.14a

Different letters in rows from a to c for each parametar indicate significantly different values among growing reagion and season $P<0.05$

3.3.Colour parameters

In the next charts (1-4) colour values for cornelian cherry from two growing areas and two growing seasons (2012 and 2013) are presented. A significant influence of growing region and season on colour parameters (except for b *) values were evident. The great differences in fruit colour among the two growing areas and seasons can be explained by inhomogeneous fruit ripening. In the chart A values for L^* (lightness) values were presented, and cornelian cherry from area Bugojno season 2013 had the highest values (L* =30.24), and the lowest values had were recorded for cornelian cherry from Bugojno area, season 2012. (L* =20.81). In other studies reported by Tural and Koca (2008) and Drkenda et al. (2014) lightness values are in range from 10.82 to 33.60. In the chart B values for greenness/redness values (a) are presented, wherein the highest values had samples of cornelian cherry from Konjic area, 2012. years (a* =23.34), and the lowest values had samples from Bugojno season 2012. (a* =14.42). Obtained results are slightly higher than those reported by Tural and Koca (2008) (from 6.25 to 15.59) and Drkenda et al. (2014), (from 7.50 to 18.33). Blueness/yelowness values b* were ranged from 6.64, for samples from Konjic area, 2012. years, to 8.12, for samples from Konjic area too season 2013. In other studies b * values are in range from 3.46 to 6.64 (Tural and Koca 2008) and from 1.22 to 11.35 (Drkenda et al. 2014). The chroma values (chart D) ranged from 16.11 for season 2013. from Bugojno area, to 24.30, for 2013. years but for Konjic area.



Charts (1-4). Colour parameters (L^*, a^*, b^*) and Chroma (C^*) of cornelian cherry fruit from different growing region (Konjic and Bugojno) and season (2012 and 2013)

4. CONCLUSIONS

Our study clearly demonstrates the significance of cornelian cherry fruits in the class of berry fruit in Bosnia and Herzegovina. At the same time this study gives enough reasons for fruit breeders and producers to intensively include cornelian cherry in their program. Bosnian cultivars of cornelian cherry showed high content of ascorbic acid content, total phenolics content and total anthocyanins content which. Cornelian cherry could be considered as a good source of natural antioxidants, which was confirmed in our measurement. Therefore, it is recommendable to use cornelian cherry in functional foods and as ingredients in pharmaceuticals, nutraceuticals, and medicine. This study confirmed significant influence of growing region and growing season on physical and chemical properties of cornelian cherry. These valuable findings about cornelian cherry should be more promoted in order to improve the quality of human life.

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