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TESTING OF CHEMICAL COMPOSITION OF WILD BERRIES

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Abstract

Berry fruit consumed fresh or processed into various products (juices, jams, fruit yogurt, ice cream, beverages, etc.) provides a valuable addition to any diet of people around the world. Surveys carried out in the last ten years show that berries, because of the content of antioxidant substances, vitamins, minerals, fiber and other physiologically active components, significantly affect the preservation of human health.

Chemical composition of berries has a great influence on their appearance, color, smell and taste. These types of fruit has a sweet taste, fruity smell, soft and juicy flesh consistency. Fruit color, depends on the berry type, can vary between the bright red and dark blue shades. Chemical fruit composition of each variety is greatly influenced by environmental factors, maturity stage and storage conditions.

In this paper the authors are presented results obtained during the examination of basic chemical composition, vitamin and mineral content, and the content of antioxidant substances in several species of wild berries, which produced in the eastern part of the Republika Srpska. Content of water determined in different berry is following: strawberries (80.51- 85.19%), raspberries (80.86-83.76%), blueberries (79.37-85.12%), black currants (75.06-80.46%), blackberries (82.16-86.11%) and gooseberries (81.16-84.24%). Depending on the type of fruit, protein content ranged from 0.50-0.92% (strawberry) to 1.42-1.65% (black currant), the average carbohydrate content from 8.00% (blackberry) to 13.06% (black currant), the average fat content from 0.23% (black currant) to 0.77% (raspberry), and ash content ranged from 0.15-0.28% (blueberry) to 0.68-1.10% (black currant). Energy value of berries is low (below 50 kcal/100 g). The analysis shows the following contents of calcium (5-50 mg/100 g), iron (0.30-1.30 mg/100 g), zinc (0.10-0.60 mg/100 g). Among the vitamins, ascorbic acid (1.9-60.51 mg/100 g) and riboflavin (0.02-0.05 mg/100 g) were determined.

The content of total phenolics and anthocyanins was determined in raspberry, strawberry and blackberry fruit.

Keywords: *wild berries, chemical composition*

Introduction

According to FAO data (FAO, 2012) berries have great economic importance in world production and processing of fruit. The countries of the Western Balkans, by participation in the production of some types of soft fruit and berries are the leading European and world producers. For example, Republic of Serbia has a leading position in raspberry production achieving the third place in the world. An average raspberry production in Serbia during the period of 2002-2010 is 82,360 Mt. In this period the average production of strawberries in Serbia is over 35,000 Mt. Production of strawberries and raspberries in Bosnia and

Herzegovina is small, but there is evident increase in seeded area with regard to the quantities produced in the last ten years. The production of raspberries in Bosnia and Herzegovina in 2010 increased 10 times compared with production level recorded in 2002 (FAO, 2012). Conventional production of this group of fruits is an example of good organization in agricultural production.

Besides large world production of berry fruit in conventional conditions (strawberries, raspberries, blackberries, black currants, red currants, gooseberries, grapes and other) harvest of wild fruits (strawberries, raspberries, blackberries, blueberries, cranberries, etc.) contributes to total world production of berries (Céspedes et al., 2010; Kubola et al., 2011; Garzón et al., 2010).

Berries on the market can come in one of three ways (Zhao, 2007): (a) direct sale - the customer pick fruit or collector is sold fruit, (b) selling through local stores or through online trade, in the case of imports, and (c) placement of processed fruits (frozen, dried fruits, fruit processed into jams, jellies, juices, wine, ice cream, fruit yogurt, dried fruit mixtures, etc).

The chemical composition of berries depends on many factors: variety, environmental factors, stage of maturity, time and method of harvest, conditions and duration of storage. The influence of these and other factors on the quality and acceptability of berries by consumers has already reported (Castrejon, 2008; Giovanelli G., Bobinaitė et al., 2012). It is very difficult to identify the specific factors which determine the quality of berry fruits. Large number of chemical substances (carbohydrates, proteins, minerals, organic acids, vitamins, pigments, phenolic compounds, etc) can be contained in different concentrations in mature fruit, and they can react each other in different ways (Starast et al., 2007).

Berries have a prominent sweet taste and fruity smell. The fruits have a soft consistency. Color of ripe fruit can vary from yellow through red and continue to blue or black shades, depending on the type of pigments that are found in fruits and on their relationship (Zhao, 2007.). Berries are an important source of minerals, vitamins and other biologically active substances. Berry fruits providing significant effects on human health.

The quality of berries is defined by the following parameters: size and weight, uniformity of fruit shape, color, texture and firmness, soluble solids percentage (°Brix), pH, titration acidity, anthocyanin content, etc.

Visual perception of fresh and / or processed fruit is the first factor that indicates the quality, color, taste and smell of the product. Volatile and nonvolatile compounds greatly influence the sensory properties of berries (taste, flavor, and color) (Konić-Ristić, 2011). Soluble sugars (sucrose, glucose, and fructose) and their relationship with organic acids and volatile aromatic substances present in fruits are most contributors of their sweet flavor (Zhao, 2007; Kubola et al., 2011). Organic acids, especially ascorbic acid, acting an important role in extension of the sustainability and preservation of fresh fruit colors based on anthocyanins stabilization. Increase consumption of berries in the world is associated with the action of some active ingredients (vitamins, minerals, dietary fiber) and their influence on the reduction of people number suffering from certain chronic diseases, including heart disease and cancer (Acosta-Montoya et al., 2010; Lee et al., 2012; Kubola et al., 2011).

Although berry fruits have been the subject of different studies reported before, there is a lack of information on chemical composition and sensory characteristics of wild berry grown in the eastern part of Republika Srpska and Bosnia and Herzegovina. The aim of this study was to examine nutritional value of some types of wild berries that grow in Podrinje region.

Materials and methods

Fruit samples tested in this paper were collected during full maturity in the period of 2011 - 2012 from wider area of Srebrenica and Bratunac municipalities. Approximately 1 kg of fresh fruits per species were collected at peak ripeness and quickly transported to the laboratory. Samples of the same fruit species were collected at 5 locations. The samples were packed in plastic bags and transferred to the laboratory where it was analyzed in refrigerated conditions. The fruits were mashed in a homogenizer and prepared for further analyses. Four replicates were used per analysis. Basic analyses of chemical fruit composition were performed using standard methods of analysis (AOAC, 1990). pH was measured in the aqueous extract using a pH meter. The titration acidity was determined by neutralizing with 0.1 M NaOH solution and results were expressed as citric acid equivalent (g/100). The content of anthocyanins and phenolics was determined using Escribano-Bailon et al. (2006) method.

The experiment was a completely randomized design with four replications. Data were subjected to analysis of variance (ANOVA) and means were separated by Duncan's multiple range test at $p<0.05$ significance level.

Results and discussion

Content of chemical compounds contained in different berries are shown in Tables 1-4. As can be seen from Table 1, the water content ranged from 75.06 % (black currant) to 86.11% (blackberries). When we compare the results for 2011 and 2012, notes that a significantly lower ($p<0.05$) water content of the fruit from 2012. One of reasons for this may be the lack of rainfall during the summer of 2012. The dry matter content is proportional to the total carbohydrates, total sugars, proteins and minerals (Table 1). The results obtained by measuring these properties are presented as a mean values. Various factors, especially, climate and rainfall have a major impact on each of these properties.

Mineral content in the berry fruit is higher than content in other plant foods, especially related to animal products (Plessi, 2007). Blackberries (0.60-3.78 mg/100 g), black currant (1.54-2.79 mg/100 g) and blueberries (0.25-1.38 mg/100 g) are exceptionally rich in iron, black currant (49.36-60.56 mg/100 g) and raspberry (28.45-30.45 mg/100 g) are rich in phosphorus, black currant is also rich in calcium (54.24-58.72 mg/100 g), while blackberries (0.51-0.62 mg/100 g) and raspberries (0.39-0.48 mg/100 g) extremely rich in zinc. As cited by (Plessi, 2007) this group of fruit is rich in content and selenium, manganese, etc.

Berry is a rich source of vitamins. Zhao (2007) stated strawberry, black currant and raspberry are well-known as a source of vitamin C, strawberries as a source of riboflavin, and black currant as a source of pantothenic acid. Strawberry also contains a high level of ascorbic acid (60.12-70.45 mg/100 g) whereas currants are recognized as a source of riboflavin (0.05 mg/100 g) (Table 2).

Several authors (Castañeda-Ovando, 2009; Céspedes, 2010; Kubola et al., 2011) reported that the fruit quality is not only result of the content of mentioned ingredients. A number of different pigments and other physiologically active compounds are contributing to the protection of human health. Total phenol content in raspberries was in the range of 240-400 mg/100 g, followed by the values recorded in blackberries ranging from 110-180 mg/100 g (Table 3). The content of total anthocyanins in the fruits ranged from 20 – 65 mg/100 g (raspberry) and 35 - 125 mg/100 g (blackberry).

Berries are a rich source of polyphenols, especially flavonoids (anthocyanins, flavonols, and flavan-3-oils). Hidoxybenzoic acid derivatives are also present in berry fruits (Zhao, 2007; Plessi, 2007; Acosta-Montoya et al., 2010; Bobinaitė et al., 2010; Buričova et al., 2011). Many factors influence the composition and quantity of phenolic compounds in fruits. The main anthocyanins, which can be found in berry fruits, differ according to the number and position of hydroxyl and metoksil groups located on the B ring. Anthocyanins found in strawberries are solely nonacylated form (over 99%) (Wu et al., 2006). Similar situation is observed with cyanidin derivates of blackberries and red and black raspberries. Blueberries are a unique berry fruit which contains contain the mono glycosides (glucosides, galactosides, and arabinosides) of delphinidin, cyanidin, petunidin, peonidin, and malvidin (Wu et al., 2005).

Total phenol content, ranged from 428 to 1079 mg/100 g in black colored fruit, 192 to 512 mg/100 g in red fruit, 428 to 451 mg/100 g in pink/red fruit, and 241 to 359 mg/100 g in yellow fruit. Obtained results are in accordance with previously published data of Wada and Ou (2002) and Zhao (2007). Anthocyanins are the major phenolic present in black raspberries, with levels ranging from 464 to 627 mg/100 g (Wada and Ou, 2002). Red raspberries contain much lower levels of anthocyanins than black raspberries, with values ranging from 19 to 89 mg/100 g. The levels of total phenolics over all studies range from 43 to 273 mg/100 g. The levels of total phenolics in blackberry over all studies range from 114 to 1056 mg/100 g. Anthocyanins are the major phenolic in the berry fruits with concentrations ranging from 31 to 256 mg/100 g (Gu et al., 2002).

Present anthocyanins and other pigments give color of berry ruits (red, purple, blue or black). In practice, there is great interest to use of anthocyanins as natural pigments instead artificial colors which represent the risk to human health. Consumers in the market are showing great interest in fresh strawberries, which have a pronounced red color. They believe that such kind of fruit has a nice taste.The composition of anthocyanin derivatives can vary significantly among types of fruit, although uniform composition can be observed within the same type.Therefore, the profile can be considered as anthocyanin fingerprint of certain products.

Storage conditions for fresh berries influence the loss of anthocyanins. For example, storage of cranberries at 0°C does not affect the loss of anthocyanins, but anthocyanins losses are over 60% when it stored at 20°C. Freezing does not affect the loss of anthocyanins. Color, smell and taste are also subject to change due to changes in pH and acidity of fruits (Table 4). Anthocyanins degrade during thermal processing of berries. Experts in the field of food technology and nutrition work intend to preserve the color of juice during the storage and processing of berries (Miszczak et al., 1995; Konić-Ristić et al., 2011).

Besides fresh berries in human nutrition these fruit can be used in the form of juice (Sánchez-Segarra et al., 2000), yogurt, and jam (Plessi et al., 2007).

Table 1. The averagechemical composition of wild berries

Mean values	Strawberry		Raspberry		Blueberry		Black Currant		Blackberry		Gooseberry	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Water, %	85.19a	80.51b	83.76a	80.86b	85.12a	79.37b	80.46a	75.06b	86.11a	82.16b	84.24a	81.16b
Ash, %	0.35a	1.00b	0.44a	0.67b	0.15a	0.28b	0.68a	1.10b	0.24a	0.46b	0.40a	0.61b
Fat, %	0.35a	0.84b	0.61a	0.94b	0.27a	0.98b	0.23a	1.09b	0.44a	0.64b	0.46a	0.62b
Proteins, %	0.50a	0.92b	1.10a	1.59b	0.72a	0.95a	1.42a	1.65a	1.27a	1.49b	0.81a	0.97a
Simple sugars, total,%	5.21a	7.06b	4.11a	4.77a	5.00a	7.17b	6.40a	8.08b	4.25a	4.98a	5.78a	6.34a
Carbohydrates, total, %	8.93a	10.11a	10.12a	11.16a	9.16a	11.48b	11.10a	13.06b	8.00a	10.15b	8.96a	9.58a
Iron, mg/100g	0.40a	3.41b	0.55a	0.79a	0.25a	1.38b	1.54a	2.79b	0.60a	3.78b	0.28a	0.78b
Phosphorus, mg/100g	20.23a	38.78b	28.45a	30.33a	11.45a	16.78b	49.36a	60.56b	21.14a	24.45b	26.12a	28.56a
Calcium, mg/100g	16.00a	28.70b	22.45a	28.48b	6.26a	14.08b	54.24a	58.72b	28.74a	30.12a	24.78a	26.46a
Zinc, mg/100g	0.10a	0.19a	0.39a	0.48a	0.11a	0.18a	0.25a	0.30a	0.51a	0.62a	0.09a	0.12a

Values in the same rows for the same type of fruit with different lower case letters are significantly different at p<0.05

Table 4. Average pH and titration acidity of the fruits of wild berries

Mean values	Strawberry		Raspberry		Blueberry		Black Currant		Blackberry	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
pH	3.33a	3.58a	2.76a	2.98a	3.30a	3.54a	2.55a	2.78a	3.08a	3.25a
Titration acidity (%)	0.45a	0.65b	1.74a	2.20b	0.40a	0.70b	2.50a	3.10b	0.20a	0.30b

Values in the same rows for the same type of fruit with different lower case letters are significantly different at p<0.05

Conclusion

The results obtained during this study suggest two things:

- that the wild berries in this region are highly nutritional rich with protective materials and
- contains some of the protective substances in quantities greater than data obtained in other parts of the world.

The reason for this is the favorable climatic conditions and altitude for growing of berry fruits.

Table 2. The average content of some vitamins in fruits of wild berries

Mean values	Strawberry		Raspberry		Blueberry		Black Currant		Blackberry	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Ascorbic acid (mg/100g)	60.12a	70.45b	20.10a	35.46b	8.14a	9.50a	17.12a	19.45a	17.45a	21.16b
Riboflavin (mg/100g)	0.02		0.03		0.04		0.05		0.04	

Values in the same rows for the same type of fruit with different lower case letters are significantly different at $p<0.05$

Table 3. The average content of total phenolics and anthocyanins in fruits of wild berries

Mean values	Raspberry		Blackberry	
	2011	2012	2011	2012
Total phenols (mg/100 g)	240a	400b	110a	180b
Total anthocyanins (mg /100g)	20a	65b	35a	125b
Color	Red		Black	

Values in the same rows for the same type of fruit with different lower case letters are significantly different at $p<0.05$

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