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Chemical composition and nutritional value of Raspberry fruit (*Rubus idaeus L.*)

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Abstract. Raspberries fruits (*Rubus idaeus L.*) as important part of our diet are known for their sensory and nutritional characteristics, because of high content of essential nutrients that are beneficial for biological activity in human health. A high consumption of plant foods, such as raspberries, appears to decrease the risk of obesity, diabetes, heart disease, and overall mortality. It can also promote a healthy complexion, increased energy, and overall lower weight. Nutritional quality was analyzed through by chemical parameter of fresh raspberry samples from plantation in Kosovo area at the ripe stage. The following quality parameters were determined in the raspberry’s fruits: pH, dry matter, total soluble solids (TSS/°Brix), total acidity (TA), TSS/TA ratio, total sugars, reducing sugars, sucrose, vitamin C, protein, and lipids. Results can be used to inform potential raspberry farmers about the nutritional qualities and consumer preferences for raspberries. The rich nutritional composition of the studied fruits makes them a very special diet. All statistical analysis was performed using the MS Excel program and SPSS 22.0 statistics software.

Keywords: Raspberry, nutrient quality, fruits

Introduction

Berry fruits, consumed fresh or processed, are nutritionally valuable food, as they are rich sources of minerals, vitamins, sugars, dietary fibers, organic acids, macro and micronutrients of pharmacological interest, and polyphenolic compounds. They have gained attention because of their potential for improving human health.

Raspberry fruits (*Rubus idaeus L.*) is an important berry crop for both the fresh and the processing market. Raspberry, is an important commercial product in fresh or processed form due to its nutritional, medicinal, and cosmetics uses [1],[2]. The term “nutraceutical” indicates a fortified food or a dietary supplement that is held to provide health or medical benefits in addition to its basic nutritional value.

Nutraceuticals are also called functional food. Raspberries fruits contain high concentrations of important nutrients, bioactive compounds and phytochemicals.

Raspberry fruit is considered as a low energy fruit that is comprised primarily of natural carbohydrates, with the main sugar form being fructose, a feature that makes berry fruit very popular among consumers. Raspberry is also an excellent source of vitamin C. It is well known that vitamin C has health and wellness attributes that make berry fruit very popular among consumers. [2].

Raspberries fruits contribute to the nutritional value of a diet. Raspberries also contain phytochemical components with documented biological activity, many of which were initially investigated based on their in vitro antioxidant properties. Some of these compounds are now recognized for their ability to influence cell signaling pathways that affect receptors, transporters, gene expression, and other cellular events. The package of nutrients and bioactive components that the raspberries deliver suggest their important protective role in human health [3].

Fruits and vegetables are a primary food source providing essential nutrients for sustaining life. They contain a variety of phytochemicals, such as phenolic acids and flavonoids, which have been associated with many health benefits. Detailed information about the health-promoting components of wild raspberries is needed to give a better insight into their use as functional foods and as ingredients in pharmaceuticals, nutraceuticals, and medicines [1].

Raspberry fruit is very interesting for consumers because of its pleasant aroma and color, low calories, and high nutrient value, with health benefits that manifest in the high amounts of antioxidants [4].

Raspberry (*Rubus idaeus L.*) are very popular fruit in Kosovo, cultivar of them is developed in Kosovo, where is commercially cultivated under several climatic conditions and cultivation modes. Raspberry production in Kosovo is experiencing a period of rapid growth. Currently, over 1,000 ha of raspberries are planted throughout Kosovo. The average raspberry yield in Kosovo is 9-12 tons per hectare. The main raspberry varieties are Polka with 75% of total production, Willamette with 10%, Meeker 10% and others 5%.

However, quality parameters and nutritional value have not been determined in raspberries fruits during ripening, especially in fruit grown under organic cultivation. Literature regarding to this raspberry cultivar is scarce. This is the first research of this type in Kosovo and it should give us a novel result. This study has been designed to investigate the nutritional quality of raspberry fruits with ripening time by using some parameters (dry matter, total soluble solids (TSS), pH, total acidity (TA), TSS/TA ratio, total sugars, reducing sugars, sucrose, vitamin C, protein, lipids.

Materials and methods

Materials

Fruits of raspberry (*Rubus idaeus L.*) from five raspberry cultivars, were grown at the different plantation located in the Kosovo and harvested at commercial maturity stage in the season 2019. Sampling was carried out on 3 trees growing in garden. Approximately 1 kg of fruits of uniform ripeness (red color) were harvested from each tree and transferred to laboratory at the day of harvest and stored overnight at +4°C. Analyses were carried out next day. Fruits were washed with demineralized water, and after removing surface water, air dried and then mashed using a kitchen blender to prepared for further analysis. Three replicates were used for analysis.

Chemical analysis

Nutritional properties

Determination of nutritional properties of raspberry fruits were performed according the standard methods of the AOAC [7]. Total soluble solids content (TSS) measured using Abbe refractometer calibrate against sucrose and expressed in °Brix. Titratable acidity (TA) was measured according to AOAC Method and expressed as milligrams of citric acid. The sugar-acid ratio of samples was determined by calculation as described below in equation: $Sugar-acid\ ratio = (TSS\ (^{\circ}Brix)) / (\% TA)$. pH was measured using pH/mv meter, and dry matter (DM) was measured in triplicate by drying 5 g of the fresh fruits at 105°C until constant weight (4-6 hours). Determination of lipids was done by Soxhlet extraction after digestion of the samples by hydrochloric acid hydrolysis, followed by extraction of the fats with petroleum ether. After the extraction, lipid content was determined by weighing. Protein was determined by the Bradford method with some modifications. Gelatin is commonly used to create the standard curve, and the absorption is measured at 545 nm in a spectrophotometer. Reducing sugar was determined using the method of Lane and Eynon and Fehling's solution as described by AOAC [7]. Total sugars were determined by the phenol-sulfuric acid method by Nielsen [8]. Glucose is commonly used to create the standard curve, and the absorption is measured at 490 nm. The sucrose mass fraction was determined by calculation from the difference between total and reduced sugars. Vitamin C content was estimated using spectrophotometric method with 2,4-dinitrophenylhydrazine as an indicator [1],[2]. Freshly processed fruit (1 g) was homogenized in a mortar with a pestle with metaphosphoric acid (5% metaphosphoric acid in 10% acetic acid solution in water), filtered and treated with 85% sulphuric acid solution and 2,4-dinitrophenylhydrazine, and then incubated at 60 °C for 60 min in a water bath. Absorbance was measured at 520 nm in a spectrophotometer (Genesys 10S UV-Visible,) for estimation of vitamin C in the fruits.

Statistical analysis

All data were expressed as the mean \pm standard deviation of triplicate experiments. All statistical analysis performed using the MS Excel program and SPSS 22.0 statistics software. Differences were tested for significance using the ANOVA procedure, with a significance level of $p < 0.05$.

Results and Discussion

The results of the chemical composition and nutritional components of the fresh raspberry fruits analyzed in period August 2019, in the five locations and cultivars are given in Tables 1-2 and figure 1.

Table 1. The chemical composition of the raspberry fruits

Sample	pH	W(DM)/%	TSS/°Brix	TA/ %	TSS/TA ratio
A ₁	3.74 \pm 0.2	9.03 \pm 0.1	9.00 \pm 0.1	0.91 \pm 0.1	9.89 \pm 0.1
A ₂	3.80 \pm 0.2	8.47 \pm 0.1	11.00 \pm 0.1	0.86 \pm 0.1	12.79 \pm 0.2
A ₃	3.81 \pm 0.1	8.96 \pm 0.1	11.00 \pm 0.1	0.89 \pm 0.2	12.35 \pm 0.2
A ₄	3.70 \pm 0.1	9.04 \pm 0.1	9.00 \pm 0.1	0.95 \pm 0.2	9.47 \pm 0.2
A ₅	3.65 \pm 0.1	8.44 \pm 0.1	10.00 \pm 0.1	0.80 \pm 0.2	12.50 \pm 0.2

Data are expressed as average value \pm standard deviation of three replicates

Table 2. The nutritional composition of the raspberry fruits

Sample	Vitamin C mg/100g	Total sugars g/100g	Reducing sugars g/100g	Sucrose g/100g	Lipids g/100g	Proteins g/100g
A ₁	46.70 \pm 0.1	4.27 \pm 0.1	3.67 \pm 0.2	0.60 \pm 0.2	0.55 \pm 0.1	0.80 \pm 0.1
A ₂	48.18 \pm 0.3	4.45 \pm 0.3	3.79 \pm 0.1	0.66 \pm 0.3	0.52 \pm 0.2	0.75 \pm 0.1
A ₃	46.44 \pm 0.3	4.64 \pm 0.1	3.95 \pm 0.1	0.69 \pm 0.1	0.59 \pm 0.1	0.81 \pm 0.2
A ₄	49.57 \pm 0.1	4.82 \pm 0.1	4.04 \pm 0.1	0.75 \pm 0.1	0.65 \pm 0.2	0.69 \pm 0.3
A ₅	50.57 \pm 0.1	4.32 \pm 0.1	3.54 \pm 0.1	0.78 \pm 0.1	0.58 \pm 0.2	0.72 \pm 0.3

Data are expressed as average value \pm standard deviation of three replicates

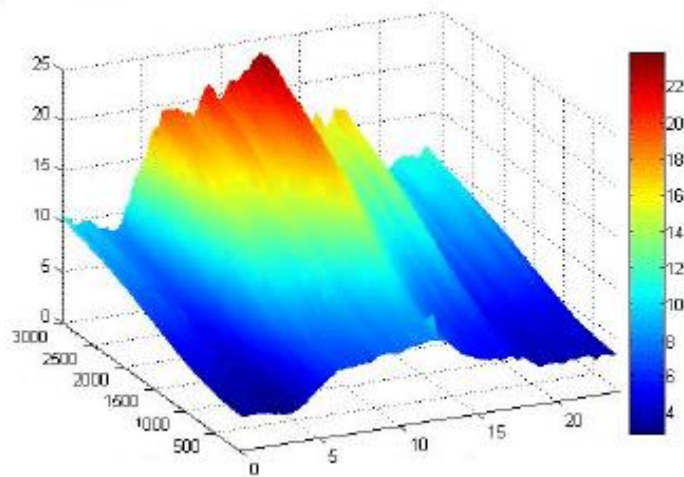


Fig.1. The 3D visualization data of chemical parameters of strawberries fruits

pH values tend to be lower, ranging from 3.65 ± 0.2 to 3.81 ± 0.1 , where the higher pH has A_3 samples with 3.81 ± 0.1 , these values are similar to many other authors studies, author reference [1]. The values for raspberry fruit of the total dry matter ranged from $8.44\% \pm 0.1$ to $9.04\% \pm 0.1$.

Soluble solids TSS/ $^{\circ}$ Brix content in fresh raspberries fruits ranged from 9.00 ± 0.1 $^{\circ}$ Brix to 11.00 ± 0.1 $^{\circ}$ Brix, the values show very good amounts of soluble solids compared to the study of author reference [1]. Samples of raspberries contained about $0.80\% \pm 0.2$ to $0.95\% \pm 0.1$ of citric acid.

Total acidity values for raspberries fruits were somewhat lower, which caused it's also lower TSS/TA ratio. The relationship between total soluble solids and total acidity is very important in determining fruit quality. In numerous researches conducted on different raspberry cultivars, the total soluble TSS/TA ratio was found to be very important, because it provides information on the balance of sugars and acids in the fruit. Raspberry fruits are a good source of vitamin C. Content of vitamin C in raspberries fresh fruit essentially different among the researched cultivars.

Samples of raspberries contained more vitamin C 46.44 ± 0.1 mg to the 50.57 ± 0.1 mg/100g, where the highest amounts are samples A_4 and A_5 . If we compare these results with other authors in most cases, we will see that the raspberry we have explored have average values compared to author reference [3]. From the above mentioned, the four raspberry varieties in our study might be considered as rich in vitamin C. The total number of sugars present in the raspberry fruit varied from 4.27 ± 0.1 g to 4.82 ± 0.1 g/100g. The comparing these fruits, we can infer that the raspberry fruit do not constitute itself as a good source of sugars, which are at a lower level than that reported by other authors on different cultivars from different parts of the world [1],[3]. Protein values were estimated between 0.69 ± 0.1 g to 0.81 ± 0.2 g per 100 g raspberries fruits, which is lower with the report of authors reference [3]. Lipid contents is 0.52 ± 0.2 g to 0.65 ± 0.2 g/100 g which is consistent with the report of

authors reference [3]. The obtained results can be useful in clarifying the quality of fruits and traditional products in order to their promotion and application as food additive and nutraceutical.

Conclusion

The present study reveals that the Raspberries fruits (*Rubus idaeus L.*) grown and developed at the Kosovo region were rich in vitamin C, sugars and minerals. Their nutritional value and quality attributes make them suitable for consumption. Tested fruit presented a considerably high content of vitamin C and moderate to high content of sugars and low content of lipids and proteins, giving nutritional and health relevance to this fruit, and these raspberries could be a promising dietary supplement and cosmetic supplement to address the needs of vitamin C and nutrients.

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