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Nutritional quality and antioxidant activity of currant fruits (Ribes spp.)

Research article

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Abstract

The purpose of this study was to comparatively evaluate the content of bioactive compounds and the antioxidant activity in four currant cultivars (white, two red and one black). The contents of sugar, glucose, total phenolic compounds and flavonoids were determined by colorimetric methods, ascorbic acid by iodometric method and the antioxidant activity was evaluated by DPPH and ABTS radical scavenging assay. The results showed that the studied chemical indices varied depending on the analyzed cultivar. Currants fruits are a rich source of phytochemicals with an important role in human health, especially compounds with considerable antioxidant activity. Blackcurrant fruits have the highest content of phenolic compounds, flavonoids and ascorbic acid and the highest antioxidant activity, demonstrating their health potential.

Keywords: currants, ascorbic acid, sugars, phenolic compounds, antioxidant activity

1. INTRODUCTION

Currant berries are very popular fruits with appetizing and digestive properties, specific taste, color and flavor. Many studies report relationships between currant fruit consumption and protection against many diseases: chronic disorders, cancer, and cardiac diseases [1, 2]. This benefic effect is explained by the high content of antioxidant substances, dietary fibers, vitamins (especially A and C), minerals and bioactive compounds with antimicrobial, anticarcinogenic, antiteratogenic, antiinflammatory and antiallergenic properties [3-6].

Currants are rich sources of phenolic compounds containing anthocyanins, flavonols, flavanols, ellagitannins, hydroxybenzoic acid, hydroxycinnamic acid, condensed tannins (proanthocyanidins) and hydrolyzable tannins [5, 7]. These phytochemicals were reported decreasing free radicals, strengthening the immune system and inhibiting tumor formation [2, 8]. Phenolic compounds have properties such as protecting the body against infections, preventing anemia by inhibiting decomposition of red blood cells, diluting the blood by increasing prostaglandin synthesis (antithrombotic effect) and preventing arteriosclerosis. (1, 9-11].

The variation in phytochemicals content in plants is dependent on many factors: variety, stage of harvesting, growing conditions, soil, storage conditions [12]. Researches were carried out focused on the identification and selection of genotypes that ensure a high nutritional value [13, 14]. In this context, the purpose of this study was to evaluate the bioactive compounds content and the antioxidant activity in four currant cultivars.

2. MATERIALS AND METHODS

2.1. Materials

The biological material was represented by fruits of four varieties of currant (*Ribes* spp): Blanka (white currant), Abundent (red currant), Rovada (red currant) and Abanos (black currant), cultivated in a private orchard near Craiova. The fruits of currant cultivars were harvested at the optimum ripe stage, and representative samples were taken to evaluate biochemical indices.

2.2. Analysis methods

Total soluble solids content SSC (%) was determined using a digital refractometer (Kruss Optronic DR 301-95) at 20°C.

Reducing sugars (Red sug. %) were extracted in distilled water (1:50 w/V), 60 minutes at 60˚C and assayed colorimetric at 540 nm with 3, 5 dinitrosalicylic acid reagent using glucose as standard [15]. The results were expressed in %.

Glucose (Glu %) content was assayed at 500 nm by glucose oxidase/peroxidase method [15]. Glucose oxidase catalyzes the oxidation of glucose by oxygen in the air to gluconolactone and hydrogen peroxide. Then, under the action of peroxidase, hydrogen peroxide reacts with the colour indicator, forming a pink compound. The results were calculated from a calibration curve obtained with glucose as standard.

Ascorbic acid was extracted in 2% hydrochloric acid, HCl; 5:50 w/v [16]. The determination of ascorbic acid was performed from the supernatant by iodometric redox titration in which iodine reacts with ascorbic acid, oxidizing it to dehydroascorbic acid. The ascorbic acid content (As A) was expressed as mg/100 g fresh weight.

Methanolic extract: For the determination of antioxidant activity, total phenolic and total flavonoids content, samples were extracted with 80% aqueous methanol (1:20 w:v) by sonicating for 60 min in a ultrasonic bath Fungilab (Madrid, Spain) equipped with a digital timer and a temperature controller, at 24°C. The resulting slurries were centrifuged at 4000 g for 5 min and the supernatants were analyzed.

The total phenolics content was determined colorimetrically at 765 nm by using the Folin-Ciocalteu reagent [17]. The total phenolic content (TPC) was calculated using a standard curve prepared with gallic acid and expressed as mg GAE/100 g fw.

The total flavonoids content was determined by colorimetric methods at 500 nm with the chromogenic system $NaNO_2$-$Al(NO_3)_3$-

NaOH [17]. The total flavonoid concentration (TFC) was calculated from quercetin calibration curve and expressed as mg Q/100 g fw.

DPPH (2, 2-diphenyl-1-picrylhydrazyl) radical scavenging assay: The capacity of sample extracts to reduce the radical 2, 2-diphenyl-1-picrylhydrazyl was evaluated colorimetrically at 517 nm [17]. The results were compared with those obtained from standard curves of trolox and ascorbic acid. Antioxidant capacity values were expressed as Trolox equivalent (TE) μM TE /g fw or AsA equivalent μM AsA/g fw.

ABTS radical cation scavenging activity was measured at 734 nm using Trolox or ascorbic acid as standard. The final results were expressed as μM TE/g fw or μM AsA/g fw.

The spectrophotometric measurements were performed with a Thermo Scientific Evolution 600 UV-Vis spectrophotometer with VISION PRO software. All determinations were performed in triplicate, and all results were calculated as mean.

3. RESULTS AND DISCUSSION

The obtained results show that the studied chemical indices vary depending on the analyzed cultivar (Table 1).

The values determined for *total soluble solids content (SSC)* vary between 8.84 % (Rovada) and 13.23% (Abanos) in the order: Rovada <Abundent <Blanka < Abanos. The results are similar to data reported in the scientific literature: 8% -14% [18, 19]; 14.5-15.5% [20] 7.4 to 10.4% [21]. The values obtained in this study are lower than those reported for genotypes cultivated at Research Station Baneasa, which vary between 18.2% and 20% for black currant cultivars and between 11.2 and 13.4 for red currant cultivars [22]. The main constituents of SSC are sugars and organic acids and represent a quality index of currant fruits. Consumer preference for high levels of sugars and relatively low levels of organic acids was observed [6].

The reducing sugars and glucose contents vary with the investigated genotype. In the present study, the content of reducing sugars varies from 4.014% (Abundent) to 7.067% (Blanka) in the order: Abundent <Rovada <Abanos< Blanka. The same variation is observed for the

glucose content with values between 2.64 % (Abundant) and 4.56 (Blanka).
The reducing sugars present in currants are glucose and fructose [3, 5]. Ersoy et all., 2018 reports for the glucose and fructose content values between 17.21 and 34.23 g/kg, respectively 8.53 and 16.23 g/kg [3].

Table 1. Chemical composition of currant fruits

No.	Cultivar	SSC (%)	Red sug (%)	Glu (%)	As A (mg/ 100 g fw)	TPC (mg GAE /100 g fw)	TFC (mg Q /100 g fw)
1	Blanka	11,12	7,067	4,56	23,18	62, 626	15, 696
2	Abundent	9,35	4,014	2,64	35,66	171, 510	38, 687
3	Rovada	8,84	5,231	3,42	38,74	124, 230	31, 241
4	Abanos	13,23	6,627	4,32	148,3	224, 682	58, 915

Ascorbic acid content varies between 23.18 mg/100 g fw (Blanka) and 148.3 mg/100 g fw (Abanos) in the order of Blanka <Abundent <Rovada <Abanos (Table 1). The highest content of ascorbic acid was obtained from black currant fruits, 6.4 times higher than the value obtained from the white currant cultivar. The variation of ascorbic acid content in the order: white currant < red currant < black currant is also reported in other studies [23].

High contents of ascorbic acid for blackcurrant cultivars are also reported in other researches: 160 mg/100 g fw to 192 mg /100 g fw [22]; 147.84 mg/100g fw - 241.12 mg/100g fw [18]; 126.51 mg/100 g [3]; 147.8 - 202.3 mg/100 g [24], even values over 350 mg/100 mL juice in some breeding lines [25]. From the point of view of the ascorbic acid content, currant fruits belong to the group rich in this vitamin. Ascorbic acid in blackcurrants is more stable than in most other sources, possibly due to the protective effects of anthocyanins and other flavonoids within the berries [25].

The content of total phenolic compounds (TPC) varies depending on the analyzed cultivar (Table 1). The highest TPC was determined in the black currant cultivar, of 224.682 mg GAE/100g fw, being 3.6 times higher than in the white currant cultivar: 62.626 mg GAE/100g fw. The same variation is observed for *the total flavonoids content (TFC)* with values between 15.66 mg Q/100g fw and 58.915mg Q/100g fw. The results are in agreement with data from the scientific literature [22, 23, 26, 27].

Phenolic groups commonly present in currant fruits are hydroxycinnamic acids, flavonols, flavan-3-ols and anthocyanins [24]. The latter contributes to their attractive pink, red or purple-blue color. Anthocyanins were predominant in black and red currants and proanthocyanidins in green and white currants. Anthocyanin deficiency in white berries was associated with the increasing levels of phenolic acids [7].

The antioxidant activity was determined by DPPH and ABTS cation radical assay which are the most accepted and used methods of evaluating antioxidant activity. The results were calculated using two standards: Trolox and ascobic acid. Antioxidant activity varies depending on the studied cultivar (Table 2).

Table 2. Antioxidant activity of currant fruits

No	Cultivar	DPPH (μM TE/ g fw)	ABTS (μM TE/g fw)	DPPH (μM AsA/ g fw)	ABTS (μM AsA/ g fw)
1	Blanka	5.263	2.018	3.616	0.863
2	Abundent	9.674	4.599	6.5564	4.491
3	Rovada	7.093	2.538	4.807	2.435
4	Abanos	28.67	9.882	19.434	9.432

All cultivars present strong radicals scavenging activity, confirming the high content of compounds with antioxidant properties. The values of DPPH radical scavenging activity ranged from 5.263 μM TE/g fw to 28.67 μM TE/g fw in terms of Trolox equivalents and from 3.616 μM AsA/g fw to 19.434 μM AsA/g fw in terms of Ascorbic acids equivalents and decreased as follows: Abanos, Abundent, Rovada, Blanka.

The studied fruits extracts were also measured and compared for their free radical scavenging activities against ABTS radical cation (Table 2). All results showed significant ABTS radical cation scavenging activity which ranged from 2.018 μM TE/g fw (Blanka) to 9.882 μM TE/g fw (Abanos) in terms of Trolox equivalents and from 0.863 μM AsA/g fw (Blanka) to 9.432 μM AsA/g fw (Abanos) in terms of Ascorbic acids equivalents.

The results obtained in this study are similar to those reported by other authors: average values of 2.35mM TE/100g fw and 0.39 mM TE/100g fw for black respectively red currant [28] 74.43 mg TE/100g fw and 24.41 mg TE/100g fw for black respectively red currant [29], for red currant average values of 25.76 mM TE/kg dm and 31.20 mM TE/kg dm for conventional respectively organic fruits [30].

Positive correlations have been observed when DPPH radical scavenging activity and ABTS radical cation scavenging activity were compared with total phenolic content and total flavonoids content, thus indicating that these compounds are responsible for the antioxidant activity being powerful antioxidants.

4. CONCLUSION

Currants fruits are a rich source of phytochemicals with an important role in human health, especially compounds with considerable antioxidant activity. The studied biochemical indices vary depending on the analyzed genotype.

Significant correlations have been observed when DPPH and ABTS radical scavenging activities were compared with phenolic compounds content and flavonoids content.

Blackcurrant fruits have the highest content of phenolic compounds, flavonoids and ascorbic acid and the highest antioxidant activity demonstrating their health potential.

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