Phenolics content and antioxidant capacity of commercial red fruit juices

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Abstract

The content of phenolics: total phenols (TP), flavonoids (TF), anthocyanins (TA) and hydroxycinnamic acid as well as the total antioxidant capacity (TAC) in nine commercial red fruit juices (sour cherry, black currant and red grape) produced in Serbia were evaluated. The total compounds content was measured by spectrophotometric methods, TAC was determined using DPPH assays, and individual anthocyanins and hydroxycinnamic acids was determined using HPLC-DAD methods. Among the examined fruit juices, the black currant juices contained the highest amounts of all groups of the phenolics and exhibited strong antioxidant capacity. The amount of anthocyanins determined by HPLC method ranged from 92.36 to 512.73 mg/L in red grape and black currant juices, respectively. The anthocyanins present in the investigated red fruit juices were derivatives of cyanidin, delphinidin, petunidin, peonidin and malvidin. The predominant phenolic acid was neoclorogenic acid in sour cherry, caffeic acid in black currant, and *p*-coumaric acid in black grape juices. Generally, the red fruit juices produced in the Serbia are a rich source of the phenolic, which show evident antioxidant capacity.

Keywords: *fruit juices; phenolics; antioxidant capacity; anthocyanins; hydroxycinnamic acids.*

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A considerable interest has been developed over the years in fruits and vegetables due to their potential biological and health promoting effects. Numerous epidemiological studies indicate that an increase in the composition of fruits and vegetables is associated with a decrease in the incidence of various diseases like cardiovascular disease, stroke, and cancer [1,2]. The protective effect of fruits and vegetables has been attributed to their bioactive antioxidant constituents, including vitamins, carotenoids, polyphenols [3]. Among various antioxidant present in fruits and vegetables, polyphenols (including anthocyanins) have received much attention since being reported to have a positive influence on human health.

Berries and red fruits are two of the most important dietary source of the polyphenols such as anthocyanins, flavonoids, flavan 3-ols and benzoic and cinnamic acid derivatives [4]. Anthocyanins belong to the class of phenolic compounds. They are water-soluble glycosides and acylglucosides of anthocyanins. Two most common naturally occurring forms of anthocyanins are the 3-*O*--glucosides and 3,5-di-glucosides of cyanidin, Delphinidin, peonidin, petunidin, pelargonidin and malvidin. The anthocyanins represent an important polyphenolic component of fruits, especially berries.

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Besides fruits and vegetables, a relevant part of intake of polyphenolic phytochemicals (including anthocyanins) is supplied by fruit juices. Juices are suitable food products in terms of ingestion of health protective phitochemicals. The consumption of polyphenol rich juice enhances antioxidant status, reduces oxidative DNA damage and stimulates immune cell functions [5].

Commercial fruit juices are a result of an industrial process in which the original fruit juice and its properties and components change. Many reports have been written about the phenolic profile in different fruit and berry samples, from fresh, freeze-dried and frozen fruit [6,7] as well as from juice and fruit extracts as raw materials [8]. However, only a few reports have been based on commercial fruit nectars [9]. Therefore, the objective of this work was to evaluate various fruit juices (sour cherry, black currant and black grape) regarding the amount of polyphenols and the antioxidant activity and to determine the individual anthocyanin compounds and hydroxycinnamic acids.

EXPERIMENTAL

Chemicals

All chemicals and reagents were of analytical grade and were obtained from Sigma Chemical Co. (St. Louis, MO, USA), Aldrich Chemical Co. (Steineheim, Germany), and Merck (Darmstadt, Germany). The calibration curves were obtained from triplicate injections of five concentrations.

Fruit juices analysis

In the present study, a total of nine fruit juices were analyzed. Cartons of sour cherry, black currant and black grape juices, each produced by three different factories, were purchased from local supermarkets. All juices analyzed are frequently consumed in Serbia. The spectrophotometric and HPLC-DAD measurements were performed immediately after opening. Between measurements, juices were closed and stored in the dark at 4 °C (refrigerator). Prior to all measurements, ten milliliters of samples were extracted with 25 mL of methanol containing 1% HCl, using an ultrasonic bath [10]. The fruit content in the tested juices ranged from 50 to 52%.

Determination of total phenolic compounds

Folin–Ciocalteu reagent was used to determine the total phenolic compounds [11]. The volume of 1 ml of each fruit juice extract, diluted 5-6 times with methanol (to obtain absorbance within the range of the prepared calibration curve), was mixed with 0.5 mL of Folin–Ciocalteu reagent previously diluted with distilled water (1:2). A volume of 2 mL of 20% sodium carbonate solution was added to the mixture, shaken thoroughly and diluted to 10 mL by adding distilled water. The mixture was to stand for 120 min and the blue color formed was measured at 760 nm with a spectrophotometer (UV/Vis spectrometer, Agilent 8454). Gallic acid was used as a standard for the calibration curve. The concentrations of gallic acid in the solution, used for obtaining of calibration curve, were 0, 50, 100, 150, 250 and 500 mg/L (R^2 = 0.998). The content of TP was expressed as mg of gallic acid equivalent (GAE) per 1 L of fruit juices. All measurements were carried out in three repetitions.

Determination of total flavonoids

The total flavonoids (TF) assay was done as previously described by Zhishen [12], with minor modifications. A volume of 1 mL of diluted extracts or standard solution of catechin (50–500 mg/L) was placed in a 10-mL volumetric flask, then 4 mL of H_2O, and after 5 min 0.3 mL of $NaNO_2$ (5%) and 1.5 mL of $AlCl_3$ (2%) were added. The mixture was shaken and 5 min later 2 mL of 1 M solution of NaOH were added, again well shaken. The absorbance was measured at 510 nm against the blank. The results were calculated according to the calibration curve for catechin (R^2 = 0.999). The content of TF was expressed as mg of catechin equivalent (CE) per 1 L fruit juice. All samples were analyzed in triplicate.

Determination of total anthocyanins

The total anthocyanin content of the fruit juices was determined using the pH-differential method [13]. Fruit juices were dissolved in buffers of KCl (0.025 M, pH 1.0) and CH_3COONa (0.4 M, pH 4.5) at a predetermined dilution factor. Absorbance (A) was measured using UV–Vis spectrophotometer at 520 and 700 nm, and the results were calculated as follows:

$$A = \left(A_{520} - A_{700}\right)_{\text{pH1.0}} - \left(A_{520} - A_{700}\right)_{\text{pH4.5}}$$

The monomeric anthocyanin (MA) pigment concentration in the fruit juices was calculated as:

$$MA = \frac{A \times M \times DF \times 100}{\varepsilon \times l}$$

where M is molar mass of malvidin-3-glucoside (493.5 g/mol) or cyanidin-3-glucosides (449.2 g/mol), ε – molar extinction coefficient for malvidin-3-glucoside (28 m^3/mol cm) or cyaniding-3-glucoside (26.9 m^3/mol cm), DF – dilution factor and l – cuvette optical path length (1 cm).

The final anthocyanin concentration is expressed as milligram per 1 L of fruit juice of malvidin-3-glucoside or cyanidin-3-glucoside. All analyses were done in triplicate.

Measurement of the DPPH$^{\cdot}$ scavenging activity

The free radical scavenging capacity of fruit juice extracts was determined according to the previously reported procedure using the stable DPPH radicals [14]. The method was based on the reduction of stable DPPH nitrogen radicals in the presence of antioxidants. An aliquot (2.5 mL) of fruit juice extracts or methanol solution of Trolox (10–30 mM) was mixed with 2.5 mL of 0.1 mM DPPH methanolic solution. The mixture was thoroughly vortexed, kept in the dark for 30 min, and after that the absorbance was measured at 515 nm against a blank of methanol without DPPH. The results were calculated according to the calibration curve for Trolox (R^2 = 0.996). DPPH values, derived from the triplicate analyses, were expressed as mmol of TE per 1 L fruit juice.

HPLC-DAD determination of anthocyanin composition

The anthocyanins were analyzed by the direct injection of the extracts, previously filtered through a 0.45 μm pore size membrane filter, in the Agilent Technologies 1200 chromatographic system equipped with the Agilent photodiode array detector (DAD) 1200 with RFID tracking technology for flow cells and a UV lamp, an automatic injector, and a Chemstation software. The column was termostated at 30 °C. After injecting 5 μL of sample extract, the separation was performed in an Agilent-Eclipse XDB C-18 4.6 mm×150 mm column. Two solvents were used for the gradient elution: A – (H_2O + + 5% HCOOH) and B – (80% ACN + 5% HCOOH + H_2O). The elution program used was as follows: from 0 to 28 min, 0.0%B, from 28 to 35 min, 25% B, from 35 to 40

min, 50% B, from 40 to 45 min, 80% B, and finally for the last 10 min again 0% B. The detection wavelengths were 320 and 520 nm. The identification and quantification of the various phenolic compounds were made using calibration curves obtained with standard solutions of cyanidin-3-glucoside, cyaniding-3-rutinoside, malvidin-3-glucoside, delphinidin-3-glucoside, chlorogenic acid, caffeic acid, p-coumaric acid and ferulic acid. The results are expressed as mg L^{-1} fruit juice.

Statistical analysis

The data were reported as mean ± standard deviation (*SD*) for triplicate determinations. The significance of inter-group differences was determined by the analysis of variance (Anova). The p value < 0.05 was considered statistically significant.

RESULT AND DISCUSSION

The results of determining phenolic composition of selected monovarietal red fruit juices from Serbia are presented in Table 1. The TP content was highest in the blank currant juices of the three samples (2698.63––2813.05 mg/L), followed by the sour cherry juice (2329.97–2480.17 mg/L), and finally by the black grape juices (2158.77–2182.10 mg/L). The phenolic content of black currant juice-1 was significantly different from the black currant juice-3 ($p < 0.05$). It is well known that genetic and agronomic or environmental factors play important roles in phenolic composition and thus nutritional quality of crops.

Comparing these results with literature, similar values were reported for sour cherry juices produced in Germany [15] (2704–4998 mg GAE/L) and for sour cherry and black currant juices produced in Croatia [16] (2054.43 and 2770.94 mg GAE/L). Using the $AlCl_3$ reagent and catechin as standard ($R^2 = 0.999$), the total flavonoid varied from 322.12 mg CE/L (black grape juice-2) to 975.09 mg CE/L (black currant juice-3). An approximately 3-fold difference in the total flavonoid content was found between the highest and lowest ranked varieties. The flavonoid contents of black currant juices were significantly different from the others ($p < 0.05$). However, the significant differences in the flavonoid content were not found in the comparisons among black currant juice-2 and black currant juice-3. Also, the significant differences in the total flavonoid content were not found between sour cherry juice-1 and sour cherry juice-2 and between black grape juice-1 and black grape juice-3. However, a significant difference in the total flavonoid content was determined in comparison between black currant juice-1 and black currant juices-2,3. The differences in the content are more conditioned by the fruit sort.

The commercial red fruit juices were analyzed using a pH-differential method and to examine their total anthocyanin (TA) content (Table 1). The highest concentration of athocyanins was found in black currant juices (757.36–920.92 mg/L), whereas the concentration of anthocyanins in all other juices was significantly lower. The data presented by other authors also confirmed that the amount of total anthocyanins was higher in black currant than in other red fruits like sour cherry, red grape, black berry, raspberry or red currant [17,18].

The radical-scavenging capacity was evaluated by measuring the scavenging activity of the examined fruit juice samples on 2,2-diphenil-1-picrylhydrazyl ($DPPH^{\cdot}$) radicals. All antioxidant results are summarized in Figure 1. All investigated juices exhibited a potent radical scavenging activity. Black currant juices showed the strongest radical scavenging activity (13.32 mmol TE/L, 14.52 mmol TE/L, respectively), followed by sour cherry juices and black grape juices. The fruit juices containing high total phenolic contents had higher antioxidant activities.

The present study reveals a very good correlation between the total phenols and antioxidant capacity

Table 1. The concentration of the total phenol, total flavonoid and total anthocyanin contents of the red fruit juices

Juice	No. of sample	*TP*[1], mg GAE/L	*TF*[2], mg CE/L	*TA*[3], mg C3GE or mg M3GE/L
Sour cherry	1	2329.97±84.96abd,a[4,5]	510.10±15.66a,a	261.61±16.11a,a
	2	2480.17±22.15a,a	580.16±60.20ab,a	503.18±19.35b,b
	3	2428.43±53.30ac,a	618.05±7.53b,b	430.09±17.71c,c
Black currant	1	2698.63±43.29b,a	888.95±16.33c,a	757.36±49.93d,a
	2	2750.07±28.48b,ab	938.28±13.40c,b	871.03±14.09e,dc
	3	2813.05±32.21b,a	975.09±12.87c,b	920.92±10.86e,c
Black grape	1	2258.77±52.18cd,a	405.24±39.55d,a	256.43±14.10a,a
	2	2182.10±22.64d,a	322.12±9.27d,b	148.92±6.21f,b
	3	2250.32±47.74d,a	378.09±6.77d,ab	220.65±3.97af,c

[1]The level of total phenolics is expressed as gallic acid equivalent (GAE) and the data are reported as mean ± standard deviation ($n = 3$); [2]the level of total flavonoids is expressed as catechin equivalent (CE) and the data are reported as mean ± standard deviation ($n = 3$); [3]the level of total anthocyanins is expressed as cyanidin-3-glucoside equivalent (C3GE) for the sour cherry and black currant juices and malvidin-3-glucoside equivalent (M3GE) for the black grape juices and the data are reported as mean ± standard deviation ($n = 3$); [4]the mean in a column followed by different letters are significantly different using the analysis of variance of the lower of < 0.05; [5]different letters depict a significant difference between some red fruit juice varieties

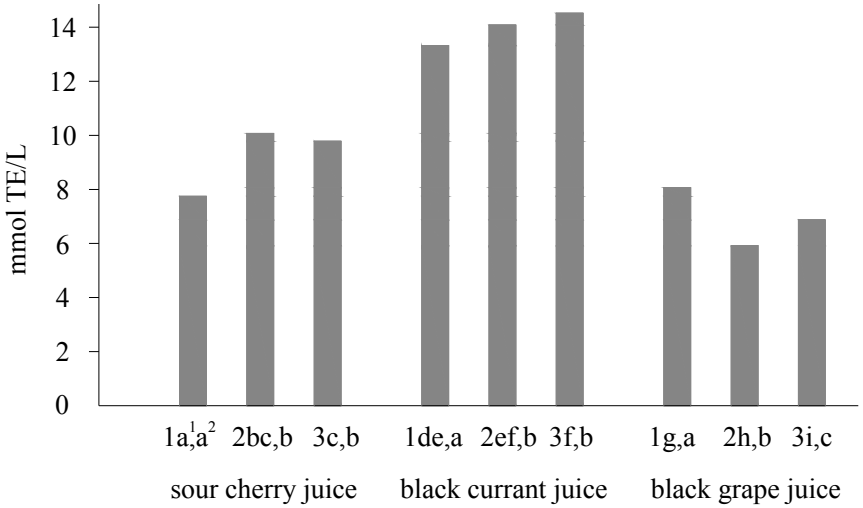


Figure 1. Antioxidant capacity of red fruit juice varieties expressed as Trolox equivalent (mmol/L). Bars with different letters depict a significant difference between all samples. Bars with different letters depict a significant difference between some red fruit juice varieties.

(R^2 = 0.992). Also, the significant correlation between the total anthocyanin content and the antioxidant capacity (R^2 = 0.994) of the tested red nectar samples was confirmed. According to the data presented by others, the best linear correlation was observed between the antioxidant capacity and total polyphenols of various red fruits (R^2 = 0.97) than between the antioxidant capacity and total anthocyanins (R^2 = 0.95) [16], which agrees with our results.

For better description of Serbian commercial red fruit juices, the profile of individual polyphenolic compounds was studied. In order to separate and determine the individual anthocyanin compounds and hydroxycinnamic acids present in the red fruit juices, HPLC method was applied. The HPLC chromatograms of the red fruit juices recorded at 520 nm are presented in Figure 2. The amounts of anthocyanins in the red fruit juices are shown in Table 2.

The sour cherry juices contained only cyanidin based pigments. Sour cherry nectars contained a mixture of three different cyanidin-glycosides: 3-glucoside, 3-rutinoside and 3-glucosyl-rutinoside. The concentrations of cyanidin-3-glucosyl-rutinoside were high (186.79 mg/L in sour cherry juice-1 to 227.88 mg/L in sour cherry juice-2, respectively, (83.79% of total anthocyanin content) whereas the concentrations of cyanidin-3- rutinoside (mean 38.24 mg/L) and cyanidin-3-glucosil-rutinoside (mean 6.82 mg/L) were relatively low. The data presented by other authors show that the main anthocyanin in sour cherry is cyanidin-3-glucoside, followed by cyanidin-3-rutinoside and cyanidin-3-glucosyl-rutinoside [19,20].

The black currant juices were characterized by the presence of glucoside and rutinoside of cyanidin and delphinidin with the rutinoside being the most abundant (delphinidin-3-rutinoside, mean value 254.51 mg/L, 53.4%; cyanidin-3-rutinoside, mean value 145.29 mg/L, 30.4% of total anthocyanin content). The data reported in the literature reveal that the main anthocyanins in black currant are rutinoside and glucoside of cyanidin and delphinidin, in agreement with our results [16––18,21].

The black grape juices were characterized by the presence of five glycosylated anthocyanins: delphinidin-3-glucoside, cyaniding-3-glucoside, petunidin-3-glucoside, peonidin-3-glucoside and malvidin-3-glucoside. The most prominent compound was malvidin-3-glucoside (Table 2), which accounted for 44.84% of the total content, followed by the corresponding glucosides of delphinidin (17.04%) petunidin (14.35%), peonidin (14.06%) and cyaniding (5.30%). A similar profile in red grapes has been reported in the literature [22].

In this study, the anthocyanin content of the selected red fruit juices was evaluated by HPLC and by spectrophotometric method. The anthocyanin content measured by spectrophotometry does not provide an accurate estimation of the actual amount of monomeric anthocyanins. Differences in the total anthocyanin content determined spectrophotometrically and by HPLC vary significantly with the age of a juice [23] because the total anthocyanin values also denote polymeric and other types of pigments.

The hydroxycinnamic acids and their tartaric acid derivatives have been monitored at 320 nm, since that is their characteristic wavelength. The chromatographic of the fruit juices monitored at 320 nm is given in Figure 3. Sour cherry juices commonly contain neoclorogenic acid, *p*-coumaric acid derivative, *p*-coumaric acid and ferulic acid (Figure 3, Table 3). Neoclorogenic acid was found to be the major hydroxycinnamic acid in sweet and sour cherries, the amount of which was relatively higher in sour cultivars than sweet cultivars

[19,24]. In our case, among the hydroxycinnamic acids, neochlorogenic acid composed 76.9–83.8%.

The main hydroxicinnamic acid found in black currant juices, which represented 42.14% of the total hydroxycinnamic acid content, was caffeic acid, followed by neochlorogenic acid. Ferulic acid and *p*-coumaric acid and were found in relatively lower amounts. These data are in accordance with those found in literature [25].

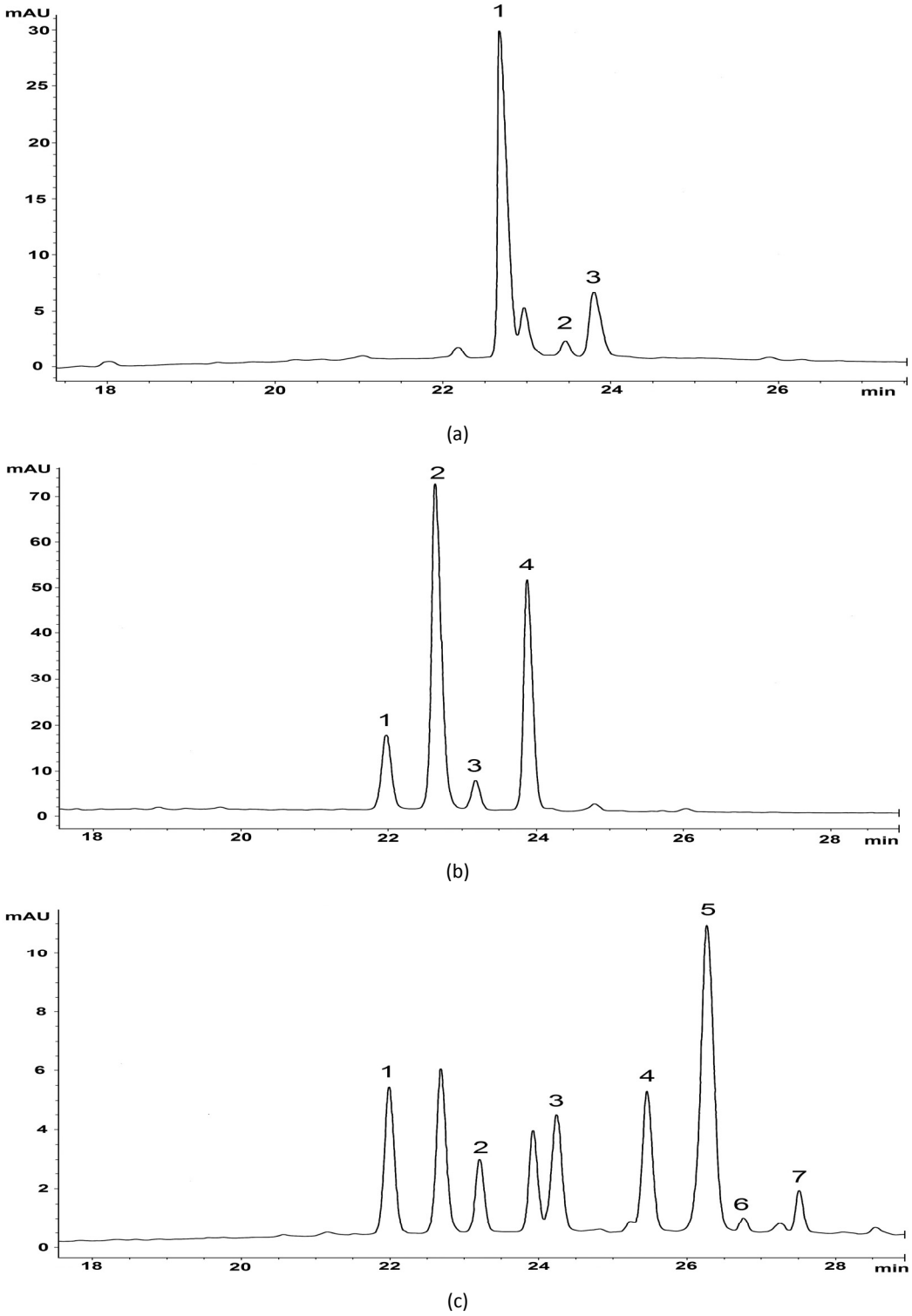


Figure 2. HPLC chromatogram of anthocyanins in a) sour cherry juice, b) black currant juice and c) black grape juice.

Table 2. The concentration of anthocyanins in fruit juices (mg/L) determined by HPLC method and percentage distribution of anthocyanins (in parentheses); The data are reported as mean ± standard deviation (n = 3)

Compound	Sour cherry		
	1	2	3
Cyanidin-3-glucosyl-rutinoside[a] (peak 1)	186.79±0.98 (79.44)	227.88±1.03 (83.02)	208.64±1.72 (83.84)
Cyanidin-3-glucoside (peak 2)	6.44±0.08 (2.74)	6.43±0.05 (2.34)	7.58±0.21 (3.05)
Cyanidin-3-rutinoside(peak 3)	41.89±0.92 (17.82)	40.18±0.08 (14.64)	32.64±0.52 (13.11)
Total	235.12 (100.00)	274.49 (100.00)	248.85 (100.00)
	Black currant		
Delphynidin-3-glucoside (peak 1)	55.22±1.17 (12.67)	48.52±1.08 (10.06)	68.52±1.35 (13.36)
Delphynidin-3-rutinoside[b] (peak 2)	238.49±1.37(54.74)	252.68±2.01(52.40)	272.36±1.75(53.12)
Cyanidin-3-glucoside(peak 3)	17.63±0.11 (4.06)	22.35±0.15 (4.64)	18.93±0.09 (3.69)
Cyanidin-3-rutinoside(peak 4)	124.30±0.96(28.53)	158.65±0.88 (32.90)	152.92±1.05 (29.83)
Total	435.64 (100.00)	482.20 (100.00)	512.73 (100.00)
	Black grape		
Delphynidin-3-glucoside (peak 1)	16.64±0.32 (17.64)	15.32±0.18 (16.59)	17.82±0.22 (16.89)
Cyanidin-3-glucoside (peak 2)	6.51±0.05 (6.90)	3.48±0.07 (3.76)	5.69±0.11 (5.39)
Petunidin-3-glucoside[c] (peak 3)	12.50±0.21 (13.25)	13.68±0.16 (14.81)	15.83±0.22 (15.01)
Peonidin-3-glucoside[c] (peak 4)	14.21±0.35 (15.09)	13.99±0.17 (15.15)	12.62±0.32 (11.96)
Malvidin-3-glucoside (peak 5)	40.24±0.58 (42.66)	42.52±0.47 (46.04)	48.35±0.63 (45.82)
Malvidin-3-glucoside[c] acetate (peak 6)	1.03±0.03 (1.09)	0.98±0.01 (1.06)	1.52±0.05 (1.44)
Vitisin A[c] (peak 7)	3.18±0.10 (3.37)	2.39±0.09 (2.59)	3.68±0.07 (3.49)
Total	94.31 (100.00)	92.36 (100.00)	105.51 (100.00)

[a]The level of cyanidin-3-glucosyl-rutinoside is expressed as cyanidin-glucoside equivalent; [b]the level of delphynidin-3-rutinoside is expressed as delphynidin-3-glucoside equivalent; [c]the level of petunidin-3-glucoside, peonidin-3-glucoside, malvidin-3-glucoside acetate and vitisin A are expressed as malvidin-3-glucoside equivalents

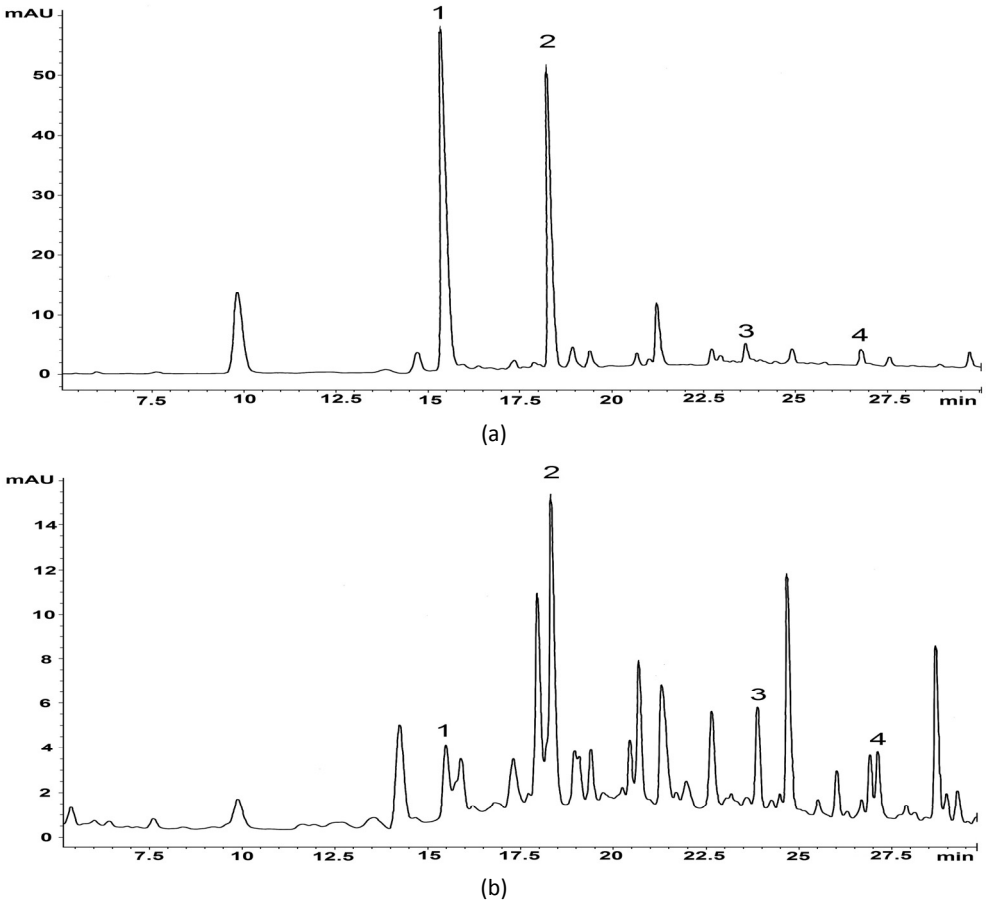
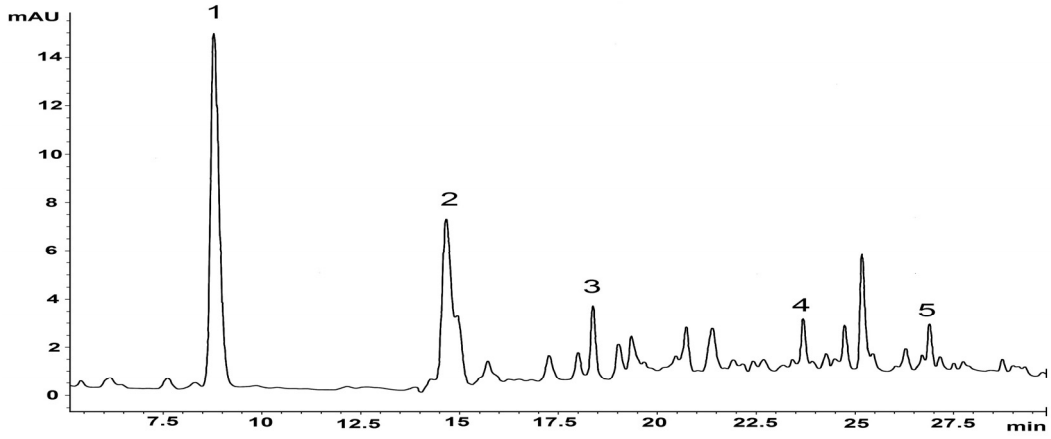


Figure 3. HPLC chromatogram of hydroxicinnamic acid in a) sour cherry juice and b) black currant juice.



(c)

Figure 3. (Continued) HPLC chromatogram of hydroxicinnamic acid in c) black grape juice.

Table 3. The concentration of hydroxycinnamic acids in the fruit juices (mg/L) determined by HPLC method and percentage distribution of hydroxycinnamic acids (in parentheses); The data are reported as mean ± standard deviation (n = 3)

Compound	Sour cherry		
	1	2	3
Neochlorogenic acid[a] (peak 1)	65.12±1.08 (80.47)	78.39±1.32 (83.80)	58.32±1.05 (76.93)
p-Coumaric acid derivate[b] (peak 2)	11.76±0.09 (14.53)	12.52±0.12 (13.38)	14.28±0.18 (18.83)
p-Coumaric acid (peak 3)	3.05±0.05 (3.78)	1.58±0.05 (1.70)	2.36±0.02 (3.12)
Ferulic acid (peak 4)	0.99±0.01 (1.22)	1.05±0.02 (1.12)	0.85±0.02 (1.12)
Total	80.92 (100.00)	93.54 (100.00)	75.81 (100.00)
	Black currant		
Neochlorogenic acid (peak 1)	3.12±0.06 (34.51)	5.83±0.07 (38.45)	3.32±0.10 (33.9)
Caffeic acid (peak 2)	4.28±0.11 (47.34)	6.38±0.18 (42.08)	3.69±0.12 (37.01)
p-Coumaric acid (peak 3)	1.07±0.07 (11.85)	2.03±0.05 (13.40)	1.91±0.08 (19.17)
Ferulic acid (peak 4)	0.57±0.02 (6.30)	0.92±0.05 (6.07)	1.05±0.03 (10.53)
Total	9.04 (100.00)	15.16 (100.00)	9.97 (100.00)
	Black grape		
t-Caftaric acid[c] (peak 1)	6.93±0.17 (33.94)	7.32±0.18 (36.09)	6.52±0.09 (28.81)
t-Coutaric acid (peak 2)	1.86±0.03 (9.11)	2.08±0.07 (10.25)	1.53±0.10 (6.76)
Caffeic acid (peak 3)	0.76±0.09 (3.72)	0.66±0.09 (3.25)	1.05±0.06 (4.64)
p-Coumaric acid (peak 4)	10.41±0.38 (50.98)	9.63±0.65 (47.50)	12.75±0.89 (56.35)
Ferulic acid (peak 5)	0.46±0.03 (2.25)	0.59±0.07 (2.91)	0.78±0.09 (3.44)
Total	20.42 (100.00)	20.28 (100.00)	22.63 (100.00)

[a]The level of neochlorogenic acid is expressed as chlorogenic acid equivalents; [b]the level of p-coumaric acid derivate is expressed as p-coumaric acid equivalents; [c]the level of *t*-caftaric acid is expressed as caffeic acid equivalents; [d]The level of *t*-coutaric acid is expressed as *p*-coumaric acid equivalents

Table 3 shows the concentrations of the hydroxycinnamic acids determined by HPLC in the studied black grape juices. The p-coumaric acid contents ranged from 9.63 to 10.41 mg/L (mean 10.93 mg/L), *t*-caftaric acid contents from 6.52 to 7.32 mg/L (mean 6.92 mg/L), *t*--coutaric acid contents from 1.53 to 2.08 mg/L (mean 1.82 mg/L), caffeic acid contents from 0.76 to 1.05 mg/L and ferulic acid contents from 0.46 to 0.78 mg/L (mean 0.61 mg/L). Thus *p*-coumaric acid was predominant in all the red grape nectars investigated, representing 51.77% of the total hydroxicinnamic acid content, as demonstrated for a number of wines [26] while ferulic acid (2.89%) was much less abundant.

CONCLUSION

These results suggest that the investigated red fruit juices contain a high content of a different group of polyphenols, which have a potent antioxidant capacity. Generally, the healthiest fruit juices are black currant juices. The red fruit juices evaluated in the study show significant variations in the anthocyanin content and profile. Some juices have a low amount of anthocyanins, as black grape juices, whereas the amount of

these phytochemicals is very high in black currant juices. The concentrations of the hydroxycinnamic acids in red fruit juices are under investigation.

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IZVOD

SADRŽAJ FENOLNIH JEDINJENJA I ANTIOKSIDATIVNI KAPACITET KOMERCIJALNIH SOKOVA CRVENOG VOĆA

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Određen je sadržaj fenolnih jedinjenja, ukupnih fenola, flavonoida, antocijana, hidroksicimetnih kiselina i njihov ukupni antioksidativni kapacitet u osam industrijskih sokova crvenog voća (višnje, borovnice i crvenog grožđa) koji su proizvedeni u Srbiji. Ukupan sadržaj fenolnih jedinjenja je određen spektrofotometrijskim metodama a ukupan antiokidativni kapacitet primenom DPPH metode. Pojedinačni antocijani i fenolne kiseline određeni su primenom HPLC-DAD metode. Sok borovnice ima najveći sadržaj svih grupa fenolnih jedinjenja. Sok borovnice takođe pokazuje veliki antioksidativni kapacitet. Sadržaj antocijana koji su određeni HPLC metodom kreće se od 92,36 mg/L u soku crvenog grožđa do 512.73 mg/L u soku borovnice. U sokovima crvenog voća prisutni su derivati delfinidina, petunidina, peonidina i malvidina. Glavne fenolne kiseline su neohlorogenska u soku višnje, kafena u soku borovnice i *p*-kumarinska kiselina u borovnici. Sokovi crvenog voća koji su proizvedeni u Srbiji bogati su fenolnim jedinjenjima i imaju značajan antioksidativni kapacitet.

Ključne reči: Voćni sokovi • Fenolni sastav • Antioksdativni kapacitet • Antocijani • Hidroksicinamične kiseline