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Short communication:

Antioxidant activity, phenolic compounds and mineral contents of boiled juices

Kurzmitteilung:

Antioxidative Aktivität, phenolische Verbindungen und Mineralgehalte von gekochten Säften

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Summary

While antioxidant activity values of boiled juice (pekmez) samples varied between 89.26 % (date) and 99.07 % (pomegranate), total phenolic contents ranged from 103.32 mg GAE/100 g to 149.56 mg GAE/100 g (pomegranate). Gallic acid contents of pekmez samples were determined between 1.16 mg/100 g (carob) and 4.23 mg/100 g (pomegranate). Also, pekmez samples contained 4.13 mg/100 g (carob)-9.51 mg/100 g (pomegranate) (+)-catechin. K contents of boiled juice samples varied from 131.48 mg/Kg (Date) to 10832.63 mg/Kg (Carob). Fe contents of boiled juice samples varied between 15.98 mg/Kg (Pomegranate) and 51.43 mg/Kg (Mulberry). The highest Zn content was found in Pomegranate boiled juice (9.90 mg/Kg). The lowest Zn content was determined in mulberry (black) pekmez (0.77 mg/Kg).

Keywords: pekmez, fruits, phenolic compounds, minerals, heavy metal, ICP-AES

Zusammenfassung

Während die antioxidative Aktivität der Proben von gekochtem Saft (Pekmez) zwischen 89,26 % (Datteln) und 99.07 % (Granatapfel) variierten, lag der Gesamtphenolgehalt im Bereich von 103,32 mg GAE/100 g bis 149,56 mg GAE / 100 g (Granatapfel). Der Gehalt an Gallussäure der Pekmez-Proben wurde zwischen 1,16 mg/ 100 g (Johannisbrot) und 4,23 mg/100 g (Granatapfel) bestimmt. Außerdem enthielten die Pekmez-Proben 4,13 mg/100 g (Johannisbrot) bis 9,51 mg/100 g (Granatapfel) Catechin. Der Kalium-Gehalt der gekochten Saftproben lag im Bereich von 131,48 mg/ kg (Datteln) bis 10832,63 mg/kg (Johannisbrot). Der Eisen-Gehalt variierte zwischen 15,98 mg/kg (Granatapfel) und 51,43 mg/kg (Maulbeere). Der höchste Zink-Gehalt wurde in Granatapfelkochsaft (9,90 mg/kg) gefunden. Der niedrigste Zink-Gehalt wurde im Saft der schwarzen Maulbeere (0,77 mg/kg) bestimmt.

Schlüsselwörter: Pekmez, Früchte, Phenolgehalt, Mineralien, Schwermetalle, ICP-AES

Introduction

Boiled juice is produced from grape and other fruit juices such as apple, carob, plum, sugar beet and fig (Alpaslan and Hayta, 2002; Tosun and Üstün, 2003; Şengül et al. 2005). Boiled grape juice is known as "pekmez" in Turkish. It is used as an ingredient for sweetness, flavor and caramelization in cereal based products. Boiled juice is an important food for human nutrition, especially babies, children, sportsmen due to high energy, mineral and organic acids content (Karakaya and Artık, 1990; Topçu et al. 1997; Demirözü et al. 2002; Tosun and Üstün, 2003; Yoğurtçu and Kamışlı, 2005). But, there is limited information about mineral content and phenolic compounds of several fruit pekmez (boiled juice) samples. Therefore, the objective of current study was to determine the antioxidant activity, total phenol, phenolic compounds and mineral contents of pekmez samples.

Material and methods

Material

The seven boiled juice (pekmez) samples (carob, date, grape, mulberry (white and black), pomegranate, rose) used in this study were provided from local market in Tokat province in Turkey. They were kept in +4 °C till use.

Methods

Extraction of phenolic compounds

Phenolic compounds were extracted according to Ivanova et al. (2005) with some modifications. 2 g of ground samples were added to 60 ml of methanol. After sample was centrifuged at 5000 rpm for 5 min, and the supernatant was collected. The extract was concentrated at 50 °C. The dried extracts were dissolved in 2 ml of methanol, and filtered. The it was injected for analyses.

TABLE 1: *Antioxidant activity and total phenol contents of boiled juice (Pekmez).*

Boiled juices (Pekmez)	Moisture (%)	Antioxidant Activity (%)	Total Phenolic Content (mg/100 g)
Grape (white)	78.3±1.16*d	93.32±2.37c	139.57±2.56d
Mulberry (white)	81.5±1.27c**	98.67±1.45b	142.49±3.72c
Grape (black)	82.7±2.13c	97.65±1.73b	146.44±3.29b
Date	74.1±0.99e	89.26±2.37d	101.32±2.78f
Carob	86.4±1.07a	93.48±2.19c	139.84±3.65d
Pomegranate	83.8±1.19c	101.34±3.21a	149.56±3.59a
Mulberry (black)	84.1±0.87b	92.49±1.67c	135.71±2.74e

*: mean±standard deviation (n:3), **: Values within each column followed by different letters are significantly different (p<0.05)

Total phenolic content and Antioxidant activity

Total phenol contents of obtained extracts were determined by using Folin-Ciacueltau (FC) reagent as described by Yoo et al. (2004). The free radical scavenging activity of sdate fruits was determined using DPPH (1,1-diphenyl-2-picrylhydrazyl) according to Lee et al. (1998).

Determination of phenolic compounds

Phenolic compounds were performed using a Shimadzu-HPLC equipped with a PDA detector and an Inertsil ODS-3 (5 µm; 4.6 x 250 mm) column. The mobile phase was a mixture of 0.05 % acetic acid in water (A) and acetonitrile (B).

Mineral Analyses

About 0.5 g dried in oven at 70±5 °C for two days, and ground samples were digested by using 5 ml of 65 % HNO_3 and 2 ml of 35 % H_2O_2 in a closed microwave system. Mineral contents were determined by Inductively Coupled Plasma Atomic Emission Spectrometry (Varian-Vista, Australia) (Skujins, 1998).

TABLE 2: *Phenolic compounds of boiled juices (pekmez) (mg/100 g).*

Phenolic Compounds	Grape (White)	Mulbery (white)	Grape (Black)	Date	Carob	Pomegranate	Mulberry (Black)
Gallic Acid	2.64 ± 0.27*b	4.06 ± 0.26a	1.46 ± 0.12c	2.06 ± 0.35b	1.16 ± 0.08c	4.23 ± 0.08a	1.68 ± 0.07c
3,4-Dihydroxybenzoic Acid	3.72 ± 0.321a**	3.22 ± 0.18a	2.13 ± 0.07b	1.61 ± 0.56c	1.14 ± 0.16c	2.47 ± 0.54b	1.86 ± 0.09c
(+)-Catechin	8.78 ± 1.02a	8.81 ± 0.13b	6.21 ± 0.13c	7.27 ± 0.49b	4.13 ± 0.36d	9.51 ± 1.57a	6.51 ± 1.09c
1,2-Dihydroxybenzene	6.98 ± 1.25a	6.03 ± 0.75b	5.48 ± 0.17c	4.21 ± 0.16d	2.42 ± 0.14e	5.21 ± 0.59c	5.68 ± 0.22c
Syringic Acid	3.91 ± 0.02a	2.36 ± 0.35b	1.13 ± 0.21c	0.43 ± 0.29d	0.18 ± 0.06d	1.46 ± 0.04c	0.59 ± 0.12d
Caffeic Acid	2.82 ± 0.17a	1.17 ± 0.21b	2.74 ± 0.12a	0.51 ± 0.19c	0.61 ± 0.31c	2.39 ± 0.11a	0.88 ± 0.13c
Rutin trihydrate	4.51 ± 0.45a	3.27 ± 0.27b	3.76 ± 0.32b	2.39 ± 0.83c	1.37 ± 0.05d	2.28 ± 0.06c	1.39 ± 0.53d
p-Coumaric Acid	0.62 ± 0.48b	0.37 ± 0.30b	1.11 ± 0.06a	0.68 ± 0.09b	0.49 ± 0.07b	1.56 ± 0.16a	0.42 ± 0.03b
trans-Ferulic Acid	1.21 ± 0.34b	1.16 ± 0.13b	2.10 ± 0.27a	0.93 ± 0.07c	0.67 ± 0.07c	2.74 ± 0.32a	1.05 ± 0.06b
Apigenin 7 glucoside	2.47 ± 0.95b	2.35 ± 0.21b	2.10 ± 0.42b	3.38 ± 0.26a	0.52 ± 0.09d	2.45 ± 0.28b	1.03 ± 0.08c
Resveratrol	1.95 ± 0.08a	1.85 ± 0.12a	1.16 ± 0.35a	1.59 ± 0.11a	0.73 ± 0.08b	0.21 ± 0.39b	0.78 ± 0.13b
Quercetin	5.81 ± 0.17a	4.25 ± 0.16b	5.60 ± 1.03a	3.81 ± 0.46c	4.43 ± 0.17b	1.87 ± 0.41d	4.19 ± 0.28b
trans-Cinnamic Acid	0.71 ± 0.11c	0.41 ± 0.24c	2.48 ± 0.23a	1.73 ± 0.38b	0.56 ± 0.21c	0.89 ± 0.36c	0.75 ± 0.05c
Naringenin	0.87 ± 0.13d	1.86 ± 0.37c	3.65 ± 0.21a	0.81 ± 0.07d	2.48 ± 0.32b	0.78 ± 0.29d	0.37 ± 0.07e
Kaempferol	1.69 ± 0.13c	1.38 ± 0.23c	3.20 ± 0.15a	2.12 ± 0.68b	2.09 ± 0.32b	1.86 ± 0.17c	0.87 ± 0.09d
Isorhamnetin	2.47 ± 0.61c	4.22 ± 0.17a	2.61 ± 0.16c	2.13 ± 0.49c	3.47 ± 0.33b	2.17 ± 0.32c	0.74 ± 0.09d

*: mean±standard deviation (n:3), **: Values within each column followed by different letters are significantly different (p<0.05)

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Statistical Analysis

Analysis of variance (ANOVA) was performed by using JMP version 9.0 (SAS Inst. Inc., Cary, N.C.U.S.A). Results were gine mean±standard deviation (Püskülcü and İkiz, 1989).

Results and Discussion

Moisture, antioxidant activity and total phenolic contents of boiled juices samples are presented in Table 1. Moisture contents of samples were found between 74.1 % (date) and 86.4 % (carob). While antioxidant activity values of pekmez samples change between 89.26 % (date) and 101.34 % (pomegranate), total phenolic contents ranged from 103.32 mg GAE/100 g to 149.56 mg GAE/100 g (pomegranate) (Tab. 1) ($p<0.05$). Koca and Karadeniz (2009) reported that total phenolics and total antioxidant activity (expressed as FRAP values) values of the pekmez samples ranged from 4603.60 to 14,252.25 mg/kg, and 47.34 to 327.86 mmol/g, respectively. Total phenolic contents varied from 138 to 243 mg of gallic acid equivalents/100 g pekmez samples (Aliyazıcıoğlu et al. (2009). The apricot pekmez had the highest phenolic content (243 ± 16), while the carob pekmez exhibited the highest DPPH (0.08 ± 0.01 mg g^{-1}) radical scavenging activity (Aliyazıcıoğlu et al. 2009).

Phenolic compounds of boiled juice (pekmez) samples are given in Table 2. Gallic acid contents of pekmez samples were determined between 1.16 mg/100 g (carob) and 4.23 mg/100 g (pomegranate) ($p<0.05$). Also, pekmez samples contained 4.13 mg/100 g (carob)-9.51 mg/100 g (pomegranate) (+)-catechin. Rutin trihydrate contents of samples ranged from 1.37 mg/100 g (carob) to 4.51 mg/100 (grape-white). In addition, quercetin contents of pekmez samples changed between 0.87 mg/100 g (pomegranate) to 4.81 mg/100 g (grape-white). Generally, boiled fruit juice (pekmez) are rich in phenolic compounds.

The macro and micro element contents of pekmez are given in Table 3. K contents of boiled juice varied between 131.48 mg/Kg (Date) and 10832.63 mg/Kg (Carob). Mg was not found in date and black mulberry boiled juices ($p<0.05$). While P contents of boiled juice (pekmez) change between 25.22 (Mulberry-black) and 615.29 mg/Kg (Mulberry-white), Ca contents of samples ranged from 10.5 mg/Kg (date) to 1169.15 mg/kg (mulberry-white). Na contents of all samples were found to be higher than those of results of other elements. Fe contents of boiled juice samples varied between 15.98 mg/Kg (Pomgranate) and 51.43 mg/Kg (Mulberry). The highest Zn content is found in Pomegranate boiled juice (9.90 mg/Kg). The highest Na contents (3532.02 mg/Kg) was found in grape (white) boiled juice sample. The detection limits pf heavy metals were found too low in all samples. K was the most abundant element in pekmez produced in different locations of Turkey with an average content of 6216–7120 mg/kg, fallowed by Ca (1398–1782), Na (128–163), P (36–59) and Fe (10.58–11.10) (Karakaya and Artık, 1990). Kavas (1990) determined high amounts of Ca (400–500 mg/100 g), K (1470 mg/100 g), Fe (9.2 mg/100 g) and Na (96 mg/100 g) in grape pekmez. Topçu et al. (1997) established 369.46 mg/100 g Ca, 89.0 mg/100 g P, 12.78 mg/100 g Mg, 7.31 mg/100 g Fe, 18.67 mg/100 g Na and 1369.40 mg/100 g K in grape pekmez. Pekmez is an important source due to K, Ca, P and F for human nutrition (Ekşi and Artık, 1984). These values were found similar compared with the results of

TABLE 3: *Mean values ± SD of macro and micro element contents of pekmez (n=3).*

Boiled juice (Pekmez)	Macro Elements (mg kg^{-1})				Micro Elements (mg kg^{-1})				
	P	K	Ca	Mg	Fe	Zn	Mn	B	Cu	Na
Grape (white)	367.07 ± 17.94c*	6574.83 ± 410.37c	721.33 ± 26.50b	239.91 ± 17.70d	22.62 ± 2.90*c	0.98 ± 0.08c	3.91 ± 0.33b	23.69 ± 1.10b	1.00 ± 0.07a	3532.0 ± 327.77a
Mulberry (white)	615.29 ± 4.36a	10552.21 ± 61.18a	1169.15 ± 20.69a	654.15 ± 17.45a	51.43 ± 1.39a	3.45 ± 0.19b	9.27 ± 0.05a	14.31 ± 0.47c	1.21 ± 0.02a	1078.4 ± 4.97d
Grape (black)	286.64 ± 6.99d	7529.82 ± 398.31b	250.62 ± 22.27b	377.42 ± 25.82c	23.00 ± 2.06c	3.70 ± 0.26b	3.46 ± 0.26b	5.48 ± 0.35d	0.95 ± 0.07b	2806.1 ± 94.02b
Date	2.68 ± 0.15f	131.48 ± 2.23e	10.51 ± 0.81d	0.00 ± 0.00	22.63 ± 0.58c	0.98 ± 0.03	0.00 ± 0.00	6.59 ± 1.13d	0.80 ± 0.08b	175.5 ± 28.00f
Carob	472.48 ± 9.91b	10832.63 ± 255.32a	681.49 ± 16.06b	446.73 ± 18.02b	27.59 ± 2.44b	2.49 ± 0.30b	2.40 ± 0.46c	3.91 ± 0.12e	1.34 ± 0.06a	1987.8 ± 59.20c
Pomgranate	414.06 ± 10.25b	7906.87 ± 193.58b	137.12 ± 18.52c	154.09 ± 6.82e	15.98 ± 7.30d	9.90 ± 10.45a	0.94 ± 0.04d	27.10 ± 3.43a	1.69 ± 0.05a	216.0 ± 11.64e
Mulberry (black)	25.22 ± 1.10e	311.82 ± 12.45d	17.12 ± 0.58d	0.00 ± 0.00	17.53 ± 1.35d	0.77 ± 0.02c	0.00 ± 0.00	2.25 ± 0.41e	0.77 ± 0.12c	165.2 ± 14.72f

*: Values within each column followed by different letters are significantly different ($p<0.05$)

Karakaya and Artık (1990). Each pekmez had antioxidant and high amount of polyphenols and minerals (Aliyazıcıoğlu et al. (2009). In conclusions, several type pekmez samples were found to be important sources of antioxidant activity, phenolic compounds and essential elements.

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Conflict of interest

No conflict of interest amoung authors.

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