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EFFECT OF ROASTING DEGREE ON THE ANTIOXIDANT ACTIVITY OF DIFFERENT ARABICA COFFEE QUALITY CLASSES

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ABSTRACT

Background. Coffee is one of the most widely consumed beverages in the world, because of its unique sensory properties and physiological properties. Coffee beverages represent a significant source of antioxidants in the consumers' diet and contribute significantly to their daily intake. The aim of this research was to investigate the effect of different roasting degrees on the content of biologically active compounds and antioxidant activity in different quality classes of Arabica coffee.

Materials and methods. Samples of green Arabica coffee (Rio Minas) of two quality classes from two production batches were used for the research. Roasting was carried out at temperatures of 167, 175 and 171°C. The total phenol content (TPC), total flavonoid content (TFC), flavonol content (FC) and antioxidant activity (DPPH, ABTS) in the coffee extracts was determined.

Results. This research shows that TPC was significantly higher ($P < 0.05$) in green coffee compared to TPC in roasted coffee, and TPC decreases as the roasting temperature increases. TFC and FC were significantly lower ($P < 0.05$) in green coffee than in roasted coffee. Differences in TPC between the 1st and 2nd classes of Arabica coffee were not significant ($P > 0.05$), while differences in TFC were significant ($P < 0.05$) only for green coffee from the second production batch and differences in FC were significant ($P < 0.05$) for green coffee and for coffee roasted at 175°C. Roasting temperatures have different influences the antioxidant activity (DPPH, ABTS) of coffee and the highest antioxidant activity was determined in coffee roasted at 171°C. An exception was 1st class Arabica coffee roasted at 167°C (ABTS). All samples of 1st class Arabica coffee had higher antioxidant activity (DPPH, ABTS) compared to 2nd class Arabica.

Conclusions. This research shows that the bioactive compounds content and antioxidant activity of different quality classes of Arabica coffee are dependent on the degree of roasting. TPC decreases when the roasting temperature increases, while TFC and FC also increase. These results indicate that the antioxidant activity of coffee depends on a variety of bioactive components in coffee beans. Antioxidant activity largely depends on the class of coffee. The coffee samples of 1st class quality (maximum 8 black beans/300 g from the sample and large bean size) had higher antioxidant activity compared to samples of 2nd quality class (maximum 19 black beans/300 g in the sample and medium-sized beans).

Key words: coffee, roasting, phenolic compounds, antioxidant activity

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INTRODUCTION

Food and certain food components can significantly affect human health (Dziki et al., 2015). A diet that includes fruits, vegetables, cereals and legumes represents a source of many antioxidants (Yashin et al., 2013). Products which can supply high amounts of antioxidants are beverages such as coffee, tea, cocoa, wine and beer (Sikora et al., 2008). Coffee is one of the most popular beverages worldwide. The type of coffee beverage, size of the standard cup and the amount of coffee consumed can significantly vary by geographical region and on an individual basis. Moderate coffee consumption is associated with a significant reduction in the risk of certain chronic diseases developing (Cavin et al., 2008). For this reason, in recent years, increased attention has been directed to the study of coffee's beneficial effects on human health. Since coffee contains significant amounts of antioxidants and other positive active components, researchers have indicated the potential beneficial health effects of coffee (Mišik et al., 2010; Nicoli et al., 1997; Trandafir et al., 2013). Svilaas et al. (2004) and Votavova et al. (2009) confirmed that coffee beverages contribute 66% of the total antioxidant intake. Recent studies have shown that coffee components such as tocopherols, carotenoids, caffeine, phenolic compounds such as chlorogenic acid, hydroxycinnamic acid and products of the Maillard reaction, such as melanoides, have antioxidant properties (Parras et al., 2007; Vignoli et al., 2011). Phenolic compounds are considered to be the most effective antioxidants, and also they have a significant influence on the stability, sensory and nutritional characteristics of the product (Klensporf-Pawlik and Przybylski, 2015; Sikora et al., 2008). Phenolic acids, their derivatives and some flavonoids belong to the group of natural phenolic compounds (Sikora et al., 2012). Coffee roasting is a complex heat transfer process and this step is probably the most important stage in coffee processing (Fereez Eduzan, 2015; Noor Aliah, 2015). The beans undergo a series of reactions during roasting, leading to the desired changes in physical properties and chemical composition (Illy and Viani, 2005). The concentration of highly active phenolic compounds in green coffee depends on coffee variety and origin, while the level in coffee as a beverage depends on the roasting degree and method of beverage preparation. Phenolic components are partially decomposed during the roasting process and depend on the roasting conditions (Farah and Donangelo, 2006).

The antioxidant activity of coffee of different types and origin was the subject of many previous studies. However, to the best of our knowledge, no data exists on the antioxidant activity of coffee of different quality classes, nor on flavonol content in coffee. The aim of this research was to investigate the effect of different roasting degrees on biologically active compound content and antioxidant activity in different quality classes of Arabica coffee. For that purpose, the total phenol, total flavonoid and flavonol content, as well as antioxidant activity were determined in the green and roasted coffee samples. Researching the possible correlations between the content of these compounds and antioxidant activity are also included in the scope of this study.

MATERIALS AND METHODS

Coffee samples and roasting conditions

Green coffee samples, Arabica (Rio Minas from Brazil, year of harvest 2014) of two quality classes from two production batches were used for the research. A local coffee manufacturer supplied us with green coffee, as is usually used and available on the local market. The coffee samples were distinguished by quality class (Table 1). The roasting process was performed in industrial conditions, in a roaster which has a capacity of 150 kg/batch. Roasting was performed at three different temperatures (three roasting degrees) according to industrial conditions of production and manufacturing specifications. Table 2 presents a breakdown of roasting.

Coffee extracts preparation

The coffee extracts were prepared according to the procedure described by Perez-Hernandez et al. (2012) with some modifications. Samples of green and roasted ground coffee were extracted with hot deionised water (90°C) at a coffee/solvent ratio 0.5/100 for 5 min with constant stirring. After extraction, the extracts were centrifuged for 5 min at 2000 rpm. Extraction was repeated three times for each sample, using the method described previously. The extracts were stored at a temperature of –20°C until analysis.

Table 1. Samples of Arabica green coffee and their classification

Green coffee samples	Green coffee beans classification on "black bean count basis"	Green coffee beans "sizing chart classification"
Arabica (G1)* Rio Minas 2nd class	N/Y 3/4 – max 19 black beans/300 g of sample	SC. 15/16 – medium size
Arabica (G2)* Rio Minas 1st class	N/Y 2/3 – max 8 black beans/300 g of sample	SC. 17/18 – large size
Arabica (G3)** Rio Minas 2nd class	N/Y 3/4 – max 19 black beans/300 g of sample	SC. 15/16 – medium size
Arabica (G4)** Rio Minas 1st class	N/Y 2/3 – max 8 black beans/300 g of sample	SC. 17/18 – large size

*Green coffee samples from the first production batch.
**Green coffee samples from the second production batch.

Table 2. Temperature regime for coffee roasting

Green coffee samples	Roasted coffee samples	Parameters of roasting process		Roasting degree
		T, °C	*T*, min	
Arabica (G1)	A1	167	25	light
Arabica (G2)	B1	167	25	light
Arabica (G1)	A2	175	25	dark
Arabica (G2)	B2	175	25	dark
Arabica (G3)	J1	171	26	medium
Arabica (G4)	K1	171	26	medium

Determination of total phenol content

The total phenol content (TPC) of each coffee extract was determined spectrophotometrically (UV/Vis spectrophotometer PerkinElmer Lambda 25), following the Folin-Ciocalteu procedure, according to Wolfe et al. (2003)'s modified method. 1.5 mL of Folin-Ciocalteu solution (stock Folin-Ciocalteu solution dissolved with water in 1/10 ratio) and 1.5 mL of 7.5% $NaHCO_3$ were added to 0.2 ml of diluted extract. Absorbance was measured after 30 min storing (in a dark place and at room temperature) at 765 nm, along with the blank. Chlorogenic and gallic acid were used as standards and the results were expressed as mg chlorogenic acid equivalents (CGA)/g of coffee sample and as mg gallic acid equivalents (GAE)/g of coffee sample.

Determination of total flavonoid content

The total flavonoid content (TFC) was determined according to method described by Ordoñez et al. (2006). 1 ml of 2% $AlCl_3$ ethanolic solution was added to 1 ml of diluted extract. The absorbance was measured after 30 min storing (in a dark place) at 420 nm, along with the blank. TFC was calculated and expressed as mg quercentin equivalents (QE)/g of the coffee sample.

Determination of flavonol content

The flavonol content (FC) was determined according to Kumaran and Karunakaran's method (2007). 1 mL of 2% $AlCl_3$ ethanolic solution and 1.5 mL (50 g/L) sodium acetate solutions were added to 1 mL of the diluted extract. Absorption at 440 nm was read after 2.5 h storing in a dark place. FC was calculated and expressed as mg quercetin equivalents (QE)/g of the coffee sample.

Determination of antioxidant activity by the DPPH method

The effect of the coffee extract on DPPH radical (2,2-diphenyl-1-1-picrylhidrazyl) was determined by the method described by Liyana-Pathirana and Shaidi (2005). 1 ml of 0.135 mM DPPH methanolic solution was added to 1 ml of the diluted extract. The mixture was left in a dark place for 30 min and absorbance was measured at 515 nm, along with the blank. Trolox was used as the standard and the results were expressed as Trolox equivalent µmol (TE)/g coffee sample.

Determination of antioxidant activity by the ABTS method

The Trolox equivalent antioxidant capacity (TEAC) of coffee extracts was estimated by ABTS radical cation (2,2-azinobis-(3-ethylbenzothiazoline-6-sulphonic acid) decolourisation assay (Re et al., 1999). The ABTS radicals were generated by reacting an ABTS aqueous solution (7 mM) with $K_2S_2O_8$ (2.4 mM) then storing it in a dark place for 16 h. A working solution was obtained by diluting the stock solution of the ABTS radical cation with methanol to obtain an absorbance of 0.7 ±0.005 at 734 nm. 1 ml of the ABTS solution was added to 1 ml of the diluted extract. The absorbance was measured after 7 min storage (in a dark place) at 734 nm, along with the blank. The results were expressed as Trolox equivalents µmol (TE)/g coffee sample.

Statistical analysis

All measurements were carried out in triplicate, and presented as mean ±standard deviation (SD). All results were subjected to one-factor analysis of variance (ANOVA) and when Duncan's test was performed to estimate the significance of differences between mean values at $P < 0.05$, using Statistica 12.0 software (StatSoft, Inc., Tulsa, OK, USA). Correlations between TPC, TFC, FC and antioxidant activity (DPPH, ABTS) were assessed by Pearson's correlation coefficient, and its significance by the t-test for $P < 0.05$.

RESULTS AND DISCUSSION

Total phenol content – TPC presented as a chlorogenic acid equivalent was higher than TPC presented as a gallic acid equivalent in green coffee samples and coffee samples roasted at 167°C, 175°C and 171°C (Tables 3 and 4). Total phenol content (mg CGA/g and mg GAE/g) were significantly higher ($P < 0.05$) in the green coffee samples compared to TPC in roasted coffee samples, which means that TPC decreases during the roasting process. The results are in accordance with literature data (del Castillo et al., 2002; Perez-Hernandez et al., 2012; Sacchetti et al., 2009; Trandafir et al., 2013). The differences in the TPC between 1st and 2nd class Arabica coffee samples were not statistically significant ($P > 0.05$) for both green coffee and coffee roasted in a different way. Total flavonoid content – TFC and FC – flavonol content were detected in the coffee samples and are shown in Tables 3 and 4. Total flavonoid content and flavonol content were significantly lower ($P < 0.05$) in green coffee than in coffee roasted differently, which is in accordance with the literature data (Hečimović et al., 2011). These results indicate that TFC and FC increase during the roasting process. The differences in the TFC between 1st and 2nd class of Arabica coffee samples from the first production batch weren't statistically significant ($P > 0.05$). Differences in FC between different classes of Arabica coffee were found in the green and differently roasted coffee samples from the first production batch. The FC in the 1st class Arabica green coffee was significantly higher ($P < 0.05$) than the FC in the 2nd class Arabica green coffee. Although the 2nd class Arabica coffee, which was roasted at 167°C, had higher FC than 1st class Arabica coffee, this difference wasn't statistically significant ($P > 0.05$). The 2nd class Arabica coffee, roasted at 175°C, had a significantly higher ($P < 0.05$) FC than 1st class Arabica coffee. The 1st class Arabica green coffee from the second production batch had significantly higher ($P < 0.05$) TFC and FC levels than 2nd class Arabica green coffee. There is no statistically significant ($P > 0.05$) difference in either TFC or FC

Table 3. Content of total phenol, total flavonoid and flavonol, and antioxidant activity of green coffee samples and coffee samples roasted at 167°C and 175°C

Parameters	Mean value ±standard deviation (n = 3)					
	G1	G2	A1	B1	A2	B2
TPC, mg CGA/g	49.90^{ab} ±3.19	51.75^{a} ±3.47	46.74^{bc} ±2.41	44.15^{c} ±1.04	35.08^{d} ±1.04	37.83^{d} ±1.27
TPC, mg GAE/g	31.65^{ab} ±1.84	32.78^{a} ±2.07	29.81^{bc} ±1.43	28.28^{c} ±0.62	23.66^{d} ±0.89	24.54^{d} ±0.75
TFC, mg Q/g	3.04^{d} ±0.17	2.98^{d} ±0.07	4.21^{bc} ±0.07	4.01^{c} ±0.21	4.63^{a} ±0.12	4.46^{ab} ±0.18
FC, mg Q/g	1.17^{e} ±0.11	1.33^{d} ±0.08	1.92^{c} ±0.01	1.84^{c} ±0.04	2.36^{a} ±0.13	2.13^{b} ±0.07
DPPH, µmol TE/g	179.23^{c} ±1.09	197.12^{b} ±3.77	203.38^{b} ±4.51	212.08^{a} ±4.10	176.44^{c} ±7.74	201.37^{b} ±4.63
ABTS, µmol TE/g	160.67^{e} ±4.18	172.05^{d} ±3.54	211.03^{a} ±2.40	215.09^{a} ±4.55	179.28^{c} ±2.35	204.61^{b} ±3.84

TPC – total phenol content. TFC – total flavonoid content. FC – flavonol content.
$^{a–e}$Values with different letters in the same row are significantly different at $P < 0.05$.

Table 4. Content of total phenol, total flavonoid and flavonol, and antioxidant activity of green coffee samples and coffee samples roasted at 171°C

Parameters	Mean value ±standard deviation (n = 3)			
	G3	G4	J1	K1
TPC, mg CGA/g	50.91^{a} ±1.18	52.41^{a} ±2.14	40.90^{b} ±0.99	42.72^{b} ±0.44
TPC, mg GAE/g	32.28^{a} ±0.70	31.19^{a} ±4.62	28.96^{ab} ±0.47	24.94^{b} ±0.81
TFC, mg Q/g	3.27^{c} ±0.09	3.57^{b} ±0.17	4.26^{a} ±0.09	4.34^{a} ±0.03
FC, mg Q/g	1.12^{c} ±0.04	1.32^{b} ±0.03	2.04^{a} ±0.04	2.00^{a} ±0.03
DPPH, µmol TE/g	185.10^{b} ±3.83	192.14^{b} ±4.48	226.14^{a} ±4.37	229.42^{a} ±2.29
ABTS, µmol TE/g	169.19^{d} ±2.94	192.13^{c} ±1.78	223.66^{b} ±2.60	228.79^{a} ±2.38

TPC – total phenol content. TFC – total flavonoid content. FC – flavonol content.
$^{a–d}$Values with different letters in the same row are significantly different at $P < 0.05$.

between coffees of different quality classes roasted at 171°C.

Coffee samples roasted at 167°C (A1, B1) and 171°C (J1, K1) had significantly higher ($P < 0.05$) antioxidant activity determined by DPPH and ABTS tests compared with the green coffee samples (G1, G2 and G3, G4) (Tables 3 and 4). Hečimović et al. (2011) determined that the antioxidant activity (ABTS) in light- and medium-roasted Arabica coffee (Minas) was higher compared to the antioxidant activity of green Arabica coffee. Coffee roasted at 175°C had significantly higher ($P < 0.05$) antioxidant activity determined only by ABTS compared to green coffee. All samples of 1st class Arabica coffee from the

first production batch (G2, B1 and B2) had higher antioxidant activity compared to the 2nd class Arabica samples (G1, A1 and A2) (Table 3). The differences established were statistically significant ($P < 0.05$) between all samples except between samples A1 and B1 for the results of the ABTS test ($P > 0.05$). Based on the results of the DPPH and ABTS tests of coffee samples from the second production batch (Table 4), it was found that 1st class Arabica coffee had the highest antioxidant activity (G4 and K1), and 2nd class Arabica coffee (G3 and J1) and the differences were only significant ($P < 0.05$) for the results of the ABTS test.

In this research, Arabica green coffee samples from two production batches were used (Table 1). The absolute values for the differences in TPC, TFC and FC and antioxidant activity were calculated between the green coffee samples and coffee samples roasted at different temperatures (167°C, 175°C and 171°C). The absolute values represent the differences between the values of the parameters examined for green coffee samples from the first production batch and coffee samples roasted at 167°C and 175°C; and the difference between the values of the parameters examined for green coffee samples from the second production batch and coffee samples roasted at 171°C.

The results indicated that coffee roasted at 167°C had a higher TPC (mg CGA/g and mg GAE/g) than coffee roasted at 171°C and 175°C. The absolute value D1 (|G1 – A1|) was lower than the absolute values D2 (|G1 – A2|) and D5 (|G3 – J1|) and absolute value D3 (|G2 – B1|) was lower than the absolute values D4 (|G2 – B2|) and D6 (|G4 – K1|) as green coffee had the highest TPC and it decreases when the temperature of roasting increases. The results are in accordance with the literature data (del Castillo et al., 2002; Perez-Hernandez et al., 2012; Sacchetti et al., 2009; Trandafir et al., 2013; Vignoli et al. 2011).

Coffee roasted at 167°C had a higher TFC (mg Q/g) than coffee roasted at 171°C. Coffee roasted at 175°C had a significantly higher ($P < 0.05$) TFC (mg Q/g) than coffee roasted at 167°C and 171°C. The absolute value D1 (|G1 – A1|) was higher than the absolute value D5 (|G3 – J1|), and the absolute value D2 (|G1 – A2|) was higher than the absolute values D1 (|G1 – A1|) and D5 (|G3 – J1|). The absolute value D3 (|G2 – B1|) was higher than the absolute value D6 (|G4 – K1|). The absolute value D4 (|G2 – B2|) was higher than the absolute values D3 (|G2 – B1|) and D6 (|G4 – K1|). TFC decreases with the temperature increase during roasting at 171°C, and with a further increases in roasting temperature (at 175°C), TFC increases. Hečimović et al. (2011) also found the highest TFC in dark-roasted Arabica coffee (Minas) and the lowest TFC was in medium-roasted Arabica coffee. Coffee roasted at 167°C had a significantly lower ($P < 0.05$) FC (mg Q/g) than coffee roasted at 171°C and 175°C. The absolute value D1 (|G1 – A1|) was lower than the absolute values D2 (|G1 – A2|) and D5 (|G3 – J1|) and absolute value D3 (|G2 – B1|) was lower than absolute values D4 (|G2 – B2|) and D6 (|G4 – K1|) because green coffee had the lowest FC, and flavonol content increases when the roasting temperature increases.

From a comparison of the results of antioxidant activity (DPPH and ABTS) for 2nd class Arabica coffee, it can be concluded that coffee roasted at 171°C had significantly higher ($P < 0.05$) antioxidant activity than coffee roasted at 167°C and 175°C (Table 5). The difference in antioxidant activity (ABTS) between the coffee roasted at 167°C and 171°C was not statistically significant ($P > 0.05$). Coffee roasted at 175°C had the lowest antioxidant activity. Similar results regarding the influence of the roasting degree on coffee's antioxidant activity were reported by Sacchetti et al. (2009). Samples of 1st class Arabica coffee roasted at 171°C had significantly higher ($P < 0.05$) antioxidant activity (DPPH) than coffee samples roasted at 167°C and 175°C. Górnaś et al. (2016) found that antioxidant activity (DPPH) decreases during the roasting process and is higher in medium-roasted coffee samples than in dark-roasted coffee samples. Antioxidant activity based on the results of the ABTS test was highest in 1st class Arabica coffee roasted at 167°C, and lowest in coffee roasted at 175°C (Table 5). Research by Nicoli et al. (1997) determined the highest antioxidant activity in medium dark-roasted Arabica coffee. Del Castillo et al. (2002) found the maximum antioxidant activity in medium-roasted coffee, while the dark-roasted coffee had the lowest antioxidant activity, despite an increase in the intensity of colour. Moreover, Hečimović et al. (2011) found the highest antioxidant activity in medium-roasted Arabica coffee (Minas). As phenol content, the basic carrier of antioxidant activity in coffee, decreases when the roasting temperature increases, it could be expect that coffee roasted at the lowest

Table 5. Absolute values for changes in total phenol, total flavonoid and flavonol, and antioxidant activity between green coffee and coffee roasted at 167°C, 175°C and 171°C

Parameters	Mean value (n = 3)					
	D1	D2	D3	D4	D5	D6
TPC, mg CGA/g	3.16^{c}	14.82^{a}	7.60^{bc}	13.96^{a}	10.01^{ab}	9.69^{ab}
TPC, mg GAE/g	1.84^{b}	7.99^{a}	4.50^{ab}	8.24^{a}	3.32^{ab}	6.25^{ab}
TFC, mg Q/g	1.17^{bc}	1.59^{a}	1.03^{cd}	1.48^{ab}	0.99^{cd}	0.77^{d}
FC, mg Q/g	0.75^{c}	1.19^{a}	0.51^{d}	0.80^{bc}	0.92^{b}	0.68^{c}
DPPH, µmol TE/g	24.15^{b}	2.79^{d}	14.96^{c}	4.25^{d}	41.04^{a}	37.28^{a}
ABTS, µmol TE/g	50.36^{ab}	18.61^{e}	43.04^{bc}	32.56^{d}	54.47^{a}	36.66^{cd}

D1 = |G1 – A1|. D2 = |G1 – A2|. D3 = |G2 – B1|. D4 = |G2 – B2|. D5 = |G3 – J1|. D6 = |G4 – K1|. D1–D6 – absolute values for changes of examined parameters, between green coffee and coffee roasted at 167°C, 175°C and 171°C.
$^{a–e}$Values with different letters in the same row are significantly different at $P < 0.05$.

temperature (167°C) will have the highest antioxidant activity level. However, the antioxidant activity of roasted coffee depends on the phenolic fractions that decrease during roasting, and also depends on non-phenolic fractions, which increase during the roasting process, due to the formation of Maillard reaction products (Sacchetti et al., 2009). According to Nicoli et al. (1997), the antioxidant activities of compounds formed during coffee roasting do not linearly increase as the temperature or roasting degree increases, which indicates that different compounds with antioxidant properties were formed during heat treatment.

Table 6. Correlations between content of total phenol, total flavonoid and flavonol, and antioxidant activity

	DPPH, µmol TE/g	ABTS, µmol TE/g
TPC, mg CGA/g	0.5085 $P < 0.05^{*}$	0.6446 $P < 0.05^{*}$
TPC, mg GAE/g	0.3779 $P > 0.05^{*}$ (ns)	0.4744 $P < 0.05^{*}$
TFC, mg Q/g	–0.4874 $P < 0.05^{*}$	–0.6135 $P < 0.05^{*}$
FC, mg Q/g	–0.6315 $P < 0.05^{*}$	–0.7197 $P < 0.05^{*}$

TPC – total phenol content. TFC – total flavonoid content. FC – flavonol content.
*Pearson linear correlation coefficients.
ns – not significant.

Correlations between the content of total phenol, total flavonoid and flavonol and antioxidant activity were calculated (Table 6). Significant correlations ($P < 0.05$) were evident between TPC [mg CGA/g] and antioxidant activity (DPPH and ABTS) and between TPC [mg GAE/g] and antioxidant activity determined with ABTS. Correlations between TPC [mg GAE/g] and antioxidant activity determined with DPPH wasn't significant ($P > 0.05$). In correlations between total flavonoid and flavonol content and antioxidant activity, Pearson linear correlation coefficients were negative but statistically significant ($P < 0.05$).

CONCLUSION

The results obtained in this study provide an overview of the effect of different roasting temperatures on total phenol content, total flavonoid content and flavonol content as well as on the antioxidant activity in different quality classes of Arabica coffee. Total phenol content was highest in green coffee, and it decreases as the roasting temperature increases. Total flavonoid content and FC were highest in coffee roasted at 175°C (dark roasting degree). Total flavonoid content and FC increases as the roasting temperature increases. The highest antioxidant activity (DPPH and ABTS) was

determined in coffee roasted at 171°C (medium roasting degree). An exception was 1st class Arabica coffee roasted at 167°C (ABTS). These results indicate that the antioxidant activity of coffee depends on a variety of bioactive components in coffee beans, whose concentration depends on the conditions of coffee roasting. The differences in TPC between 1st and 2nd classes of Arabica coffee weren't significant ($P > 0.05$), while the differences in TFC were significant ($P < 0.05$) only for green coffee from the second production batch, and the differences in the FC were significant ($P < 0.05$) for green coffee and for coffee roasted at 175°C. These results indicated that antioxidant activity largely depends on the class of coffee, as 1st quality class coffee (maximum 8 black beans/300 g of the sample and large size of beans) had higher antioxidant activity compared to the samples of the 2nd quality class (max 19 black beans/300 g of the sample and medium size of beans).

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