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EXPLORING THE PHYTOCHEMICAL PROFILE AND SENSORY PROPERTIES OF GREEN AND ROASTED *COFFEA ARABICA* L. BEANS FROM DIVERSE GEOGRAPHIC REGIONS

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Abstract. *The aim of study was to evaluate the phytochemical quality indicators (dry matter, ash, crude protein, antioxidant activity, total flavonoids, polyphenols and phenolic acids) of 100% Arabica (Coffea arabica L.) from Brazil, Colombia, Bolivia, Tanzania, El Salvador and Cuba. The samples were first analyzed as raw green coffee and then after the roasting process (medium roast 240 °C, 14 minutes). The same measurements were then performed on the roasted coffee as on the green coffee, to compare the samples and draw attention to the changes that occur during the roasting process. Finally, a sensory analysis (color, taste, aroma) was performed (the coffee was served using the French press method). The total dry matter content in green coffee was on average 93.05%, the crude protein content was 13.07% and the ash content was 2.94%. Using the DPPH method was determined the antioxidant activity, which was in the range of 7.32 – 21.55 mg TEAC/g (TEAC – Trolox equivalent antioxidant capacity) and the total content of polyphenols was on average 45.65 mg GAE/g (GAE – gallic acid equivalent). Subsequently, we determined the total content of flavonoids on average 31.91 mg QE/g (QE – quercetin equivalent) and the content of phenolic acids on average 13.14 mg CAE/g (CAE – caffeic acid equivalent). This was followed by roasting and repeating all measurements, with which was found an increase in dry matter by 5.93% and ash by 0.19%. When determining the total crude protein, only imperceptible changes occurred. The most significant decrease was observed in polyphenols and flavonoids, the total contents of which decreased during roasting, since these are relatively thermolabile substances. The content of total polyphenols after roasting in the tested samples ranged from 26.58 to 34.36 mg GAE/g, which is a decrease of more than 25%. As for flavonoids, the value ranged between 10.56 and 17.79 mg QE/g. The antioxidant activity did not change significantly, since various other bioactive substances participating in the antioxidant activity formed during roasting. The crude protein content also did not change significantly. The sensory evaluation took place without problems and all samples were evaluated relatively positively, the respondents evaluated the color, aroma, taste.*

Keywords: Coffea spp., polyphenols, antioxidant activity, sensory evaluation, roasting, DPPH.

INTRODUCTION

Coffea arabica L., also known as Arabica coffee, is one of the most popular coffee species worldwide. It is believed to be the first coffee species to be commercially cultivated and is the dominant cultivar, accounting for about 60% of global production (Lashermes et al., 1999*). Coffea arabica* was first mentioned in Yemen and documented as early as the 12th century (Söndahl, 2005). Wild plants are 9 to 12 m tall and have an open branching system; the leaves are opposite, simple elliptic-ovate to oblong, 6–12 cm long and 4–8 cm broad, glossy dark green. The flowers are white, 10–15 mm in diameter, and grow in axillary clusters. The seeds are contained in a drupe 10-15 mm in diameter, maturing bright red to purple and usually contain two seeds. Dried coffee berries, stripped of pulp and skins, contain similar acids, proteins and caffeine as roasted coffee. However, roasting coffee acquires sensory properties that green beans lack, primarily the characteristic smell, aroma, taste and color. Dry green beans intended for roasting contain: 12% water, 13% protein, 12% fat, 9% carbohydrates, 1-1.5% caffeine, 9% acid, 35% cellulose and 4% ash (Wintgens, 2009). The coffee beans after medium roast are already a bit darker and larger than in the first stage. Their surface is dry. The aroma of the coffee is slightly spicy and distinctly fruity. The fruit can also be felt in taste. Despite the still dominant acidity, a slightly sweet taste also appears in the coffee. The body develops and the aftertaste lasts a bit longer. Espresso has a thin, light creama. Coffee roasted in this way is still little used commercially, due to its distinctly exotic and sour taste. The non-volatile fraction of green coffee is primarily composed of water, carbohydrates, proteins, free amino acids, lipids, minerals, organic acids, chlorogenic acids, trigonelline, and caffeine. Of these compounds found in green coffee, chlorogenic acids are the most abundant, caffeine, trigonelline, and diterpenes from the lipid fraction are most likely bioactive and may also be important contributors to the beverage after roasting. In addition, traces of theophylline and theobromine have been identified in the seeds and reported to be metabolites of caffeine (Mazzafera et. al,. 2009). Many studies have shown that coffee consumption may help prevent several chronic diseases. Long-term coffee consumption is associated with a significant dose-dependent reduction in the risk of developing type 2 diabetes (Nawrot et. al., 2003). Coffee intake also reduces the risk of liver damage in people at high risk of liver disease, including liver damage, cirrhosis, and hepatocellular carcinoma (Homan and Mobarhan, 2006). The risk of Alzheimer's disease is lower in individuals who regularly consume caffeinated coffee than in those who do not (Mendonca and Cunha, 2010). Coffee has also been shown to improve endurance performance in long-term physical activities. Interestingly, the relative risk of suicide was reduced by 13% for each cup of coffee consumed per day (Kawachi et. al., 1996). Coffee consumption is generally inversely associated with cancer risk at various sites, including the liver and colon

and rectum, there is no universal.

The aim of this study was to evaluate the phytochemical quality indicators of 100% Arabica coffee *(Coffea arabica* L.) sourced from Brazil, Colombia, Bolivia, Tanzania, El Salvador, and Cuba. It was assessed various parameters, including dry matter, ash content, crude protein, antioxidant activity, total flavonoids, polyphenols, and phenolic acids. The coffee beans were analyzed in their green form and subsequently after medium roasting to determine how the roasting process influences these phytochemical properties.

MATERIALS AND METHODS

Material

The five coffee samples (100 Arabica) – Brazil, Bolivia, Tanzania, El Salvador and Cuba were provided by the private supplier from Nitra (Slovakia). Green coffee (100 g) was fed to a micro-roaster coffee machine (Gene Café, CBR-101, Korea). The beans were roasted by using medium roasting style –240 °C, 14 minutes. Roasted coffee bean was ground in a grinder machine (Krups, GVX 2, Bur Grinder, Germany). The samples were ground to an average particle size (20 mesh), suitable for preparation in a paper filter. To prepare the extract, 0.1 g of sample was extracted with 20 ml 95 °C distilled water, after 5-minute extraction filtered through filtrate paper (Whatman no 1) and used for analysis (antioxidant activity, total polyphenol, flavonoid and phenolic acid content).

Chemical

All the chemicals used were of analytical grade and were purchased from Sigma- Adrich (St. Louis, MO, USA) and CentralChem (Slovakia).

Dry matter, ash, and crude protein content

AACC method 08-01 used to determine the dry matter and ash content (AACC, 1996). The semi-micro-Kjeldahl method was used to calculate the nitrogen content. The usual factor of 6.25 was used to convert nitrogen to protein.

DPPH – Free radical scavenging activity

According to the steps outlined by Sanchéz-Moreno et al. (1998), the 2,2-difenyl-1-picrylhydrazyl (DPPH) assay used to measure the samples' capacity to scavenge free radicals using a spectrophotometer (Jenway 6320D, UV VIS, UK). Trolox (10 – 100 mg/L; $R^2 = 0.989$) was used as a standard.

Total polyphenol content

The total polyphenol content of samples determined spectrophotometrically (Jenway 6320D, UV VIS, UK) using modified Folin-Ciocalteu method by

Singleton et al. (1965). Gallic acid (25 – 300 mg/L; R^2 = 0.999) was used as a standard.

Total Flavonoid Content

Total flavonoids will be determined spectrophotometrically (Jenway 6320D, UV VIS, UK) using a modified method of Willett (2002). Quercetin (10 – 500 mg/L; R^2 = 0.999) was used as a standard.

Total Phenolic Acid Content

Total phenolic acids content will be determined (Jenway 6320D, UV VIS, UK) using the method of Jain et al. (2017). Caffeic acid (10 – 550 mg/L; R^2 = 0.988) was used as a standard.

Sensory analysis

A sensory panel of 30 panelists – 15 women and 15 men, aged 22 to 65 – determined the organoleptic properties of roasted coffee prepared in style French Press. The panelists were asked to assess the color, taste and aroma. A 9-point hedonic scale was used to rate the samples, with values ranging from 9 (like very much) to 1 (strongly dislike).

Statistical analysis

All experiments were carried out in triplicate and the results reported are the results of those replicate determinations with standard deviations.

RESULTS AND DISCUSSION

Dry matter, ash, and crude protein content

When determining the dry matter, it was found that the average value for green coffee was 93.05% (Tab. 1). The highest value was measured in the sample from Colombia, which had a dry matter content of 93.822%. In contrast, the lowest value was found in the sample from El Salvador, with a dry matter content of 92.24%. Thus, it can be concluded that coffee is a sustainable crop, primarily due to its low moisture content and high dry matter content. However, we must adhere to the correct storage and packaging parameters to maintain this moisture level, as increased humidity poses a risk for the proliferation of bacteria and microscopic filamentous fungi. After roasting, the dry matter content increased in all tested samples (Tab. 1). The composition of the seed changes dramatically during roasting due to pyrolysis, caramelization and Maillard reactions. The moisture content of roasted coffee (1.5% - 5%) is much lower than that of green coffee and varies depending on the degree of roasting. The beans become more brittle and can be chewed relatively easily, unlike green beans. However, even though roasted coffee seems to be a durable product in terms of dry matter and moisture content,

care should be taken to store it properly, in a closed container and in a cool room.

When determining the total crude protein, it was measured at an average value of 13% (Tab. 1). The highest measured value of crude protein was determined for the Cuba sample at 13.78% and the lowest for the Salvador sample at 12.06%. All samples had a similar protein content without large deviations. After roasting, the samples measured average values of 13.93%. The highest crude protein content was found in the Cuba sample (14.91%), which was an increase of 1.13% compared to the same green coffee sample. The lowest crude protein content was found in the Tanzania sample (13.16%). Overall, it can be concluded that the crude protein content did not change much during the roasting process (Tab. 1). Part of the coffee protein is degraded, and free amino acids and peptides are consumed by Strecker reactions. Some of these amino acids react with reducing sugars to form (via the Maillard reaction) low molecular weight compounds and melanoidins, which incorporate other components such as chlorogenic acids, galactomannans and arabinogalactan proteins into their structures. Globulin 11S is the main protein of coffee beans – 45% of the total protein, but there is no conclusion yet about its participation in coffee quality. It is now generally known that free amino acids and peptides are required for the formation of coffee aroma. However, the mechanisms leading to the defined mixtures of free amino acids and peptides remain unknown (Bhattarai et al., 2022).

The ash content determined in green coffee samples was on average 2.94%, with the highest content being reached in the Bolivia sample with a value of 2.96%. The lowest ash content was reached in samples from Brazil, Cuba, and El Salvador with a content of 2.93% (Tab.1). After roasting, a slight increase was recorded compared to green coffee beans, which is due to the difference in the water/dry matter ratio in green coffee and coffee after roasting. The highest difference was recorded in the El Salvador sample, where the ash content increased from 2.93% to 3.14%. The lowest difference was in the Bolivia sample, where the ash content increased from 2.96% to 3.1%. The average value of all samples was 3.13%, which is an increase of 0.19% compared to green coffee beans (Tab. 1). Regarding the mineral content of roasted coffee, data from the literature are sparse and show a small increase related to weight loss during roasting (Ferreira et.al., 1971; Clarke, 1985). There is evidence that both mineral content and profiles in coffee can be influenced by growing conditions (e.g. fertilizers, maturity), prior processing operations (dry vs. wet processing) and fermentation (Clarke, 1985). Since the mineral content of coffee is not affected by roasting and is known to vary only according to the maturity of the coffee beans, elemental analysis could be a potential candidate for differentiating between defective and non-functional beans in roasted coffee. Oliveira et. al., (2006) and Vasconcelos et. al., (2007) evaluated the total mineral content of defective coffee beans compared to non-defective ones. Both studies reported higher mineral contents of defective beans (~6%) compared to healthy ones (~5%) before and after roasting.

Table 1. Results of dry matter, ash and protein content in green and roast coffee samples

Sample	Dry matter (%)	Ash content (%)	Crude protein (%)
Brazil green	93.38 ±0.11	2.93 ±0.02	13.39 ±0.14
Brazil roast	99.06 ±0.13	3.16 ±0.01	13.94 ±0.02
Tanzania green	92.73 ±0.09	2.94 ±0.04	12.06 ±0.11
Tanzania roast	98.75 ±0.09	3.12 ±0.02	13.16 ±0.09
El Salvator green	92.24 ±0.14	2.93 ±0.01	12.07 ±0.01
El Salvator roast	99.91 ±0.14	3.14 ±0.05	13.28 ±0.01
Colombia green	93.82 ±0.05	2.95 ±0.05	13.21 ±0.04
Colombia roast	99.12 ±0.14	3.17 ±0.02	14.14 ±0.03
Bolivia green	92.75 ±0.12	2.96 ±0.05	13.54 ±0.02
Bolivia roast	99.16 ±0.08	3.13 ±0.02	14.18 ±0.01
Cuba green	93.44 ±0.04	2.93 ±0.01	13.78 ±0.05
Cuba roast	98.91 ±0.01	3.11 ±0.02	14.91 ±0.05

mean± standard deviation

The average antioxidant activity value of green coffee was 14.131 mg TEAC/g. As we can see in Tab. 2, the highest value was measured in a coffee sample from Tanzania with a value of 21.55 mg TEAC/g, which is a big difference compared to the sample with the lowest value of El Salvador 7.32 mg TEAC/g. With relatively high antioxidant activity are the samples from Bolivia 17.54 mg TEAC/g and Colombia 14.01 mg TEAC/g. The differences between the samples can be explained by the differences in the countries and localities where they came from different agro-ecological conditions, which have a significant impact on how many antioxidant compounds are synthesized in coffee.

The average antioxidant activity value of roasted coffee was 8.38 mg TEAC/g, which is a significant decrease compared to the average value of green coffee of 14.13 mg TEAC/g. The highest antioxidant activity value was recorded in the Tanzania sample of 10.27 mg TEAC/g, which is a difference compared to the green sample of this coffee of 11.28 mg TEAC/g. The lowest value was determined in the Salvador sample of 4.28 mg TEAC/g, which overall showed the lowest antioxidant activity of all samples, whether before or after roasting (Tab. 2). Czakóová, (2019) measured the antioxidant activity of roasted coffee beans using the same DPHH method. She followed the same method, but used a roasting level called cinnamon roast, which uses slightly lower roasting temperatures than in roasting regime used for sample of this study (medium roast). Czakóová, (2019) used different mixtures of samples to determine antioxidant activity, but for the Tanzania Iyela PB sample she measured a value of 53.47 mg TEAC/L, so for our Tanzania sample we determined a value of 10.27 mg TEAC/L. If we compared the results in the same units, our antioxidant activity value in the Tanzania sample would be lower, which could result in the influence of agroecological factors such as vintage, soil, processing method, type of roasting.

By determining the total polyphenols in green coffee samples, it was measured

an average value of 45.65 mg GAE/g (Tab. 2). The highest polyphenol value was achieved in the sample from Brazil at 52.8 mg GAE/g. The lowest value was found in the sample from Colombia at 39.69 mg GAE/g. The highest limit was also reached in samples from Tanzania at 51.91 mg GAE/g and Cuba at 44.58 mg GAE/g. When determining the total polyphenols of roasted coffee, an average value of 31.708 mg GAE/g was measured, which is a decrease of 13.943 mg GAE/g compared to the total polyphenol content of green coffee. The highest measured value was reached by the Brazil sample at 34.36 mg GAE/g and the lowest by Cuba at 26.58 mg GAE/g. The lowest decrease compared to green coffee was in the Colombia sample, where the total amount of polyphenols decreased from the original 39.69 mg GAE/g to 33.13 mg GAE/g (Tab. 2). There is growing evidence that some polyphenols, such as chlorogenic acid, have biological effects in the small intestine that alter the form of glucose taken up. Chlorogenic acid has been shown to inhibit the action of glucose-6-phosphate, which plays a key role in regulating glucose metabolism. It increases alertness and motivation, helps reduce the risk of depression, and increases the need for exercise. Long before epidemiological studies suggested a link between coffee consumption and health, the antimutagenic properties of chlorogenic acids and their metabolites were demonstrated in a series of animal and in vitro studies. Recent studies have confirmed these findings and elucidated several mechanisms of action, including scavenging free radicals, metal chelation, inactivation of reactive compounds, and alterations in metabolic pathways.

The total flavonoid content in the green coffee samples was on average 31.91 mg QE/g. The highest measured value was found in the sample from Tanzania at 37.98 mg QE/g and the lowest measured value was in the sample from Cuba at 28.74 mg QE/g (Tab. 2). After roasting, a decrease of almost 50% was observed in each sample compared to the green coffee samples before roasting, which can be explained by the fact that flavonoids are the most sensitive to high temperatures in terms of stability among polyphenolic compounds (Tab. 2). Flavonoids are effective free radical scavengers as shown *in vitro* studies. However, even with very high flavonoid intakes, plasma and intracellular flavonoid concentrations in humans are probably 100 to 1,000 times lower than the concentrations of other antioxidants, e.g. ascorbate (vitamin C), uric acid and glutathione. Flavonoids are considered the most common, important and widely distributed group of phenols present in plants with highly effective antioxidants. Flavonoids inhibit metal-initiated lipid oxidation by forming complexes with metal ions (Mestanza et al., 2023).

The measured value of phenolic acids in green coffee samples was on average 13,136 mg CAE/g. The highest content of phenolic acids was in the sample from Tanzania, 16.01 mg CAE/g, and the lowest in the sample from El Salvador, 10.79 mg CAE/g (Tab.2). When determining the total phenolic acid content of roasted coffee, a decrease was recorded compared to green coffee. The average phenolic acid content of roasted coffee was 6.808 mg CAE/g, which is 6.328 mg CAE/g less than in green coffee samples. The highest value was achieved by the Tanzania sample, 8.02 mg CAE/g, while

the lowest value of the total phenolic acid content was achieved by the Cuba sample, only 4.4 mg CAE/g. The highest decrease compared to the same green coffee sample was observed in the Tanzania sample, a decrease of 7.99 mg CAE/g (Tab. 2).

Phenolic acids are substances that act as primary antioxidants, as they react with free radicals that are formed in the body. The activity depends on the number of hydroxyl groups in the molecule (Hírešová, 2015). Active antioxidants are cinnamic acids and their esters, so-called depsides, primarily quinic acid and chlorogenic acid (but more than 30 cinnamic acid esters are found in coffee). Chlorogenic acid refers to all natural quinic acid esters. These are the main acids of green coffee, where they occur in an amount of 7-10% of dry matter. During roasting, approximately 30-70% of it degrades to form phenols (benzoic acid, pyrogallol, pyrocatechol, resorcinol) and other compounds.

Table 2 Results of antioxidant activity (DPPH), total polyphenols (TPC), flavonoids (TFC) and phenolic acids (TPAC) in green and roast coffee samples

Sample	DPPH (mg TEAC/g)	TPC (mg GAE/g)	TFC (mg QE/g)	TPAC (mg CAE/g)
Brazil green	11.20 ±1.11	52.81 ±0.12	30.17 ±0.04	11.77 ±0.12
Brazil roast	8.14 ±0.03	34.36 ±0.12	14.84 ±0.01	7.11 ±0.12
Tanzania green	21.55 ±0.13	51.91 ±0.14	37.98 ±0.08	16.01 ±0.14
Tanzania roast	10.27 ±0.03	33.02 ±0.11	17.79 ±0.09	8.02 ±0.11
El Salvator green	7.32 ±0.01	42.80 ±0.01	31.79 ±0.04	10.79 ±0.01
El Salvator roast	4.28 ±0.02	30.36 ±0.04	17.51 ±0.02	8.01 ±0.04
Colombia green	14.10 ±0.15	39.69 ±0.05	28.84 ±0.03	12.36 ±0.05
Colombia roast	9.25 ±0.04	33.13 ±0.02	15.79 ±0.03	6.62 ±0.02
Bolivia green	17.54 ±0.02	42.13 ±0.03	33.98 ±0.07	14.67 ±0.03
Bolivia roast	9.94 ±0.11	32.80 ±0.02	13.50 ±0.01	6.71 ±0.02
Cuba green	13.17 ±0.11	44.58 ±0.01	28.74 ±0.04	13.22 ±0.01
Cuba roast	8.43 ±0.07	26.58 ±0.02	10.56 ±0.05	4.41 ±0.02

mean± standard deviation; DPPH – 2,2-difenyl-1-picrylhydrazyl; TEAC – Trolox equivalent antioxidant capacity; GAE – gallic acid equivalent; QE – quercetin equivalent; CAE – caffeic acid equivalent

Sensory analysis

When evaluating coffee color, distinct characteristics emerge based on origin and scoring: Brazil (4 points) exhibits a muted color, suggesting a darker, less vibrant roast, Colombia (9 points) bright and lively appearance, indicating a well-developed roast with golden to deep brown hues, often linked to higher acidity and fruitiness. Tanzania (9 points) similar to Colombia, it shows a vibrant color profile, reflecting fruity and floral characteristics, El Salvador (7 points) presents a balanced color, suggesting a moderate roast with sweetness and complexity, Bolivia (8 points) rich and inviting color, indicating a well-crafted roast with nuanced flavors, Cuba (4 points) similar to Brazil, it has a less vibrant color, possibly reflecting a darker, traditional roasting style (Figure 1).

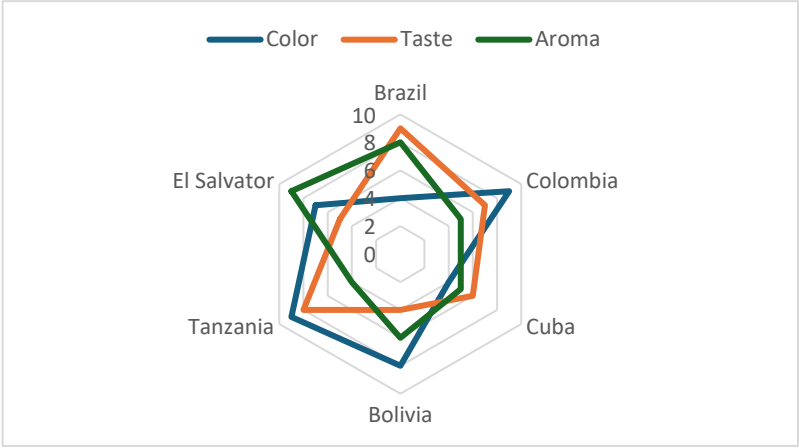


Figure 1. Results of sensory analysis of roasted coffee samples (sum of all evaluators)

The sensory evaluation of coffee reveals distinct taste profiles among various origins. Brazilian coffee stands out with a score of 9, showcasing a rich, well-rounded flavor often characterized by chocolate and nutty notes, along with a pleasant sweetness. Colombian coffee, rated at 7, offers a balanced taste with bright acidity and fruity undertones, though slightly less complex than its Brazilian counterpart. Tanzanian coffee, scoring 8, is notable for its vibrant acidity and berry-like flavors, providing an intriguing contrast to the smoother Brazilian profile. El Salvador's coffee, with a score of 5, tends to be milder and less memorable, lacking the depth found in higher-rated origins. Bolivia, at 4, presents a more subdued flavor profile that may come across as flat or lacking in character. Finally, Cuban coffee, rated 6, offers a unique taste experience, often marked by earthy and herbal notes, but it does not quite reach the level of complexity found in the top-rated coffees. Overall, the sensory evaluation highlights a spectrum of flavors, with Brazilian and Tanzanian coffees leading the pack in taste quality (Fig. 1). The sensory evaluation of coffee aromas reveals a diverse range of characteristics across different origins. Brazilian coffee stands out with a score of 8 points, indicating a rich and well-rounded aromatic profile that likely includes nutty and chocolatey notes. In contrast, Colombian coffee, with a score of 5, presents a more subdued aroma, typically featuring fruity and floral nuances but lacking the complexity found in Brazilian varieties. Tanzanian coffee, scoring 4 points, offers a less pronounced aroma, often marked by mild citrus hints but lacking depth. El Salvador's coffee excels with a top score of 9, showcasing a vibrant and captivating aroma, possibly rich in caramel and spicy undertones. Bolivian coffee scores 6 points, suggesting a balanced aroma with a moderate level of sweetness and earthiness. Finally, Cuban coffee, also scoring 5 points, presents a familiar yet less distinctive aromatic profile, often

characterized by a blend of earthy and mild floral notes. Overall, the evaluation highlights the distinct sensory properties of each coffee origin, with El Salvador and Brazil leading in aromatic complexity (Fig. 1).

CONCLUSIONS

The total dry matter content in green coffee was on average 93.05%, the crude protein content was 13.07%, and the ash content was 2.94%. Using the DPPH method, the antioxidant activity was determined in the range of 7.32 - 21.55 mg TEAC/g and the total polyphenol content was on average 45.65 mg GAE/g. The total flavonoid content was on average 31.91 mg QE/g and the phenolic acid content was on average 13.13 mg CAE/g. This was followed by roasting and repeating all measurements, during which an increase in dry matter by 5.93% and ash by 0.19% was found. Only imperceptible changes occurred in the determination of the total crude protein. The most significant decrease was recorded in polyphenols and flavonoids, which can be explained by the fact that these are relatively thermolabile substances. The content of total polyphenols after roasting ranged from 26.58 to 34.36 mg GAE/g, which is a decrease of more than 25%. As for flavonoids, the value ranged between 10.56 and 17.79 mg QE/g. Antioxidant activity varied, but not significantly, since various other bioactive substances are formed during roasting, which support antioxidant activity. The content of crude protein also did not change significantly. Sensory analysis showed that all samples were evaluated relatively positively, respondents evaluated the color, aroma, and taste. Overall, it can be concluded that coffee in our diet contributes to a very important source of bioactive substances, but consumption is necessary only in adequate quantities, since excessive drinking coffee can have an adverse effect on the body due to the content of alkaloids. However, it is important, especially to store ground coffee correctly. Therefore, we recommend that everyone drinks coffee mainly from freshly ground beans.

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