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Comparison of Bioactive Properties and Phenolic Compounds of Turkish Coffee, Filter Coffee and Espresso Coffee

Sevde Nur Çataltepe, Nurhan Uslu , Mehmet Musa Özcan

Department of Food Engineering, Faculty of Agriculture, Selcuk University, Konya

Abstract

In this study, total phenolic content, total flavonoid content, antioxidant activity and phenolic compound contents of Turkish coffee, espresso and filter coffees taken from a local business were compared. Coffee is a popular beverage consumed in social life and has important effects on human health due to its rich bioactive compounds. Phenolic compounds such as caffeic acid and its derivatives, chlorogenic acids and flavonoids make significant contributions to the antioxidant activity of coffee.
When the obtained results were examined, the highest total phenolic and flavonoid amounts were found in espresso coffee as 6185.71 mg GAE/100 g and 4886.90 mg QE/100 g, respectively. The coffee with the highest antioxidant activity was determined as filter coffee (70.25 mmol TE/kg). The dominant phenolic compounds of coffee were determined as caffeic acid (113.73 mg/100 g) and chlorogenic acid (85.47 mg /100 g) in Turkish coffee, and protocatechuic acid (118.27 mg /100 g) in espresso coffee at the maximum level. When the flavonoid contents of coffees were compared, espresso coffee (2709.53 mg/100 g) ranked first in terms of catechin amount , followed by Turkish coffee (1270.80 mg/100 g). It has been observed that coffees prepared with three different methods, namely decoction (Turkish coffee), pressure (espresso) and infusion (filter coffee), contain significant amounts of phenolic compounds and have high antioxidant activity.

Key Words: *Antioxidant activity, Phenolic compound, Espresso, Turkish coffee, Filter coffee*

Introduction

Coffee, the fruit of evergreen sapling-sized trees, is a member of the Rubiaceae family (Kaur et al., 2018). The origin of coffee is Abyssinia/Ethiopia. Coffee, which is said similarly in most parts of the world, took its name from the " Kaffa" region in Abyssinia where coffee is grown (Topalakçı, 2011). Although there are many stories about the emergence of coffee, the most well-known is that it was discovered by goat shepherds. Observing that goats did not sleep at night and were constantly moving after consuming coffee berries, shepherds boiled and drank this fruit, and the coffee adventure that has continued until today began (Kaplan, 2011).
Among the Rubiaceae family, the ones with commercial importance *are Coffea arabica* (Arabica) and *Coffee canephora* (Robusta) (Olechno et al., 2021). *Coffee arabica* (Arabica) and *Coffee canephora* (Robusta), which account for 70% and 30% of global production, respectively (Neves et al., 2019). The chemical composition of coffee beans varies depending on the region where they are grown, the type of soil there, cultivation methods, species, climatic conditions, as well as the processing of the beans, i.e. cleaning and roasting (Zukiewicz-Sobczak et al., 2012). More than 1500 different compounds of coffee beans have been identified, of which 30-40% constitute carbohydrates, 13% fats, and 4% proteins, including free amino acids (Uslu, 2022).
Coffee beans contain aroma compounds, vitamins and minerals. In addition, coffee contains essential oils and phenolic compounds. Among the polyphenols contained in them, chlorogenic (CLA) and caffeic acid are distinguished (Olechno et al., 2020). It is also an important source of compounds with antioxidant potential such as (Çelik & Gökmen, 2018). However, most coffee globally is roasted and the antioxidant profile of coffee changes during roasting due to the degradation of natural antioxidants, the formation of new ones such as melanoidins and the formation of other Maillard reaction products (MRPs) (Nunes & Coimbra, 2007). The taste, quality and phytochemical properties of coffee, the interaction of water and coffee, and the brewing times and techniques are of great importance due to the fact that coffee contains many soluble and insoluble compounds during extraction (Cordoba et al., 2020)There are many techniques used to brew coffee such as (Komes & Belščak-Cvitanović, 2014). In this study, the total phenolic content, total flavonoid content, antioxidant activity and phenolic components of Turkish coffee, espresso and filter coffees purchased from a local business were compared

Materials and Methods

Material

Turkish coffee, espresso and filter coffee purchased from a local business in Konya were analysed after cooling at room temperature.

Methods

Coffee samples were diluted 10-fold to prepare the extracts and made ready for analyses.

Total Phenolic Content

Total phenolic contents of coffee extracts were detected using Folin Ciocalteu (FC) reagent (Yoo et al., 2004). Extracts (0.5 ml) were mixed with 2.5 ml FC reagent and 1.5 ml sodium carbonate solution. For absorbance values, samples stored in the dark at room temperature for 2 h, were measured in a spectrophotometer at a wavelength of 725 nm. The results were recorded as mg gallic acid equivalent (GAE)/100 g.

Total Flavonoid Content

Total flavonoid contents of coffee extracts were determined according to the method described by Hogan et al. (2009) The extracts (1 ml) were mixed with 0.3 ml $NaNO_2$, 0.3 ml $AlCl_3$ and 2 ml NaOH. The absorbance of the mixture was recorded at 510 nm with a spectrophotometer. The results were expressed as mg quercetin equivalents (QE)/100 g.

Antioxidant Activity Determination

Antioxidant activity of coffee extracts was determined using 2,2-diphenyl-1-picrazyl (DPPH) as suggested Lee et al. (1998). After the extracts (0.1 ml) were mixed with 2 ml of DPPH solution, the absorbance values of the samples, kept in the dark for 30 min at room temperature, recorded at 517 nm in a spectrophotometer. The results are given as mmol trolox equivalent (TE)/kg.

Determination of Phenolic Compounds

The phenolic compounds of coffee extracts were detected by HPLC (Shimadzu) equipped with a PDA detector and an Inertsil ODS-3 (5 µm; 4.6×250 mm) column. A mixture of 0.05% acetic acid in water (A) and acetonitrile (B) with a flow rate of 1 ml/min at 30 °C was used as the mobile phase. The injection volume was 20 µL. Peaks were taken at 280 °C using a PDA detector. The elution program was used: 0–0.10 min 8% B; 0.10–2 min 10% B; 2–27 min 30% B; 27–37 min 56% B; 37–37.10 min 8% B; 37.10–45 min 8% B. Total run time per sample was 60 minutes.

Results and Discussion

Total phenolic contents, total flavonoid contents and antioxidant activities of coffees prepared with three different methods, namely decoction (Turkish coffee), pressure (espresso) and infusion (filter coffee), are shown in Table 1. When the results obtained were examined, the highest total phenolic content was found in espresso coffee as 6185.71 mg GAE/100 g, while this value was recorded as 3787.76 mg GAE/100 g and 2212.93 mg GAE/100 g in Turkish coffee and filter coffee, respectively. In a study, the highest total phenolic content in coffees prepared in a coffee (Olechno et al., 2020). In another study, the highest total phenolic content was found in espresso coffee as 9.87 mg GAE mL^{-1}, while the same value was found as 5.05 mg GAE mL(Derossi et al., 2018). In a study conducted Kaur et al. (2018), it was reported that coffee made with the decoction method had higher total phenolic content than coffee made with the infusion method. Considering the literature data, the highest total phenolic content was found in espresso, followed by Turkish coffee and filter coffee.

The highest total flavonoid content was found in espresso as 4886.90 mg/100 g, these values were 1632.14 mg/100g and 875.48 mg/100 g in Turkish coffee and filter coffee, respectively. Uslu (2022)8671.77 mg/100 g) was found to be higher than that of coffee made with the infusion method (8518.71 mg/100 g). According to another study, the total flavonoid content in espresso was detected as 554.78 µg QE/ mL (Jung et al., 2021). In another study, it was determined that coffee prepared with the decoction method (69.24 mg/g) had higher total flavonoid content than the hard infusion method (35.76 mg/g) (Kaur et al., 2018). Among the pressure (espresso), decoction (Turkish coffee) and infusion (filter coffee) methods, espresso had the highest total flavonoid content, followed by Turkish coffee and filter coffee.

The antioxidant activities using the DPPH method were equal to 70.25 mmol TE/kg in filter coffee, 66.64 mmol TE/kg in Turkish coffee and 51.63 mmol TE/kg in espresso coffee. In a study, the antioxidant activity of espresso with the DPPH method (1587.7 mmol TE/L) was found to be higher than that of filter coffee (628.9 mmol TE/L) (Chavez et al., 2022). In another study, the antioxidant activity value was higher in the infusion method (8.51 mmol TE/kg) than in the decoction method (7.38 mmol TE/kg) (Uslu, 2022).

The phenolic compounds of coffees are given in Table 2. Caffeic acid (113.73 mg/100 g) and chlorogenic acid (85.47 mg/100 g) in Turkish coffee, protocatechuic acid (118.27 mg/100 g) in espresso coffee and caffeic acid (55.73 mg/100 g) in filter coffee were determined as the main phenolic acids.

The flavonoid contents of coffees are shown in Table 3. Espresso coffee (2709.53 mg/100 g) ranked first in terms of catechin content, followed by Turkish coffee (1270.80 mg/100 g) and filter coffee (597.33 mg/100 g). In a study recorded by Górecki and Hallmann (2020), caffeic acid (28.37 mg/g) was found in 3-minute brewing, while caffeic acid (27.74 mg/g) was found in 6-minute brewing. In another study, epigallocatechin (0.64 mg/g) was found in a coffee brewed at a medium level (Król et al., 2020).

Table 1. Total phenolic, total flavonoid contents and antioxidant activities of coffee samples

Coffee Samples	Total Phenol Content (mg GAE/100 g)	Total Flavonoid Content (mg QE/100 g)	Antioxidant Activity (mmol TE/kg)
Espresso coffee	6185.71 ± 194.68	4886.90 ± 50.68	51.63 ± 1.43
Filter coffee	2212.93 ± 32.80	875.48 ± 8.25	70.25 ± 0.00
Turkish coffee	3787.76 ± 110.37	1632.14 ± 14.29	66.64 ± 0.08

Table 2. Phenolic acid contents of coffee samples

Phenolic acids (mg /100g)	Espresso coffee	Filter coffee	Turkish coffee
Gallic acid	40.80 ± 0.69	32.33 ± 1.00	2.60 ± 0.04
Protocatechuic acid	118.27 ± 4.23	46.20 ± 2.75	4.87 ± 0.07
Chlorogenic acid	39.27 ± 1.38	52.60 ± 1.78	85.47 ± 3.01
Caffeic acid	32.73 ± 0.27	55.73 ± 2.84	113.73 ± 5.94
Coumaric acid	17.80 ± 1.20	1.33 ± 0.04	1.53 ± 0.03
Ferulic acid	1.67 ± 0.05	4.53 ± 0.12	5.13 ± 0.23
Cinnamic acid	0.67 ± 0.02	0.67 ± 0.02	7.73 ± 0.32

Table 3. Flavonoid contents of coffee samples

Flavonoids (mg /100 g)	Espresso coffee	Filter coffee	Turkish coffee
Catechin	2709.53 ± 18.25	597.33 ± 3.23	1270.80 ± 3.89
Routine	7.73 ± 0.19	6.47 ± 0.20	55.40 ± 1.61
Hesperid	7.00 ± 0.35	0.80 ± 0.03	1.60 ± 0.06
Quercetin	9.73 ± 0.19	4.47 ± 0.05	2.67 ± 0.06
Kaempferol	36.13 ± 0.29	30.60 ± 0.43	29.67 ± 0.53

In this study, bioactive properties of espresso, filter and Turkish coffees, which were obtained a local coffee shop, were analyzed and compared. The highest total phenolic and flavonoid contents were found in espresso coffee, followed by Turkish coffee and filter coffee. Antioxidant activity results were recorded as the opposite of the others, the highest in filter coffee, followed by Turkish coffee and espresso coffee. The main phenolic acids were found to be caffeic acid, chlorogenic acid and protocatechuic acid. The dominant flavonoid was determined as catechin.

Conclusion

In this study, bioactive properties of espresso, filter and Turkish coffees, which were obtained a local coffee shop, were analyzed and compared. The highest total phenolic and flavonoid contents were found in espresso coffee, followed by Turkish coffee and filter coffee. Antioxidant activity results were recorded as the opposite of the others, the highest in filter coffee, followed by Turkish coffee and espresso coffee. The main phenolic acids were found to be caffeic acid, chlorogenic acid and protocatechuic acid. The dominant flavonoid was determined as catechin.

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