

The Investigation of the Element Contents in the Turkish Coffees

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Abstract

Coffee is one of the most popular drinks across the world and its enormous commercial and social importance is obvious. Coffee has become the essential consumption matter and one of the rituals of many societies for several years.

Turkish people's first confrontation with it dates back to 16th century, in Ottoman era. Since then, because of the differences in terms of preparation and presentation styles, the coffee has been named as "Turkish Coffee". According to this presentation style, roasted and then finely ground coffee beans are boiled in a pot, usually with sugar, and served in a cup where the grounds are allowed to settle.

Turkish coffee contains many components such as caffeine, flavonoids, phenolic compounds and minerals. There are many elements in the structure of the Turkish coffee and have various effect on human health.

In this study, determination of magnesium (Mg), iron (Fe) and calcium (Ca) contents in Turkish coffee aimed for conscious consumption. Inductively coupled plasma optical emission spectrometry (ICP-OES) was used for these analysis. From the results of experiments Mg, Fe and Ca contents were found in Turkish coffee as 21.46, 0.008 and 78.48 ppm respectively. Element contents which are found in 1, 2 and 5 cups of coffee are calculated. Analysis data were calculated with two different results such as daily intake for adults (mg) and percentage intake for adults (%). Furthermore, the daily intake of element from coffees that affects human health is also investigated.

Keywords – Turkish Coffee, element, ICP-OES, analysis

1 Introduction

Coffee is one of the most popular beverage which has been cultivated and consumed throughout the centuries [1]. Coffee consumption is prevalent in the world due to its physiological effects as well as its pleasant taste and aroma [2]. Coffee is an important plantation crop (containing more than 90 species) belonging to the family Rubiaceae, subfamily Cinchonoideae and tribe Coffeae [3,4]. They are shrubs or small trees (Fig. 1), native to subtropical Africa and southern Asia [4].

There are two main species of coffee beans in the world, Coffee Arabica, and *Coffea canephora* var. *robusta*, commonly known as arabica and robusta. These two coffee varieties have highest agronomical importance, with the first accounting for

approximately 70% of the world production [6].



Figure 1. Coffee plant [5]

In Turkey, drinking Turkish coffee is a cultural behavior from the days of the Ottoman Empire through the present. Turkish coffee combines special preparation and brewing techniques with a rich communal traditional culture [7]. It is not a special

type of bean. *Coffea arabica* is used for Turkish coffee. Firstly, coffee beans are roasted and ground finely to prepare Turkish coffee. After that coffee is boiled in a pot usually with sugar, and served in a cup where the grounds are allowed to settle (Fig. 2). At present, this method of serving is found in the Middle East, North Africa, the Caucasus, the Balkans, Bali, and Eastern Europe [8].



Figure 2. Turkish coffee [9].

Due to widely consumption of Turkish coffee in Turkey its chemical composition, namely the presence of essential, non-essential and toxic elements, has to be known.

There are many elements in the structure of coffee and have various effect on human health.

Calcium (Ca) is a mineral that is necessary for developing and maintaining healthy bones and teeth. The body needs calcium to carry out many important functions such as regulating your heartbeat, conducting nerve impulses, clotting blood and stimulating hormone secretions [10]. Ca deficiency causes brittleness that occurs on hair and nail, osteoporosis and dental caries (tooth decay). Kidney stones, hypercalcemia, milk alkali syndrome, and renal insufficiency are adverse effects of excessive Ca consumptions [11-13].

Magnesium (Mg) has many effects on the human body. It has important role in activation of many enzymes. It is a cofactor in more than 300 enzyme systems which are responsible for protein synthesis, muscle and nerve function, blood glucose control, and blood pressure regulation. Mg deficiency causes irritability, depression, muscle contraction-cramps and heart rhythm disturbances [14-16].

Iron (Fe) is an important mineral that is necessary various body functions including the transport of oxygen and carbon dioxide in the blood. This is essential for providing energy in daily life. Fe is found in the hemoglobin of red blood cells and in the

myoglobin of muscle cells. Fe deficiency causes the anaemia on the human body [17, 18].

There are various studies about element contents of coffees. Ozdemir, Kipcak, Derun, Tugrul and Piskin (2010) studied on boron amount in coffees [19]. Jaganyi, Vanmar and Clark (1999) determined coffee element bu using ICP-OES method. ICP-OES is very often applied in the elemental analysis of coffee samples [20]. Ozdestan (2014) determined 5 elements (Mg, Mn, Zn, Na, K) in coffees [8]. Stelmach, Pohl, and Madeja (2015) determined content of Ca, Cu, Fe, Mg and Mn in green coffee brews [21]. Oliveira et al. (2012) studied on soluble powdered instant coffees [22].

The purpose of this study is to determine the content of Ca, Mg and Fe of the Turkish coffees that are sold in Turkey. Also how elements affect the human body is investigated.

2 Experimental

2.1 Preparation and Infusion of the Turkish Coffee Samples

Turkish coffees are purchased from the local market in Istanbul, Turkey (Fig 3). All of the samples are analyzed at the beginning of their shelf life.

Sterilization is the first step to prevent impurity during ICP-OES analysis. All glasswares are cleaned by soaking them in a 10% (v/v) CrO_3 solution and rinsed abundantly with ultra-pure water before use.

ISO 3103 (ISO; 1980) brewing method is used to prepare coffee infusions. In this method, 2 g of coffee which is the average value in a cup of coffee, is weighed and brewed with 100 mL distilled water.

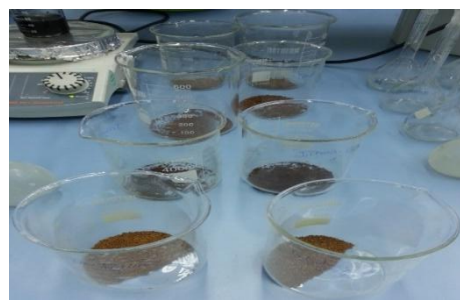


Figure 3. Turkish coffee samples



Figure 4. Brewed coffees



Figure 6. Perkin-Elmer Optima 2100 DV, ICP-OES

2.2 Preparation of the Calibration Sets and Elemental Analysis of the Coffee Samples

Tüm The calibration standards are prepared by diluting Ca, Mg and Fe standard solutions. Standard solutions are shown in Fig. 5.

ICP-OES is one of the most powerful and popular elemental analysis technique that uses to determination of trace elements in a myriad of sample types. In ICP-OES technique, the sample is subjected to enough high temperatures for causing excitation and/or ionization of the sample of atoms [23]. It has high sensitivity for detecting the major trace elements [24].

Determinations are carried out using Perkin-Elmer Optima 2100 DV model ICP-OES equipped with an AS-93 auto sampler (Fig. 6). The measured samples are given in Fig. 7. All samples and blank solutions are measured in triplicate.



Figure 5. Standard solutions

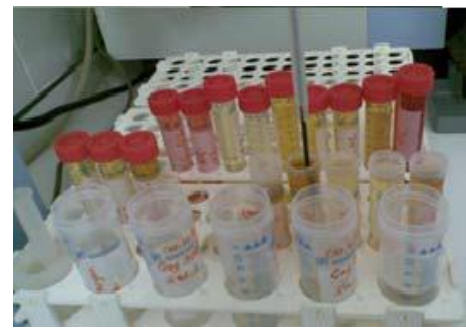


Figure 7. Measured coffee samples

The measurement conditions are listed in Table I.

Table 1. ICP-OES measurement conditions

ICP-OES measurement conditions	
Power kW	1.45
Plasma flow (L.min ⁻¹)	15.0
Auxiliary flow (L.min ⁻¹)	0.8
Nebulizer flow (min ⁻¹)	1 L

2 Results and Discussions

3.1 Analysis Results

The mean element concentration values of Turkish coffees in mg/L (ppm) are shown in Table II. From the results obtained, the Ca amount in Turkish coffee is the highest and it is followed by Mg amount and Fe amount.

Table 2. Content of Elements in Turkish Coffee

Element	Content (ppm)
Ca	78,48
Mg	21,46
Fe	0,008

The average Ca, Mg, Fe contents in Turkish coffee calculated as 78,48 ppm, 21,46 ppm, 0,008 ppm respectively.

The distribution of concentrations of three elements in Turkish coffee is shown in Figure 8.

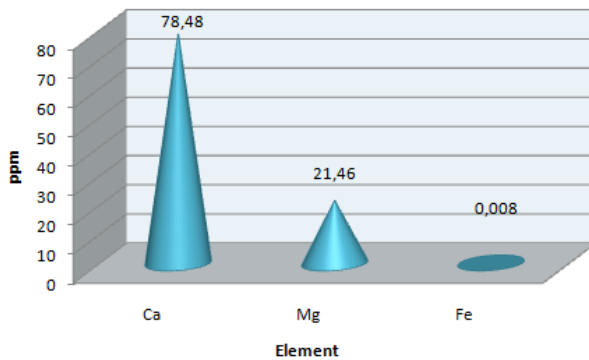


Figure 8. Element concentrations of Turkish coffee

3.2 Daily Dosage Calculations

Element content of 50 ml Turkish coffee which is the average volume value in a Turkish coffee cup is analyzed and data are expressed as mg by using (3.1). Amounts of caffeine in 1, 3 and 5 cups of Turkish coffee is also calculated by using (3.2) and (3.3).

$$m(\text{mg}) = C \left(\frac{\text{mg}}{\text{l}} \right) \times \frac{\text{l}}{1000 \text{ ml}} \times 50 \text{ ml} \quad (3.1)$$

$$m(\text{mg}) = C \left(\frac{\text{mg}}{\text{l}} \right) \times \frac{\text{l}}{1000 \text{ ml}} \times 50 \text{ ml} \times 3 \quad (3.2)$$

$$m(\text{mg}) = C \left(\frac{\text{mg}}{\text{l}} \right) \times \frac{\text{l}}{1000 \text{ ml}} \times 50 \text{ ml} \times 5 \quad (3.3)$$

where 'm' is the element contents of Turkish coffee and "C" is the element concentration.

Daily essential element requirements for human body

in 9-50 ages are in Ca; between 1000-2500 mg.day⁻¹ and in Fe; between 8-45 mg.day⁻¹ for both of men and women, in Mg 400-420 mg.day⁻¹ for men and 310-320 mg.day⁻¹ for women.

These elements of intake percentages were calculated by using (3.4) and the values of daily requirements for human body [25].

$$DMI = mx100/DRI \quad (3.4)$$

Where 'DRI' is recommended dietary reference intakes.

3 Conclusion

Human Daily maximum element intake is given in Table III. The recommended maximum daily Ca, Mg and Fe intake amount which are between 1000-2500, 310-420 and 8-45 mg for adults respectively can be seen in Table III. The table also shows us recommended Ca and Fe amounts are the same for men and women between 19-50 years but recommended Mg amounts for males is higher than females.

Ca, Mg and Fe contents of the analyzed Turkish coffees are calculated for 1, 3 and 5 cups respectively. Analysis data were calculated with two different results such as daily intake for adults (mg) and percentage intake for adults (%). Results are shown in the Table IV and Table V, respectively.

Table 3. Recommended Daily Maximum Intake

	Years	Ca (mg/day)	Mg (mg/day)	Fe (mg/day)
Male	9-30	1000-2500	400	8-45
	31-50	1000-2500	420	8-45
Female	9-30	1000-2500	310	8-45
	31-50	1000-2500	320	8-45

Table 4. Daily Element Intake (mg)

Daily Element Intake (mg)			
	Ca	Mg	Fe
1 Cup	3,924	1,073	4x10 ⁻⁴
3 Cups	11,772	3,219	12x10 ⁻⁴
5 Cups	19,620	5,365	20x10 ⁻⁴

Table 5. Daily Element Intake (%)

Daily Element Intake (%)			
	Ca	Mg	Fe
1 Cup	0,157-0,392	0,225-0,346	8×10^{-4} - 50×10^{-4}
3 Cups	0,470-1,177	0,766-1,038	26×10^{-4} - 150×10^{-4}
5 Cups	0,785-1,962	1,277-1,730	44×10^{-4} - 250×10^{-4}

Ca is an essential element for human body. It has important role to build healthy teeth and bone. Mg is a cofactor in many enzyme systems. Fe is found in the structure of hemoglobin. These elements are so important for the human health.

As can be seen from Table IV and V, Turkish coffees element content in 1 cup, 3 cups and 5 cups lower than daily maximum element intake for adults.

As a result the investigated Turkish coffee do not reach the maximum daily dosage of element concentration.

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