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Comparison of Metal Content of Coffee Samples Grown in Different Countries by Inductively Coupled Plasma Optical Emission Spectroscopy

Sabah H. Al-Jaf [1*], **Sinan Saydam** [2]

[1]Garmian University, College of Education, Department of Chemistry, sulaymaneyah, Iraq
[2]Firat University, Faculty of Science, Department of Chemistry, 23200 Elazig, Turkey
[*]sabah.hassan@garmian.edu.krd

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Abstract

Coffee is the one of the most consumed beverage across the world. Therefore, it has a commercial value and social importance. Coffee consumption continues to increase due to its physiological effects, its pleasant taste, aroma and many health benefits. In this study six different coffee samples from six different countries were analyzed for determining concentration of 17 elements by using inductively coupled plasma optical emission spectroscopy (ICP-OES). According to the obtained results, elements were classified into three groups of macro, micro, and trace elements according to their concentration; among the macro elements potassium concentration were highest (10508 mg/L) average concentration in all samples; whereas the average concentration of calcium were found to be lowest (296.33 mg/L) in this group. Micro elements showed the concentration order of: Sr > Mn > Fe > Al > Ba > Cu > Zn by concentration of 12.66, 12.28, 6.35, 3.81, 3.79, 3.05, and 2.61 mg/L respectively. Concentrations of selenium were higher than all other elements in the group of trace elements by average concentration of 0.61 mg/L. The results obtained in this study showed there are significant differences between different elemental content of different coffee samples grown in different region.

Keywords: Coffee, coffee sample, elements, Trace element, analysis, Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES).

1. Introduction

Coffee is one of the most consumed drinks in world that it is ranked after petroleum as the second most traded global commodity [1] and it is exported to more than 167 different countries with more than 9.0 million ton annual consumption in recent years [8]. Coffee is an agricultural product that plays an important role in the international trade [2].

Coffee is an important plantation crop which belongs to the *Rubiaceae* and *genera Coffea* family; they are shrubs or small trees (Figure 1). Usually the coffee plant is a woody perennial tree that is growing at region of higher altitudes [5]. *Coffea arabica* (Arabica coffee) and *Coffea canephora* (Robusta coffee) are the most important types among 70 different species of *genera Coffea* that have been reported. There is difference in caffeine contents, taste, and appearance between these two varieties. Arabica coffee is favored by a hedonic trend of consumers as compared to Robusta coffee [5].

Figure 1. Arabica Coffee Plants.

It is recognized that the coffee beverage is a rich source of elements, including those that are essential for the human health, in addition to non-essential elements and even toxic to human take up from a polluted soil [2]. Coffee contains various elements such as Na, B, Mg, Fe, Ca, K and many other elements. These elements have various effects on human health such as Na helps to regulate the body's water balance. [3, 9]. Mg is a cofactor of enzyme systems [10]. Fe is an important for normal human physiology and for most life forms [12].

Therefore, the determination of total concentrations of elements in coffee enables to assess its nutritive quality and also helps to judge its possible ill-effect that may cause to the human health [2].

Information available in literature about the levels of the trace elements present in coffee beans from different origins is limited, different analytical techniques in a number of studies have been used for the determination of some elements (major, minor and toxic element) in different types of roasted, and green coffee beans in different countries around the world [6].

Concentration of l4 elements (Ca, Cd, Pb, Mn, Fe, Na, K, P, Mg, Cr, Ni, Co, Cu, Zn) in coffee were determined by Grembecka et al. [7]. Oliveira et al. determined amount of 9 elements (Mg, Na, Fe, Ca, K, P, Cr, Ni, and Mn) in soluble powdered instant coffees [4]. The levels of some bioactive amines, five elements (K, Na, Mg, Zn, and Mn), total ash content, pH values, and total dry matter content in ground coffee and brewed Turkish coffees were investigated by Ozdestan [15]. Stelmach, et al. measured total concentrations of Mn, Cu, Mg, Fe, and Ca, in the green coffee infusions by using high resolution-continuum source flame atomic absorption spectrometry [11]. Ashu et al. determined the concentrations of 11 elements (Cd, Cu, Co, Ca, Mn, K, Fe, Pb, Na, Zn, Mg) in three different brands of roasted coffee powders from Ethiopia and their infusions by flame atomic absorption spectrometry (FAAS) [6]. Szymczycha et al. compared six procedures for sample preparation, for determining the amount of (Ca, Pb, Mg, Ba, Ni, Fe, Cd, Mn, P, Cr, Sr, Zn and Cu) in slim instant coffees by inductively coupled plasma optical emission spectrometry (ICP-OES), they established that the extraction with aqua regia provides better results as compared to other digestion procedures [16].

This study was aimed to determine the concentrations of some major, minor and trace elements in six different coffee samples from six different origins (Brazil, Colombia, Ethiopia, Guatemala, Kenya, and Yemen) where the coffee plants grown. The coffee samples were analyzed for seventeen elements (Al, As, Ba, Ca, Cr, Cu, Fe, K, Mn, Na, Ni, P, Se, Sn, Sr, Zn, and Mg) by using inductively coupled plasma optical emission spectroscopy (ICP-OES).

2. Materials and Methods

2.1. Chemical reagents

All of the reagents that have been used in present study were of the analytical grades. All of the prepared aqueous solutions prepared by deionized water. Concentrated HNO_3 and HCl (Merck, Darmstadt- Germany) solutions were used for the digesting the coffee samples. All of the standard solutions prepared by diluting multi-element (1000μg/mL) ICP standard (Bernd Kraft der standard). Deionized water was obtained from (Thermos – Germany) water purification system. All glassware and plastic bottles that used in this work were washed by 10% (m/v) HNO_3 and rinsed many times with deionized water.

2.2. Coffee samples

Six coffee samples from six different origins (Brazil (CB), Colombia (CC), Ethiopia (CE), Guatemala (CG), Kenya (CK), and Yemen (CY)) were selected for the analysis. All coffee samples were purchased from local markets of Turkey.

2.3. Sample preparation

Digestion of the coffee samples were done by taking 0.500g of each coffee sample into a beaker and 2 ml of aquaregia (1:3 HNO_3: HCl) were added then the resulting mixture were sonicated in ultra-sonic bath for 1 hour, after that 10.0 ml of deionized water were added, filtrated to remove any undissolved particle then diluted to 25 ml with deionized water.

2.4. Operating conditions for ICP – OES instrument

An ICP – OES instrument (Spectro-Arcos – Germany) used for the analysis of elements under study. The conditions of the operation of ICP – OES instrument were as follows: 1400 watts of a RF power, 13 L/min coolant flow rate, 1 L/min auxiliary flow, 0.83 L/min nebulizer flow and 1.2 mL/min of sample uptake rate. Measurements of all of the elements were done in triplicate. Table 1 shows the characteristics data of the calibration curves of elements using ICP-OES.

3. Results and Discussion

3.1. Analysis Results

In this study, concentration of 17 elements (Al, As, Ba, Ca, Cr, Cu, Fe, K, Mn, Na, Ni, P, Se, Sr, Sn, Zn and Mg) were determined in coffee samples by inductively coupled plasma optical emission spectroscopy (ICP-OES). According to the obtained results in this study the measured elements can be classified into three main group, due to their concentration, the first group will be named as macro or essential element because their concentrations are too high in coffee as compared to other elements and include five elements which are (Ca, K, Na, P and Mg), the concentration trend of macro elements were fund to be as follows: K > Mg > Na > P > Ca by concentration range of 9360-11635, 420.63-500.77, 240.73-353.38, 251.07-342.38, and 243.93-334.73 mg/L for K, Mg, Na, P, and Ca respectively.

Coffee beverages are one of the important sources of some micro elements like Mn, Zn and Cu which are necessary for the metabolic processes in human. Second group of elements determined in coffee in present study were some micro elements and including elements like (Zn, Al, Cu, Ba, Sr, Fe, and Mn).

The order of mean concentrations of the micro elements in all analyzed coffee samples was found to be: Sr> Mn> Fe> Ba> Al> Cu> Zn by the concentration of 9.583-16.783, 7.283-14.617, 5.1667-8.1, 1.3-6.45, 2.95-4.5833, 2.85-3.33, and 1.9-3.25 mg/L for Sr, Mn, Fe, Ba, Al, Cu, and Zn respectively.

The third and final group of elements determined is trace elements in which coffee samples contain some essential trace elements like Ni, Cr, and Se which are essential nutrients that are cofactors for the metabolism and some other biological processes. Trace elements like (Ni, As, Se Cr, and Sn) were determined in coffee samples in present study, among trace elements; Se is the highest concentration by 0.45-0.73 mg/L followed by Ni, Cr, Sn and As by concentration of 0.01667-0.36667, 0.05-0.3, 0.06667-0.15, and 0.05-0.16667 mg/L for Ni, Cr, Sn, and As respectively. The analysis results of the coffee samples for all the elements studied are given in table 2 as mg/L.

Table 1. Characteristics data of the calibration curves of elements using ICP-OES.

Elements	**Equation**	**R^2**	**Wave length(nm)**	**Linear range ($mg.L^{-1}$)**	**DL ($mg.L^{-1}$)**
Al	y = 3.2113x + 0.1235	1.00000	176.641	0.00355 – 24	0.00355
As	y = 9.0001x + 0.0804	0.99994	189.042	0.00264 - 2.4	0.00264
Ba	y = 1055.1x + 16.513	0.99994	455.404	0.000441- 2.4	0.000441
Ca	y = 0.0767x + 0.0524	0.99998	315.887	0.00419 – 600	0.00419
Cr	y = 76.47x + 0.6904	0.99993	267.716	0.000457 - 2.4	0.000457
Cu	y = 169.69x + 2.0525	0.99995	324.754	0.00126 - 2.4	0.00126
Fe	y = 0.1165x - 0.0181	0.99982	259.941	0.00145 – 60	0.00145
K	y = 5.9976x + 0.7163	0.99957	766.491	0.0316 – 24	0.0316
Mn	y = 0.5213x - 0.0009	0.99997	257.611	0.000226 – 6	0.000226
Na	= 0.053x + 0.0606	0.99987	589.592	0.0552 – 240	0.0552
Ni	y = 68.03x + 0.4872	0.99996	231.604	0.000974 - 2.4	0.000974
P	y = 6.7779x - 0.5846	0.99998	177.495	0.00245 – 60	0.00245
Se	y = 4.9216x + 0.2345	0.99976	196.090	0.0087 - 2.4	0.0087
Sr	y = 6.6695x + 0.0972	0.99978	407.771	9.63e-005 - 2.4	9.63e-005
Sn	y = 20.731x + 0.1671	0.99998	189.991	0.00194 - 2.4	0.00194
Zn	y = 0.2307x + 0.0011	1.00000	213.856	0.000633 – 24	0.000633
Mg	y = 0.0081x - 0.0028	0.99999	279.079	0.00576 – 240	0.00576

3.2. Comparison with Previous Studies

Generally the results that obtained in this study showed good agreement with most of the reported values except for some of the macro elements in which the results obtained here is slightly lower than previous reported values. Concentrations of calcium, potassium, sodium, magnesium, iron, and nickel in coffee samples obtained in present study were lower than the reported values by Krivan et al. 1993 [13], Santos et al. 2008 [17], Martin et al. 1999 [18], and Sussela et al. 2001 [20]. Concentrations of sodium in present study were higher than the reported values by Tagliaferro et al. 2007 [19], and Anderson and Smith 2002 [14].Amount of phosphorus (P), aluminum (Al), barium (Ba), copper (Cu), manganese (Mn), zinc (Zn), arsenic (As), chromium (Cr), and selenium (Se) found in coffee samples in present study were in good agreements with the values reported previously, while concentration of strontium (Sr) obtained in present study were slightly higher than values that reported by Santos et al. 2008 [17], martin et al. 1999 [18], and Sussela et al. 2001 [20].

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Table 2. Concentrations (mg/L) of elements (mean ± standard deviation) in six coffee samples.

	CB	CC	CE	CG	CK	CY
Al	3.633 ±0.160	4.250±0.050	2.950±0.100	2.950±0.132	4.500±0.450	4.583±0.104
As	0.166±0.076	0.116±0.125	0.050±0.043	0.050±0.000	0.083±0.028	0.083±0.057
Ba	0.933±0.028	6.916±0.028	3.200±0.050	6.450±0.050	3.983±0.057	1.300±0.000
Ca	283.82±14.07	306.87±17.25	243.93±9.93	298.03±10.97	310.88±14.54	334.73±9.70
Cr	0.066±0.076	0.300±0.100	0.116±0.057	0.050±0.025	0.083±0.028	0.150±0.050
Cu	2.850±0.100	3.266±0.202	2.916±0.076	2.966±0.104	3.016±0.125	3.333±0.076
Fe	5.166±0.650	7.033±0.828	5.183±0.664	5.533±0.505	7.100±0.785	8.100±0.427
K	10357±21	10012±161	10723±68	11635±154	9360±83	10964±216
Mn	11.667±0.562	13.483±0.825	7.283±0.404	12.650±0.541	14.617±0.709	14.000±0.436
Na	302.82±3.87	293.45±1.89	240.73±4.58	333.42±2.60	294.57±1.80	353.38±0.65
Ni	0.150±0.050	0.333±0.076	<DL	0.016±0.028	0.216±0.028	0.366±0.028
P	295.27±12.82	299.73±10.38	325.98±14.84	251.07±5.09	342.38±11.98	283.67±6.23
Se	0.616±0.125	0.700±0.229	0.533±0.125	0.450±0.132	0.733±0.057	0.633±0.160
Sn	0.066±0.076	0.133±0.763	0.083±0.028	0.100±0.050	0.083±0.057	0.150±0.000
Sr	9.583±0.029	16.783±0.252	9.733±0.126	15.767±0.104	12.967±0.076	11.183±0.208
Zn	2.266±0.175	2.816±0.175	1.900±0.132	2.416±0.104	3.250±0.180	3.050±0.132
Mg	463.48±18.64	455.35±25.14	420.63±21.24	447.75±16.50	500.77±24.18	493.60±14.08

Comparison of the results in present study with some previous studies for determination of macro, micro and trace elements are showed in table 3, 4 and 5 respectively.

Table 3. Comparison of the results of present study with previous studies for macro elements.

element	Concentration ranges in mg/L						
	Present study	Krivan et al. 1993	Santos et al. 2008	Martin et al. 1999	Sussela et al. 2001	Tagliaferro et al. 2007	Anderson and Smith 2002
Ca	243-334	869-1171	1227-1437	870-1170	490-971	1150-1580	934-1234
K	9360-11635	14000-16000	19435-20111	13000-15000	14000-29000	532-770	17500-19600
Na	240-353					2.5-9.8	9.6-1467
P	251-342		2660-3067				1710-2110
Mg	420-500	1800-2000	2145-3067	1500-2000	2000-3100		2058-2410

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Table 4. Comparison of the results of present study with previous studies for micro elements.

element	Concentration ranges in mg/L			
	Present study	Krivan et al. 1993	Santos et al. 2008	Sussela et al. 2001
As	0.05-0.166		<13	
Cr	0.05-0.3	0.4-1	<0.7	0.7-0.8
Ni	0.016-0.366		<0.8	0.6-1.9
Se	0.45-0.733		<5.8	
Sn	0.066-0.15			

Table 5. Comparison of the results of present study with previous studies trace elements.

element	Concentration ranges in mg/L						
	Present study	Krivan et al. 1993	Santos et al. 2008	Martin et al. 1999	Sussela et al. 2001	Tagliaferro et al. 2007	Anderson and Smith 2002
Al	2.95-4.583		15.6-262				3-36
Ba	0.933-6.45		0.754-1.04				
Cu	2.85-3.333	12.1-19.8	13.4-14.2	11.8-17.8	0.4-16		12.5-18.1
Fe	5.166-8.1	37-57	46.9-94.4	40-73	16-92	129-983	12-31
Mn	7.283-14.617	18-56	17.8-19.3	12-45	7-13		19-39
Sr	9.583-16.783	3.2-18	4.51-5.5	4.1-12	1.1-2.6		
Zn	1.9-3.25	5-7.8	5.27-6.28	4.9-36.9	2.4-8.9	7.4-7.62	6.51-8.03

The chemical composition of the coffee is mostly related to the origin in which the coffee plants grown. The primary factor connected with the elements is the soil conditions, variety of the coffee, and the methods of cultivation of the coffee plants [14]. Procedures included in the green and roasted coffee beans processing or even the methods of the brewing of the coffee are also important [7].

The results showed that there are significant differences between the concentration of (Al, Ba, K, Na, Ni, Sr, and Zn) for coffee samples from different origins, highest amount of Al is exist in CY and lowest Al concentration is observed for CE and CG, CC contains highest amount and CY contains lowest amount of Ba; highest concentration of K were observed for CG but CK contains lowest amount of K; highest concentration of Na were observed for CY and the lowest amount observed for CE; CC contains highest amount Sr but lowest amount of Sr were observed for CB; highest concentration of Zn were observed for CK and lowest amount were observed for CE. For elements like (As, Se, Sn, and Mg) no significant differences were observed for different coffee samples. For other elements significant difference were observed between the concentrations of only one or two coffee sample with other samples. Figure (2, 3, and 4) shows the differences among the concentration of (macro, micro, and trace) elements in different coffee samples.

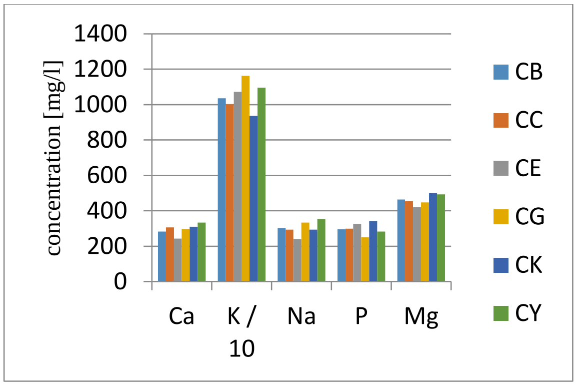

Figure 2. Levels of macro elements in different coffee samples.

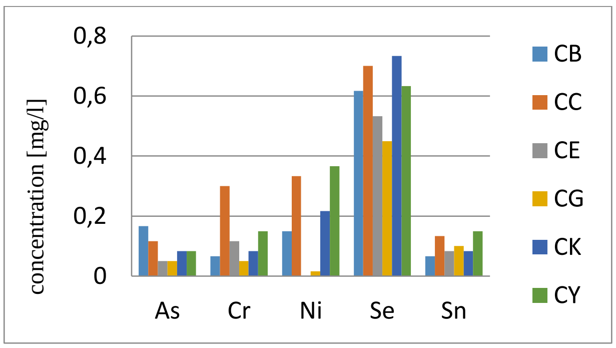

Figure 3. Levels of micro elements in different coffee samples.

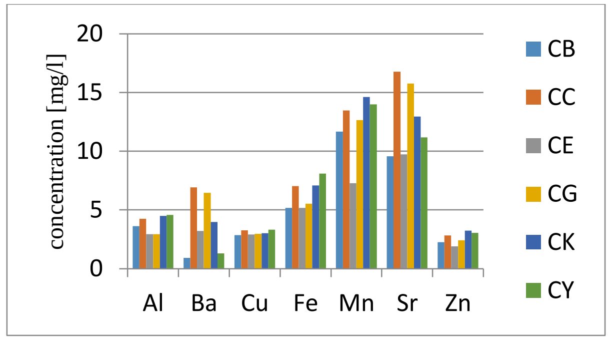

Figure 4. Levels of trace elements in different coffee samples.

3.3. Comparison with DRI of Elements

Highest concentration of each element from present study were selected to be compared with dietary reference intakes of the elements when (1 and 3) cups of coffee were used for drinking each day if approximately 3 gr of coffee were used for preparing a single cup of coffee, percent daily intake of elements also calculated and the results showed that none of the elements in coffee samples exceeds the maximum daily intake levels even in the case of drinking more than 3 cups of coffee per day, thus all six coffee samples analyzed in present study are safe according to their element content. Dietary reference intake of elements under study, compared with the results obtained in present study are showed in table 6.

Table 6. Comparison of the results of present study with dietary reference intake of the elements.

Elements	DRI (mg/day) (19-50 years)	Concentration of elements in coffee samples (mg/L) (highest value)	Element intake from one cup (3 gr) of coffee (mg)	Element intake from three cups (9 gr) of coffee (mg)	Daily Element intake (%)	
					1 cup	3 cups
Al	ND	4.583	0.013749 mg	0.041247 mg	---	---
As	ND	0.166	0.000498 mg	0.001494 mg	---	---
Ba	ND	6.916	0.020748 mg	0.062244 mg	---	---
Ca	1000-1200	334.73	1.00419 mg	3.01257 mg	0.083-0.1 %	0.25-0.30 %
Cr	0.025-0.035	0.3	0.0009 mg	0.0027 mg	2.57- 3.6 %	7.71- 10.8 %
Cu	0.89-0.9	3.333	0.009999 mg	0.029997 mg	1.11- 1.12 %	3.33- 3.37 %
Fe	8-18	8.1	0.0243 mg	0.0729 mg	0.135- 0.3 %	0.405- 0.91 %
K	4500-4700	11635	34.905 mg	104.715 mg	0.74- 0.77 %	2.22- 2.32 %
Mn	1.6-2.3	14.616	0.043848 mg	0.131544 mg	1.9- 2.7 %	5.71- 8.22 %
Na	1300-1500	353.38	1.06014 mg	3.18042 mg	0.07- 0.08 %	0.21- 0.24 %
Ni	0.6-1	0.366	0.001098 mg	0.003294 mg	0.109-0.183 %	0.329- 0.549 %
P	600-700	342.38	1.02714 mg	3.08142 mg	0.146- 0.171 %	0.44- 0.51 %
Se	0.05-0.055	0.733	0.002199 mg	0.006597 mg	3.99-4.39 %	11.99- 13.19 %
Sn	ND	0.15	0.00045 mg	0.00135 mg	---	---
Sr	ND	16.783	0.050349 mg	0.151047 mg	---	---
Zn	8-11	3.25	0.00975 mg	0.02925 mg	0.088- 0.12 %	0.26- 0.36 %
Mg	320-420	500.77	1.50231 mg	4.50693 mg	0.35- 0.47 %	1.07- 1.4 %

ND: Not Determined, DRI: Dietary Reference Intake

3.3. Correlation between Elements

To determine correlation between concentrations of elements in coffee samples, Pearson's correlation coefficient were assessed. As can be seen from table 4 very high positive correlation ($r>0.9$) is observed only for Cu-Fe, Ca-Mn, Ba-Sr and Zn-Mn pairs of elements. high positive correlations ($0.7<r>0.9$) exhibit the following pairs of elements: Ca-Al, Ca-Cu, Cr-Cu, Al-Fe, Fe-Ca, Al-Mn, Fe-Mn, Ni-Al, Ni-Cu, Ni-Fe, Ni-Mn, Zn-Al, Al-Mg, Ca-Zn, Ca-Mg, Fe-Zn, Fe-Mg, Mn-Mg, Zn-Ni, Zn-Mg, Mn-Na and Ni-Ca. while high negative correlation exist between P-K and Al-Ba. For other pairs of elements, positive or negative correlations are established and they are moderate ($r= \pm0.4$ to ±0.7), low ($r= \pm0.2$ to ±0.4) or almost negligible ($r= 0$ to ±0.2).

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	Al	As	Ba	Ca	Cr	Cu	Fe	K	Mn	Na	Ni	P	Se	Sn	Sr	Zn
As	0.227 0.365															
Ba	-0.716 0.489	-0.216 0.388														
Ca	0.716 0.001	0.073 0.772	0.028 0.911													
Cr	0.365 0.136	-0.044 0.862	0.332 0.179	0.259 0.299												
Cu	0.615 0.007	-0.117 0.643	0.141 0.577	0.739 0.000	0.733 0.001											
Fe	0.790 0.000	-0.013 0.960	-0.010 0.967	0.846 0.000	0.536 0.022	0.901 0.000										
K	-0.586 0.011	-0.216 0.390	0.040 0.875	-0.065 0.797	-0.225 0.370	0.004 0.988	-0.224 0.372									
Mn	0.731 0.001	0.129 0.610	0.165 0.512	0.923 0.000	0.209 0.406	0.562 0.015	0.724 0.001	-0.265 0.288								
Na	0.375 0.126	0.031 0.904	-0.079 0.756	0.787 0.000	-0.096 0.705	0.417 0.085	0.459 0.055	0.378 0.122	0.716 0.001							
Ni	0.867 0.000	0.185 0.461	-0.111 0.661	0.772 0.000	0.644 0.004	0.811 0.000	0.859 0.000	-0.385 0.114	0.704 0.001	0.437 0.070						
P	0.310 0.211	0.040 0.874	-0.199 0.428	-0.177 0.488	0.187 0.459	0.002 0.994	0.199 0.430	-0.767 0.000	-0.112 0.657	-0.665 0.003	0.128 0.613					
Se	0.499 0.035	-0.361 0.141	-0.071 0.778	0.271 0.271	0.362 0.140	0.283 0.256	0.358 0.144	-0.592 0.010	0.337 0.171	-0.014 0.957	0.514 0.029	0.363 0.139				
Sn	0.300 0.227	-0.016 0.949	0.106 0.677	0.402 0.098	0.393 0.106	0.526 0.025	0.456 0.057	0.146 0.564	0.267 0.285	0.278 0.264	0.411 0.090	-0.119 0.638	-0.071 0.781			
Sr	0.107 0.673	-0.100 0.964	0.918 0.000	0.380 0.119	0.396 0.104	0.361 0.141	0.246 0.325	0.028 0.912	0.504 0.033	0.271 0.277	0.196 0.435	-0.342 0.165	0.022 0.930	0.241 0.334		
Zn	0.851 0.000	0.044 0.861	0.084 0.740	0.874 0.000	0.318 0.198	0.667 0.003	0.883 0.000	-0.432 0.073	0.911 0.000	0.513 0.029	0.777 0.000	0.212 0.398	0.421 0.082	0.313 0.206	0.366 0.135	
Mg	0.736 0.001	0.131 0.605	-0.249 0.319	0.832 0.000	0.135 0.593	0.558 0.016	0.801 0.000	-0.330 0.182	0.813 0.000	0.505 0.033	0.669 0.002	0.270 0.278	0.340 0.168	0.218 0.384	0.028 0.912	0.874 0.000

Table 4. Correlations between the elements according to Pearson's correlation coefficient.

4. Conclusion

Coffee is one of the most widely consumed beverages throughout the world. In this six coffee samples from different origins were analyzed for determination of 17 inorganic elements. Concentration of elements were determined by using inductively coupled plasma optical emission spectroscopy (ICP-OES), sample preparation procedure based on the partial decomposition in aquaregia is simple, safe, reproducible, and reliable for the determination of total concentrations of As, Ba, Ca, Cr, Cu, Fe, K, Mn, Na, Ni, P, Se, Sn, Sr, Zn, and Mg. in addition, the use of aquaregia improves the sample solubilisation, reduces the reagents consumption and the time of analysis.

The results obtained in this study showed there are significant differences between different elemental content of different coffee samples grown in different region, for most of the elements determined especially macro and micro elements coffee beans from Yemen (CY) and Kenya (CK) have higher concentration than other samples, except for the elements like Ba and Sr in which Colombian coffee beans (CC) contain highest amount and K and As in which coffee beans from Guatemala (CG) and Brazil (CB) contain higher amount of these two elements respectively**.** The element content of all coffee samples in present study were lower than dietary reference intake of the elements, thus all coffee samples are safe for daily usage.

Author's Contributions

Sabah H. Al-Jaf: Drafted and wrote the manuscript, performed the experiment and result analysis.

Sinan Saydam: Assisted in analytical analysis on the structure, supervised the experiment's progress, result interpretation and helped in manuscript preparation.

Ethics

There are no ethical issues after the publication of this manuscript.

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