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Mineral and Heavy Metal Contents of Several Coffee Types Species

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Mineral and heavy metal contents of ground tumbleweed seed, date seed powder and Arabic coffee kernels and their hot coffees were determined by inductively coupled plasma atomic emission spectrometry (ICP-AES). Calcium, K, Mn and Na contents of ground coffee samples ranged from 1200.38 to 6752.66 mg/Kg; 17841.6 to 83649.88 mg/Kg; 6158.43 to 2120.29 mg/Kg; 232.74 to 553.64 mg/Kg, respectively. Iron contents of ground coffees vary from 2.83 to 109.03 mg/Kg while Fe content of hot coffees varied from 15.31 to 616.60 mg/Kg. Cadmium, Mn, Mo, Pb and Zn contents of hot coffee drinks were found at the high levels. Important differences were generally detected among mineral contents of ground seeds and hot coffee drinks.

Keywords: Coffee, Date seed, Tumbleweed, Minerals, Heavy metal.

INTRODUCTION

Coffee is the most important food commodity worldwide and ranks second, after crude oil, among all commodities^{1,2}. Economic importance of coffee is mainly due to the coffee brew or beverage, an infusion prepared from the roasted and ground beans. Most coffee beverage consumed around the world is produced by the species coffee arabica. This is considered to be superior due to its sensory properties³. The quality of coffee used for beverages is strictly related to the chemical composition of the roasted beans, which is affected by the composition of the green beans and post-harvesting processing conditions such as drying, storage, roasting and grinding^{4,5}. When considering the nutritional significance of coffee, it is important to distinguish between the minerals extracted from coffee beans and those present in the tap water used in their preparation⁶. Minerals represent about 4 % of dry weight, most of which are soluble in water and therefore present in a cup of coffee. These minerals include calcium, phosphorus, magnesium, sodium, potassium, iron, copper, zinc, selenium and manganese⁷. In addition, there are local beverages gundelia coffee, date seed coffee used instead of normal arabic coffee. Although these beverages should theoretically be good sources of some minerals, there is very little quantitative information on either the amounts of coffee which individuals drink in a day or their contribution the total mineral intakes⁶. The aim of this study was to determine mineral content and heavy metal contents of beverages

obtained from coffee (Arabica), date seed powder coffee and gundelia coffee.

EXPERIMENTAL

Ground kernels of tumbleweed and date seeds used for coffee were roasted at 200 °C for 3 min and then were prepared as coffee for hot drink. Standard arabic coffee was purchased from a local market. Ground instant arabic coffee and substitutional coffees were added to 80 mL of distilled water as 3, 4 and 5 g and then boiled on hot flame for 2 min until foaming. After cooling, each of the hot drinks were filled into clean and colourful bottles and then their orificies were tightly closed and the drinks were stored in a cold condition before analysis. Before the analysis the hot coffee was filtered and then directly analyzed by ICP-AES.

Determination of mineral contents: Collected coffee samples were dried at 70 °C in a drying cabinet with air-circulation until they reached constant weight. Later, about 0.5 g dried and ground samples were digested by using 5 mL of 65 % HNO₃ and 2 mL of 35 % H₂O₂ in a closed microwave system (Cem-MARS Xpress) at 200 °C. The volumes of the digested samples were completed to 20 mL with ultra-deionized water and mineral concentrations were determined by inductively coupled plasma-optical emission spectroscopy (ICP-AES; (Varian-Vista, Australia). Measurement of mineral concentrations was checked using the certified values of the related minerals in the reference samples received from the

National Institute of Standards and Technology (NIST; Gaithersburg, MD, USA). Distilled deionized water and ultrahigh-purity commercial acids were used to prepare all reagents, standards and samples. After digestion treatment, samples were filtrated through Whatman No 42. The filtrates were collected in 50 mL flasks and analyzed by ICP-AES. The mineral contents of the samples were quantified against standard solutions of known concentrations which were analyzed concurrently⁸.

Working conditions of ICP-AES:

Instrument	:	ICP-AES (Varian-Vista)
RF Power	:	0.7-1.5 kw (1.2-1.3 kw for Axial)
Plasma gas flow rate (Ar)	:	10.5-15 L/min. (radial) 15" (axial)
Auxiliary gas flow rate (Ar)	:	1.5"
Viewing height	:	5-12 mm
Copy and reading time	:	1-5 s (max.60 s)
Copy time	:	3 s (max. 100 s)

Statistical analyses: Results of the research were analysed for statistical significance by analysis of variance⁹.

RESULTS AND DISCUSSION

Some mineral and heavy metal contents of ground tumbleweed seed, date seed powder and Arabic kernels and their hot coffees are given in Tables 1 and 2. Important differences were generally detected among mineral contents of ground kernels and hot coffee drinks. A considerable decrease was seen in mineral and heavy metal contents of coffees prepared as hot drink. While cobalt contents of ground coffees varied between 0 ppm to 0.553 ppm, cobalt wasn't detected in any hot coffee drink. Calcium, K, Mg, Mn, Na and P contents of hot coffee drinks were significantly lower than those of

ground coffee samples. Low levels of Cd, Cr, Mn, Ni and Zn contents found in hot coffee drinks is a gladsome position. Cobalt, Pb and Se were not detected in any of hot coffee drinks. Calcium, K, Mn and Na contents of ground coffee samples varied between 1200.38 to 6752.66 mg/Kg; 17841.6 to 83649.88 mg/Kg; 6158.43 to 2120.29 mg/Kg; 232.74 to 553.64 mg/Kg, respectively. It was seen that Fe content increased in the coffee prepared as hot drink. While Fe content of ground coffees varied from 2.83 ppm to 109.03 mg/Kg, Fe content of hot coffees varied between 15.31 ppm to 616.60 mg/Kg. In addition, while Co is not found in all coffee powders, it was determined as 0.553 ppm and 0.507 ppm in date and tumbleweed hot coffees, respectively. This increase may result from the pot and the spoon used in the preparation of hot coffee. Also, Ni contents (361.4 ppm) of hot normal coffee was found at the high level compared with coffee powder (0.06 ppm). In addition, Cd, Mn, Mo, Pb and Zn contents of hot coffee drinks were found at the high levels according to their corresponding powder values. As a result, many heavy metals are not present in hot coffee and some are present in very low levels in hot coffee. High transition rates of macro elements to hot coffee is thought to result from the tonic effect of coffee. Typical coffee contents 32 mg/L Ca, 1.6 P, 61 Mg mg/L, 14 Na, 785 K, 1.8 Fe, 0.44 Mn, 0.005 Cr, 0.20 Cu, 0.09 Zn⁷. Coffee brew contains many of the most important functional ingredients known, like flavonoids *i.e.*, catechins and anthocyanins¹⁰. Coffee is a better source of potassium and magnesium and may contribute significantly to manganese intakes in some instances⁶.

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TABLE-1
MINERAL AND HEAVY METALS OF SEVERAL COFFEE POWDERS (mg/Kg)

Raw powder samples	Mineral and heavy metals									
	Al	Co	Mo	Ca	B	Cd	Cr	Cu	Fe	K
Coffee	0.0 ± 0.0	0.0	0.08±0.01*	153.75±12.7	1.97±0.11	0.016±0.003	0.17±0.03	2.38±0.12	21.60±1.27	2513.80±28.9
Date seed	0.58±0.1	0.0	0.11±0.02	79.19±3.9	1.99±0.07	0.008±0.001	2.39±0.17	1.97±0.11	616.59±17.93	246.47±12.71
Tumbleweed	0.30±0.05	0.0	0.06±0.01	312.79±21.3	1.52±0.09	0.004±0.001	0.08±0.01	1.80±0.09	15.31±3.71	978.56±28.73
Raw powder samples	Mineral and heavy metals									
	Mg	Mn	Na	Ni	P	Pb	S	Se	Zn	
Coffee	359.73±17.23	4.54±0.98	23.28±1.24	0.06±0.01	180.84±4.57	0.0	189.35±5.78	0.0	0.91±0.11	
Date seed	80.31±3.7	3.82±0.56	27.73±0.98	19.35±1.08	39.61±1.98	0.0	106.73±8.71	0.0	2.06±0.98	
Tumbleweed	221.58±11.62	1.03±0.13	25.40±2.13	0.10±0.03	266.64±25.87	0.0	140.22±6.57	0.0	1.11±0.11	

*mean ± standard deviation

TABLE-2
MINERAL AND HEAVY METAL CONTENTS OF HOT COFFEE BEVERAGE (ppm)

Hot coffee samples	Mineral and heavy metals									
	Al	Co	Mo	Ca	B	Cd	Cr	Cu	Fe	K
Arabic coffee	1.68±0.17*	0.0±0.0	0.186±0.009	1200.4±32.7	31.9±1.7	0.112±0.007	0.82±0.05	1.64±0.11	109.0±3.7	17841.6±47.4
Date seed	5.75±0.13	0.553 ±0.011	0.294±0.003	6752.7±43.9	129.6±3.9	0.120±0.011	1.24±0.09	6.16±0.17	2.8±0.8	83649.9±51.9
Tumbleweed	0.0±0.0	0.507±0.021	0.201±0.011	3996.6±28.6	45.9±1.6	0.045±0.009	0.83±0.03	12.80±1.26	10.4±0.79	74848.6±39.4
Hot coffee samples	Mineral and heavy metals									
	Mg	Mn	Na	Ni	P	Pb	S	Se	Zn	
Arabic coffee	2120.3±17.6	22.6±1.3	553.6±11.3	361.4±3.6	2959.5±11.5	0.262±0.011	2330.4±12.7	1.75±0.17	17.5±0.12	
Date seed	7654.6±24.9	47.1±2.7	607.7±9.7	2.6±0.3	38271.3±28.3	0.184±0.021	10229.0±32.9	0.79±0.09	10.69±0.09	
Tumbleweed	6158.4±28.4	128.2±1.8	232.7±3.9	0.70±0.06	10239.1±32.6	0.0±0.0	2791.8±24.8	1.21±0.32	15.09±0.54	

*mean ± standard deviation

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