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ENVIRONMENTAL STUDIES: LEVELS OF METAL CONTENTS IN DRINKING WATER AND IN TEA LEAVES COMMERCIALLY AVAILABLE IN EGYPT AND THEIR INFUSIONS

Akmal S. Gaballa*[*,1], N. Shehata[1], A. A. El-Maadawy[1] and A.A Hamouda[2]
[1]*Faculty of Specific Education, Zagazig University, Zagazig, Egypt*
[2]*Hydrogeo-chemistry Department, Desert Research Center, Egypt*

ABSTRACT:

Na, K, Ca, Mg, Mn, Fe, Zn, Cu, Co, Cd, Pb, Ba, Al, B, Cr, Mo, Ni, Sr, V, As, Hg, Se and Sb contents of the used drinking water and commercially available Egyptian tea leaves (Al-Arosa, Lipton, Dilma Black Teas and Dr Life green Tea) and their infusions were analyzed by Inductively coupled plasma spectrometry (ICPS), Flame photometer, and UV/Visible spectrophotometer. The used drinking water was characterized by its low content of metal ions and some metal ions (As, Hg, Se and Sb) were low to be detected. The metal contents of tea leaves were found to be higher than those of tea infusions. In both black tea leaves and their infusions levels of metals (Fe, Co, Cd, B, Cr, Mo, V and Pb) were too low assuring that the commercially available Egyptian tea possess no health risk from toxic elements. The concentrations of metals in the four tea brands were found in the following order; K > Mg > Mn > Zn> Ba > Al > Ni.

Conclusively, from these results it could be concluded that drinking tap water and tea brands infusions under investigation are safe for public health and provide an acceptable quantity of mineral and trace elements per day.

Key Words: Drinking water, Black tea, Green tea, Tea infusion, Heavy metals, Inductively Coupled Plasma Spectrophotometer (ICPS).

INTRODUCTION:

A glass of safe and pure drinking water equals life. However, drinking water can contain gases, minerals, bacteria, metals and/or chemicals that can affect your health and the quality of water. Part of these contaminants occurs naturally such as heavy metals may be caused by human activity, from pesticides and fertilizers. Many drinking water standards do not guarantee that the glass of tap water will be absolutely safe and pure. There are no guarantees that it is totally risk-free, for several reasons: 1) The process used to set drinking water standards is imperfect and rarely based on conclusive studies conducted on

[*] Corresponding author, E-mail: akmalsg@yahoo.com; akmalsg@zu.edu.eg Tel.: 002 0100 3627093

humans. 2) Very little research is available on the health effects of drinking small amounts of chemicals over long periods. 3) Regulatory decisions are often complicated by economic, political and social considerations. 4) The standards also consider the possible presence of other chemicals, which may increase or decrease the toxicity of the contaminant (Dozier *et al*., 1997& 1999).

Safe drinking water supplies are critical for protecting public health. Drinking water treatment and monitoring technologies are used by public water utilities to assure compliance with existing drinking water standards. The World Health Organization (WHO) set up some guidelines for drinking-water quality which are the international reference point for standards setting and drinking-water safety (Postawa, 2012& WHO's 1993 and 2006).

Most of Egyptian peoples drink tea infusion in large amounts exceeded than one and half liter (5-10 glasses/day) in some cases. There are many categories of tea which are distinguished by different processing methods and, consequently, different concentrations of the chemical components in tea. The main types of consumed tea are black and green tea. The black tea is a completely fermented (oxidized) tea leaves. The chemical components in black tea have a number of health benefits (Das *et al.*, 2005; Wheeler *et al.*, 2004 and Katiyar *et al.*, 1997). Drinking black tea has many medical benefits such as decreasing heart attacks, inhibiting the growth of cancer because it contains chemicals that reduce and inhibit the risk of cancer of the stomach, colon, and breast, calming inflammation, disrupting the work of viruses, and neutralizing bacteria, which causes diarrhea, pneumonia, skin infections, and bladder infections. Also drinking green tea reduces the risk of cancer, heart disease, blood pressure, prevents tooth decay and virus infection. In addition to the organic components, different minerals and trace metals are present in black tea leaves and their infusions (Moreda-Pineiro *et al.*, 2003).

Many trace elements are essential for the health and their deficiency or excess may cause disease and be harmful to health (O'Dell *et al.*, 1997). In addition to their nutritional value trace elements have also been associated with the flavoring characteristics of tea (Lamble *et al.*,1995). Heavy metals in the body have a lot of side effects on human health. Barium (Ba) increase blood pressure. Cadmium (Cd) and Mercury (Hg) case kidney damage. Chromium (Cr) cases Allergic dermatitis. Copper (Cu) cases Gastrointestinal in Short term exposure. Lead (Pb) has slight deficits in attention span and learning abilities. Selenium cases Hair or fingernail loss, numbness in fingers or toes or circulatory problems. The accurate determination of the trace element content of tea infusion is very important in assessing any possible implications for health. There is a variation in the mineral composition due to different origins of the plant (Kumar *et al.*, 2005). The metal content of the tea is influenced by the soil composition and local environmental factors (Moreda-Pineiro *et al.*, 2003). The quality of tea brands available in many countries was assessed based on contents of heavy metals (AL-Oud, 2003; Gebretsadik *et al.*, 2010 and Egyptian. Standards, 2005). Tea infusions are tea beverages prepared by soaking tea leaves in boiled water. Generally, mineral contents of tea leaves are higher than those of tea infusions. Type of tea, temperature of soaking water and soaking time has an effect on the concentration of the extracted ions into the tea infusion.

There are health problems due to chemical contaminates of drinking water and tea infusions. Understanding the relation between these chemical contents in drinking water, tea infusion and diseases is very important. The target of this study is the determination of levels of more than 19 metal as metal ions in three different resources of Egyptian tap drinking water and in commercially available Egyptian black and green tea using ICP Spectrophotometer (Cd, Co, Fe, Mn, Pb, Ni, Cr, Cu, Sr, V, Zn, Al, Mo), Flam photometer (Na^+, K^+), titrimetrically (Ca^{2+}, Mg^{2+}) and UV/Visible spectrophotometer (B), and correlate the amount of metals in the used drinking water, black and green tea with that extracted into tea infusion.

To take an overview or feedback on the metal content levels of drinking water and tea infusions, the dietary aspect and implied health impact on water and tea beverage consumers.

Therefore, the aim of this study was the determination of levels of metal contents to different samples of tap drinking water, some tea leaves and their infusions consumed widely in Egypt using modern techniques such as ICPS and other suitable analytical methods.

MATERIALS AND METHODS:

Samples and Reagents

Three different types of black tea samples commonly used in Egypt (Lipton, Arosa, and Black Dilmah) were collected from local markets. The fourth type was the green tea (Dr Life).

Lipton tea is packing by Unilever Mashreq-Tea Co, Egypt (New Borg El-Arab City, first industrial zone, Plot 5, Block 11/1, Alexandria).

Arosa tea is a dust black Kenyan tea imported and packed by El-Fath Co for food industries, A.R.E. (El-Ebor City, first industrial zone, part 7-8-block 13018).

Dilmah black tea is a Ceylon tea produced by MJF Group (111NegomboRoad, Peliyagoda, Sri Lanka). Dilmah tea packed in Seri Lanka and imported by Shaheen Co for trade, 3-El-Kamal St, Helmeat-Elzayton, Cairo, Egypt).

Dr Life Green tea is produced in Egypt by Family Farmacia Co (38, Sharkia Ind. Zone, Belbis-10^{th} of Ramadan road).

These samples of black tea and green tea were selected for the study because (i) they are widely consumed and most available in the local market of Egypt and (ii) the tea brands represent different tea plantations found at different locations.

Sampling and the methods of analysis which are used to collect and determine the chemical characteristics of water are presented. The method of analysis can be grouped as gravimetric, volumetric, physicochemical and instrumental. After the water samples have been collected from the water points (Bi-distilled water, Five stage Filtered water, Cairo City Tap water: Third Assembly, Zagazig City Tap water: El-Sayadeen), they preserved in a proper way.

Sample preparation:

Concentrated HNO_3 (Merck) and $HClO_4$ (Aldrich) acids were used for the digestion of both the black and green tea samples.

For each of the tea brands, four packages of 2.0 g each were mixed thoroughly and grinded to fineness using an electronic blender. Three samples of 2.0 g from each of the four tea brands were then used for the determination of the total metal content in the tea leaves in a net volume 200 mL solution.

Even though there are different ways of preparing tea infusion around the world, for this study we used the common practice for serving tea beverage in Egypt which is direct boiling of the black or green tea leaves in boiling water. The black and green tea infusion was prepared as follows: 200 mL of each distilled and deionized water, Five stage Filtered water, Cairo City Tap water: Third Assembly, and Zagazig City Tap water: El-Sayadeen were boiled in a 1000 mL Pyrex glass conical flask on a hot plate and 2.0 g of black or green tea brands were added in to the defined boiling water and allowed to boil for 5 min, then cooled and filtered to obtain the pure black tea infusion. Each type of used water was added to make it 200 mL. All samples of black and green tea infusions were prepared for the determination of their total metal content.

The total metal content of the different kinds of used water were determined before using for tea sample preparations.

Distilled and deionized water was used throughout the experiment for rinsing of the glassware and dilution of sample solution.

Equipment and instrumentation

Round bottom flasks fitted with reflux condenser were used in Kjeldahl digestion block for the digestion of both the black and green tea samples.

The heavy metals which include cadmium (Cd), cobalt (Co), iron (Fe), manganese (Mn), lead (Pb), nickel (Ni), chromium (Cr), copper (Cu), strontium (Sr), vanadium (V), zinc (Zn), aluminium (Al), and molybdenum (Mo) are detected by ICP Spectrophotometer Thermo Jarrel Ash model POEMS 3, using 1000 ppm (Merck) stock solution for standard preparations.

Sodium (Na^+), potassium (K^+) are measured by Flam photometer, Jenway Model pep 7 (UK). Calcium (Ca^{2+}), magnesium (Mg^{2+}) and barium (Ba^{2+}) ions are determined titrimetrically. Boron (B) is measured by UV/Visible spectrophotometer, Unicam model UV4-200 (UK). Total concentration of these ions are measured as milligrams per liter (ppm).

Digestion of tea leaves and infusion samples:

To prepare a clear colorless sample solution for the different four black and green tea that is suitable for the analysis using ICPS and other instruments, a digestion procedures were assessed using the HNO_3 and $HClO_4$ acids. The choice of the optimized digestion procedure was made by observing clarity and colorlessness of the final solution. In addition, the digestion procedure should use the smallest volume of the reagents to avoid the risk of contamination and cost decrease (Griepink *et al.*, 1989 & Matsuura *et al.*, 2001). Among the different digestion procedures, digestion of 2.0 g black and green tea leaves with 25 mL of 5:1 mixture of concentrated HNO_3 and concentrated $HClO_4$ heated around 300 °C for three hours gave a clear colorless solution and this procedure was chosen for the digestion of black and green tea leaves throughout this study.

Exactly 2.0 g of black and green tea leaf samples was transferred quantitatively into a 200 mL round bottom digestion flask. Exactly 25 mL of freshly prepared 5:1 mixture of concentrated HNO_3 and concentrated $HClO_4$ was added to the sample. The sample was swirled gently, fitted to a reflux condenser and digested continuously for three hours at a temperature around 300 °C on a Kjeldahl digestion block. The digest was quantitatively transferred to a 200 mL volumetric flask and made up to the mark with distilled-deionized water. Digestion was made in triplicate and hence a total of twelve digests were made for the four brands. Digestion of a reagent blank was performed in parallel with the tea leaves samples keeping all digestion parameters the same. In a similar way, tea infusion samples were digested according to the known method (Gebretsadik *et al.*, 2010; Matsuura *et al.*, 2001 & Ozdemir *et al.* 1998).

All the digested leaf samples (4 samples), tea infusion samples (12 samples) and other different free water samples were stored in refrigerator until analysis. For each sample, the results were obtained from the mean sum of three replicates.

Calibration procedure, determination of metals and detection limits:

Calibration curves were prepared to determine the concentration of the metals in the sample solution. Calibration metals were made from diluted solutions prepared from stock standard solutions. The correlation coefficients of the calibration curve for the entire analytes were higher than 0.999 which assured a linearity of responses for individual analytes. Determination of the metals in drinking water, tea leaves and after infusion samples was made by ICPS, Flam photometer, titrimetrically and UV/Visible spectrophotometer. For each of the measured sample, three repeat measurements were performed. Detection limit was calculated based on calculation of the standard deviation of six replicate measurements of blank solutions. A detection limit three times the calculated standard deviation of the blank solutions was used for this study

(Ismail, 2000; Sharma *et al*., 2005; Natesan *et al*., 1990; Kumar *et al*., 2005; Stagg *et al*., 1975; Peterson *et al*., 2004 and Wrobel *et al*., 2000).

RESULTS AND DISCUSSION

Levels of metals in drinking water

According to American Society for Testing and Materials (ASTM), Tap and mineral drinking water is characterized by its low contents of mineral salts and other trace elements as well as other different constitutions. The concentration of Sb is lower than 0.005 ppm, As is lower than 0.01 ppm. The inorganic metal ions contents (Na, Al, Mg, Ca, Zn, Cu, Mn, Fe) have an effect its taste and house use. Other inorganic elements such as cations of (Cr, Hg, Se, Cd, As, Pb, Ba, F, Sb, B, Ni, Mo) and some organic compounds have a bad effects on the human health, Table 1.

Table 1. Metal contents (ppm) of the used four drinking water samples compared with standards

Metal	Samples				Standards		
	Bi-distilled & deionized water	Five stage Filtered water	Cairo City Tap water (Third Assembly)	Zagazig City Tap water (El-Sayadeen)	Egypt. Standards of Tap drinking water (rule 458/2007)	WHO	EC
Na	-	37	36	200	200.0	200	150-175
K	-	4	4	2	-		
Ca	-	38.745	36.82	16.26	350.0		
Mg	-	14.85	14.20	6.087	150.0		
Mn	-	<0.004	0.011	0.385	0.4	0.1	0.05
Fe	-	<0.01	<0.01	<0.01	0.3	0.3	0.3
Zn	-	<0.0009	0.014	<0.0009	3.0	5.0	3.0
Cu	-	<0.007	<0.007	0.0286	2.0	1.0	1.0
Co	-	<0.001	<0.001	<0.001	-	-	-
Cd	-	0.0007	0.0007	0.0007	0.003	0.005	0.005
Pb	-	0.1418	<0.006	0.0909	0.01	0.05	0.05
Ba	-	0.0360	0.0343	0.0276	0.70		
Al	-	<0.04	0.0853	<0.04	0.2	0.2	0.2
B	-	<0.02	<0.02	<0.02	0.50	-	1.0
Cr	-	<0.02	<0.02	<0.02	0.05	0.05	0.005
Mo	-	0.0294	0.0036	0.0097	0.07		
Ni	-	<0.001	<0.001	<0.001	0.02	-	0.05
Sr	-	0.4032	0.4031	0.2395	-		
V	-	<0.01	<0.01	<0.01	-		
As	-	-	-	-	0.01	0.05	0.05
Hg	-	-	-	-	0.001	0.001	0.001
Se	-	-	-	-	0.01	0.01	0.01
Sb	-	-	-	-	0.02		
Total dissolved metal ions		95.340	91.647	225.260	707.264	206.766	155.721-180.721

WHO: World Health Organization.
EC: European Community.

Sodium ion content in the three case studied are varied in comparison with the normal range of standards. Five stage filtered water and Third Assembly are of low range (36-37 ppm) in comparison with the Egyptian standards of tap drinking water (200 ppm). Also, calcium, magnesium and manganese ions contents are of low content in comparison with the Egyptian standards of tap drinking water, Table 1.

Fe, Zn, Cu, Co and Cd ions are below the normal ranges of Egyptian standards of tap drinking water which means the good taste and house using without problems.

Lead content was found to be below the normal range in Third Assembly City but were found to be high in the water of five stage filtered water and El-Sayadeen City in comparison with Egyptian standards of tap drinking water (0.01 ppm).

Al, B, Cr, Mo, Ni and Ba ion concentrations were found in lower range in comparison with different standards of drinking water. As, Hg, Se and Sb ions were not detected in the three water samples under investigation.

***Levels of metals in black and green tea leaves*:**

In a similar way, the levels of metals in some commercial black and green tea leaves in Egypt were quantified by ICP and other experimental techniques either in crude samples. The concentrations of the metals in each type of the commercially available Egyptian black and green tea leaves are given in Table 2.

Table 2. Metal contents (ppm) of crude digested tea leaves samples used in Egypt in deionized water used in this study

Metal	Lipton black tea	Arosa black tea	Dilmah black tea	Dr. Life green tea	Egypt. standards of tea leaves
Na	160	110	150	145	
K	210	400	330	150	
Ca	42.66	32.11	7.498	15.00	
Mg	20.02	28.18	19.99	20.00	
Mn	12.05	16.08	3.712	4.00	
Fe	2.992	4.188	1.896	2.20	150.0
Zn	0.3831	0.4749	0.2713	0.150	
Cu	0.1373	0.1746	0.2221	0.190	50.0
Co	<0.001	0.0027	<0.001	<0.001	
Cd	<0.0007	0.0009	<0.0007	0.0007	
Pb	<0.006	0.1256	<0.006	<0.006	4.0
Ba	0.1865	0.5812	0.1379	0.1450	
Al	8.298	16.22	12.08	11.08	
B	0.6527	1.922	1.40	1.50	
Cr	0.085	0.0828	<0.02	<0.02	
Mo	0.0087	<0.002	0.0069	0.007	
Ni	0.077	0.072	0.0461	0.051	1.0
Sr	0.3579	0.0918	0.0728	0.0828	
V	<0.01	<0.01	<0.01	<0.01	
Total metal ions	457.93977	610.2465	527.3708	349.4435	206.0

The levels of metals in the black and green tea leaves varied widely because it depends on the origin, soil contents with minerals and process of manufacture and packing. Na, K, Ca, and Mg were found in good amounts. Co, Cd, Pb, Cr, Mo, Ni and V were found in low amounts and safe percent. Some elements like Ba, Al, B, Cr and Sr were found slightly high amounts but in the average range indicating that Egyptian tea leaves under investigations contain the essential elements in appreciable amounts and possess no health risk from toxic elements.

The results of the present study are consistent with the results reported by different authors, particularly, the increasing trend of the metals concentrations. The order is K > Na > Ca > Mg > Mn > Al > Fe > B > Zn > Cu > Ba and with concentrations of Co, Cd, Pb > Mo and V being low detected by the defined method. The concentration of the toxic heavy metals are expected to be very low in Egyptian tea since these metals are usually related to environmental pollution caused by different industrial activities. The amount of heavy metals in tea leaves has been used as an indication for contamination of the environment by heavy metal particles (Sharma *et al.*, 2005).

Levels of metals in tea infusion samples:

The present study showed that the tea beverage contains K, Ca, Mg and Mn in appreciable amount. It was also found that the essential heavy metals were extracted from tea leaves to tea infusion. The amounts of the metals extracted widely differ. K was the highest of all metals in the four black tea brands. The concentrations of metals in the Egyptian tea infusion are given in Tables 3-5.

Since different research reports employed different approaches to prepare tea infusion samples, indirect comparison of the present study may be practical. Different papers have been published on metal contents of tea infusions. The results obtained in the present study are in agreement with papers published on this subject (Moreda-Pineiro *et al*., 2003; Lamble *et al*., 1995; AL-Oud, 2003; Gebretsadik *et al*., 2010; Gillies *et al*., 1983; Powell *et al*., 1998; Han *et al*., 2006; Ozdemir *et al*., 1998; Griepink *et al*.; 1989; Natesan *et al*., 1990; Dang. 2005; Nas *et al*., 1993; Tautkus *et al*., 2004; Mokgalaka *et al*., 2004; Wang *et al*., 2005; Pohl *et al*., 2007 and Tayfur *et al*., 2013). The comparison of concentrations of metals in the Egyptian tea infusions obtained in the present study to that reported in the literature is given in Tables 3-5.

The percentage of extracted metals from tea leaves to tea infusion in different kinds of boiled drinking was found to vary widely. For instance, the largest amount of extraction was found for K > Mg > Mn > Zn. The other three metals were also extracted to significant degrees; Cu > Ba > Ni.

Table 3. Level of extracted metals (ppm) from popular commercial tea leaves into boiled Five Stage Filtered water

Metal	Five stage filtered water	Lipton black tea	Arosa black tea	Dilmah black tea	Dr. Life green tea
Na	37	40	40	40	40
K	4	120	120	110	47
Ca	38.745	10.51	14.46	17.71	35.45
Mg	14.85	24.98	25.07	23.11	19.37
Mn	<0.004	4.405	4.898	1.076	1.421
Fe	<0.01	<0.01	<0.01	<0.01	<0.01
Zn	<0.0009	0.2804	0.2535	0.2555	0.1489
Cu	<0.007	0.0261	0.0406	0.0275	0.019
Co	<0.001	<0.001	<0.001	<0.001	<0.001
Cd	0.0007	<0.007	<0.0007	<0.0007	<0.0007
Pb	0.1418	<0.006	<0.006	0.0115	<0.006
Ba	0.0360	0.0521	0.0741	0.0466	0.0433
Al	<0.04	2.719	3.836	3.706	2.095
B	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	<0.02	<0.02	<0.02	<0.02	<0.02
Mo	0.0294	<0.002	0.0052	<0.002	<0.002
Ni	<0.001	0.0385	0.0382	0.224	0.0178
Sr	0.4032	0.2505	0.2844	0.325	0.3902
V	<0.01	<0.01	<0.01	<0.01	<0.01
Total metal ions	95.340	203.3556	209.0277	196.5558	146.0249

Table 4. Levels of extracted metals (ppm) from popular commercial tea leaves into boiled Cairo City Tap water (Third Assembly)

Metal	Cairo City Tap water (Third Assembly)	Lipton black tea	Arosa black tea	Dilmah black tea	Dr. life green tea
Na	36	40	40	40	40
K	4	100	100	100	57
Ca	36.82	15.13	23.46	21.79	32.29
Mg	14.20	22.02	26.04	24.53	18.12
Mn	0.011	3.195	3.898	0.9559	1.506
Fe	<0.01	<0.01	<0.01	<0.01	<0.01
Zn	0.014	0.1396	0.199	0.1526	0.1427
Cu	<0.007	0.0331	0.0339	0.0319	0.023
Co	<0.001	<0.001	<0.001	<0.001	<0.001
Cd	0.0007	<0.0007	<0.0007	<0.0007	<0.0007
Pb	<0.006	<0.006	0.0174	<0.006	0.0049
Ba	0.0343	0.0472	0.0642	0.0403	0.0454
Al	0.0853	2.321	3.977	4.266	2.285
B	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	<0.02	<0.02	<0.02	<0.02	<0.02
Mo	0.0036	0.0036	0.0044	<0.002	<0.002
Ni	<0.001	0.0304	0.0418	0.0206	0.0161
Sr	0.4031	0.2993	0.4018	0.3674	0.395
V	<0.01	<0.01	<0.01	<0.01	0.0286
Total metal ions	91.647	183.2869	197.833758	192.2244	151.9104

Table 5. Levels of extracted metals (ppm) from popular commercial tea leaves into boiled Zagazig City Tap water (El-Sayadeen)

Metal	Zagazig City Tap water (El-Sayadeen)	Lipton black tea	Arosa black tea	Dilmah black tea	Dr. Life green tea
Na	200	190	180	190	200
K	2	110	120	90	57
Ca	16.26	6.412	7.695	9.684	17.84
Mg	6.087	16.65	16.98	14.53	10.78
Mn	0.385	3.95	4.186	0.8597	1.563
Fe	<0.01	<0.01	<0.01	<0.01	<0.01
Zn	<0.0009	0.3639	0.4206	0.3348	0.297
Cu	0.0286	0.0427	0.047	0.0455	0.031
Co	<0.001	<0.001	<0.001	<0.002	0.0021
Cd	0.0007	<0.0007	<0.0007	<0.0007	<0.0007
Pb	0.0909	0.0178	0.0155	0.0123	0.0219
Ba	0.0276	0.0400	0.0436	0.0303	0.0445
Al	<0.04	2.519	3.427	3.143	1.989
B	<0.02	<0.02	<0.02	<0.02	<0.02
Cr	<0.02	<0.02	<0.02	<0.02	<0.02
Mo	0.0097	<0.002	0.0038	<0.002	<0.002
Ni	<0.001	0.038	0.0453	0.0215	0.0199
Sr	0.2395	0.1549	0.1610	0.1933	0.2469
V	<0.01	<0.01	<0.01	0.0228	<0.01
Total metal ions	225.26	330.352	333.1865	309.0319	288.436563

Tables 3-5 present the amounts of individually extracted metals from the tea leaves of the four brands into tea infusion. In comparison with the metal content in tea leaves (Table 1), the amount of Ca, Pb and Sr in tea infusion was found to be decreased. There is no remarkable evidence for extraction of Fe, Co, Cd, B, Cr, Mo, and V from tea leaves to tea infusions in the three types of used drinking water, Tables 3-5. The extracted Na from tea leaves into boiled Zagazig City Tap water (El-Sayadeen) was increased however; the extraction of Na into boiled Cairo City Tap water (Third Assembly) and boiled Five Stage Filtered water was not changed. There is a remarkable decrease of calcium ion contents in many samples under investigation. The significant variation in the metal contents of the commercially available Egyptian tea leaves as well as their infusions might arise from the specific environmental conditions in which the tea plant was cultivated (Moreda-Pineiro *et al.*, 2003), packing and other environmental conditions.

Generally, the levels of metal contents in three resources of drinking water in Egypt, commercially four brands of Egyptian tea leaves and in their infusions were determined by ICP Spectrophotometer, Flam photometer, and UV/Visible spectrophotometer. The metal contents of drinking water, tea leaves were found to be higher than those of tea infusions. In both black tea leaves and their infusions levels of metals (Fe, Co, Cd, B, Cr, Mo, V and Pb) were too low assuring that the commercially available Egyptian tea possess no health risk from toxic elements. The concentrations of metals in the four tea brands were found in the following order; K > Mg > Mn > Zn> Ba > Al > Ni.

This study confirms that the commercially available Egyptian teas could be a source of dietary minerals and trace metals. The extraction efficiency of the metals into tea infusion varied widely indicating that these metals exist in tea leaves in different forms. It is hard to imagine that, the metal contents of drinking water could play a role on the major intake of metals from tea leaves. The source of water and methods of treatments must be understood to protect the public health and provide an acceptable quality drinking water and tea quantities per day.

Standards are needed to judge the quality of drinking water and should be applied to all water systems and tea infusions.

Conclusively, from these results it could be concluded that drinking tap water and tea brands infusions under investigation are safe for public health and provide an acceptable quantity of mineral and trace elements per day.

REFERENCES

Adam Postawa, Editor(s) (2012): *Best Practice Guide on Sampling and Monitoring of Metals in Drinking Water*. Publication Date: 15 Jan 2012 •ISBN: 9781843393832, Pages:156.; http:// health. usgs. Gov /dw _contaminants /.; Metals and Related Substances in Drinking Water comprises the Proceedings of COST Action 637–METEAU, held in Kristianstad, Sweden, October 13-15, (2010).

AL-Oud, S.S. (2003): Heavy Metal Contents in Tea and Herb leaves. *Pak. J. Biol. Sci.* 6, 208-2012.

Dang, M.V. (2005): Soil-Plant Nutrient Balance of Tea Crops in the Northern Mountainous Region, Vietnam *Agric. Ecosystems Environ.*, 105: 413-418.

Das, D.; Mukherjee, S.; Mukherjee, M.; Das, A. S. and Mitra, C. (2005): Aqueous extract of black tea (Camellia sinensis) prevents chronic ethanol toxicity. *Curr. Sci.*, 88: 952-961.

Dozier, M.C. and McFarland, M. (2005): *Drinking Water Standards*. Texas Cooperative Extension, The Texas A&M University System., http://tcebookstore.org, http://soilcrop.tamu.edu.; Egypt. Standards_ ES: 559-1/2005, 140-10

EPA Drinking Water and Health What You Need to Know (1999). EPA 816-K-99-001, October 1999, *United States Environmental Protection Agency*, Office of Water, Washington, D.C.; Water On Tap: A Consumer's Guide to the Nation's Drinking Water (1997), EPA-815-K-97-002, July 1997, Environmental Protection Agency, Office of Water, Washington, D.C., United States.

Gebretsadik, D.W. and Chandravanshi, B.S. (2010): Levels of metals in commercially available Ethiopian black teas and their infusions. *Bull. Chem. Soc. Ethiop.,* 24(3): 339-349.

Gillies, M.E. and Brikbeck, J.A. (1983): Tea and Coffee as sources of some minerals in the New Zealand diet. *Am. J. Clin. Nutr.*, 38: 936-942.

Griepink, B. and Tolg, G. (1989): Sample digestion for the determination of elemental traces in matrices of environmental concern. *Pure Appl. Chem.*, 61: 1139-1146.

Han, W.-Y.; Zhao, F.-J.; Shi, Y.-Z.; Ma, L.-F. and Ruan, J.-Y. (2006): Scale and causes of lead contamination in Chinese tea. *B. Environ. Pollut.*, 139: 125.

Ismail, M.; Manickam, E.; Danial, A.M.; Rahmat, A. and Yahaya A. (2000): Chemical composition and antioxidant activity of Strobilanthes crispus leaf extract. *J. Nutr. Biochem.*, 11: 536-542.

Katiyar, S.K. and Mukhtar, H. (1997): Tea antioxidants in cancer chemoprevention. *J. Cellular Biochem. Suppl.*, 27: 59-67.

Kumar, A.; Nair, A.G.C.; Reddy, A.V.R. and Garg, A.N. (2005): Availability of essential elements in Indian and US tea brands. *Food Chem.*, 89: 441-448.

Lamble, K. and Hill, S.J. (1995): Determination of trace metals in tea using both microwave digestion at atmospheric pressure and inductively coupled plasma atomic emission spectrometry. *Analyst*, 120: 413-417.

Matsuura, H.; Hokura, A.; Katsuki, F.; Itoh, A. and Haraguchi, H. (2001): Multielement determination and speciation of major -to-trace elements in black tea leaves by ICP-AES and ICP-MS with the aid of size exclusion chromatography. *Anal. Sci.*,17: 391-398.

Mokgalaka, N.S.; McCrindle, R.I. and Botha, B.M. (2004): Multielement analysis of tea leaves by inductively coupled plasma optical emission spectrometry using slurry nebulisation. *J. Anal. At. Spectrom.*, 19: 1375-1378.

Moreda-Pineiro, A.; Fisher, A. and Hill, S.J. (2003): The classification of tea according to region of origin using pattern recognition techniques and trace metal data. *J. Food Comp. Anal.*, 16: 195-2011.

Nas, S.; Gokalp, H.Y. and Sahin, Y. (1993): K and Ca content of fresh green tea, black tea, and tea residue determined by X-ray fluorescence analysis. *Z. Lebensm. Unters. Forsch.*, 196: 32-7.

Natesan, S. and Ranganathan, V. (1990): Content of various elements in different parts of the tea plant and in infusions of black tea from southern India. *J. Sci. Food Agric.*, 51: 125-139.

O'Dell, B.L. and Sunde, R. A. (1997): *Handbook of Nutritionally Essential Mineral Elements,* Marcel Dekker: New York, USA.

Ozdemir, Y.; Gucer, S. (1998): Speciation of manganese in tea leaves and tea infusions. *Food Chem.,* 61: 313.

Peterson, J.; Dwyer. J; Jacques, P.; Rand, W.; Prior, R. and Chui, K. (2004): Tea variety and brewing techniques influence flavanoid content of black tea. *J. Food Compos. Anal*., 17(3-4): 397-405.

Pohl, P.; Prusisz, B. (2007): Fractionation analysis of manganese and zinc in tea infusions by two-column solid phase extraction and flame atomic spectroscopy. *Food Chem.*, 102: 1415-24.

Powell, J.J.; Burden, T.J. and Thompson, R.P.H. (1998): In vitro mineral availability from digested tea: a rich dietary source of managanese. *Analyst*, 123: 1721-4.

Sharma, V.; Gulati, A. and Ravindranath, S. D. (2005): Extractability of tea catechins as a function of manufacture procedure and temperature of infusion. *Food Chem*., 93: 141-148.

Stagg, G.V. and Millin, D.J. (1975): The nutritional and therapeutic value of tea. *J. Sci. Food Agri*c., 26: 1439-1459.

Tautkus, R.; Kazlauskas, R. and Kareiva, A. (2004): Determination of copper in tea leaves by flame atomic absorption spectrometry. *Chemija,* 15: 49-52.

Tayfur, M.; Karaagaoglu, N.; Basoglu, S. and Mercanlıgil, S.M. (2013): Influence of brewing pots on mineral content of black tea infusions. *Turk. J. Biochem*., 38 (1): 57–62.

Wang, X.P.; Ma, Y.J. and Itoh, M. (2005): Analysis of 23 mineral elements in tea samples collected from China and Japan by using ICP-AES and ICP-MS combined with a closed decomposition. *Guang Pu Xue Yu Guang Pu Fen Xi* , 25: 1703-7.

Wheeler, D.S. and Wheeler, W.J. (2004): The medicinal chemistry of tea. *Drug Develop. Res*., 61(2): 45-65.

WHO's Guidelines for Drinking-water Quality, set up in Geneva, (1993), Are The International Reference Point For Standard Setting And Drinking-Water Safety. (*http://www.lenntech.com/applications/drinking/standards/who-s-drinking-water-standards.htm* #ixzz2WToQjOQy). WHO Guidelines for Drinking-Water Quality (2006), WHO/EU Drinking Water Standards Comparative Table.

Wrobel K, Wrobel K & Urbina EMC. 2000: Determination of total aluminum, chromium, copper, iron, manganese, and nickel and their fractions leached to the infusions of black tea, green tea, *Hibiscus sabdariffa*, and Ilex paraguariensis (mate) by ETA-AAS. *Biol. Trace Elem. Res.,* 78(1-3):271-280.

دراسات بيئية : تقدير مستوى العناصر فى مياه الشرب لبعض الأحياء المصرية و ورق بعض انواع الشاى شائعة الإستخدام فى مصر و مستخلصاته بإستخدام تقنيات حديثة

أكمل جاب الله[1,*] - ناهد شحاته[1] - أهداب المعداوى[1] - عادل حمودة[2]
كلية التربية النوعية –جامعة الزقازيق- الزقازيق – مصر
قسم الهيدروجيوكيمياء- مركز بحوث الصحراء- مصر

الملخص :

أهتم هذا البحث بتقدير العناصر التالية Na, K, Ca, Mg, Mn, Fe, Zn, Cu, Co, Cd, Pb, Ba, Al, B, Cr, Mo, Ni, Sr, V, As, Hg, Se , Sb ذات التأثيرات الفيزيائية و الصحية المختلفة فى مياه الشرب لأماكن مختلفة بمصر وماء فلتر متعدد المراحل ، أوراق بعض أنواع من الشاى شائعة الإستخدام فى مصر (العروسه Al- Arosa ، ليبتون Lipton ، دلما Dilma ، Black Tea ، د. لايف الأخضر Dr Life green) و مستخلصاتها . تم استخدام تقنيات حديثة لأول مرة فى تقدير بعض العناصر وهو جهاز Inductively coupled plasma spectrometry (ICPS) و أستكمل تقدير باقى العناصر الأخرى بإستخدام جهاز Flame photometer و جهاز UV/Visible spectrophotometer . أوضحت نتائج التحليل ان مياه الشرب التى تم تحليل محتواها من العناصر تميزت بإحتوائها على نسب منخفضة من عناصر As, Hg, Se, Sb و بالتالى آمنة على الصحة العامه .

وجد ايضا أن نسب العناصر فى أوراق الشاى أعلى من مثيلاتها فى المستخلصات الساخنة . العناصر التالية (Fe, Co, Cd, B, Cr, Mo, V, Pb) . توجد بنسب منخفضة جدا فى أوراق الشاى و مستخلصاته و بالتالى أكدت ان هذه الأنواع آمنه تماما على الصحة العامه من العناصر السامه. تركيز العناصر فى الأنواع الأربعة من الشاى وجد كما يلى: K > Mg > Mn > Zn> Ba > Al > Ni.

* Corresponding author, E-mail: akmalsg@yahoo.com; akmalsg@zu.edu.eg Tel.: 002 0100 3627093