INFLUENCE OF HOME PREPARATION METHODS OF BLACK TEA BEVERAGE ON THE MINERALS CONTENT

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Abstract

Tea as a non-alcoholic beverage, is the most popular beverage in Egypt. It contains several essential nutrients, which are beneficial for human health. This study aimed to determine chemical composition and mineral, (Zinc, Iron, Copper, Lead, Aluminum, manganese, and Cadmium, Sodium and Potassium) content before and after home preparation for three types of black tea (Indian, Malawian and Kenyan). Tea drinks were prepared using three traditional methods of different black tea as following (T1) black tea added to cold distilled water, then heated to boil for 2 minutes, (T2) black tea added to hot distilled water and then boiling continued for 2 minutes and (T3) black tea added to boiled distilled water and stand for infusion for 2 minutes. All prepared samples of tea drink were cooled at room temperature and consequently subjected to analysis. Among the metals analyzed, potassium was the most abundant, and ranging from 1492.14 to 1723.8 µg/g of different black tea types before preparing drinks of Indian and Kenyan sample, followed by Sodium with 99.3 µg/g in Malawian black tea. From the results, it was clear, that toxic heavy metals (Lead) had the lowest concentration in all samples with a concentration ranged from 1.34 to 2.11 µg/kg in Kenyan and Malawian black tea. Cadmium was not detected both in samples or treatments. The black tea samples were analyzed for Al and Zn concentration of dust tea and tea drinks. The results showed an average concentration of Al and Zn in dust tea, ranged from 1.57 to 17.18 and 7.5 to 15.2 µg/kg respectively. It could be concluded that mineral concentration in black tea drink show reduction in all samples, specially, heavy metal for (T1) and (T3).

Key words: Black tea – Chemical composition – Mineral contents.

INTRODUCTION

Tea is considered as one of the most popular beverage in Egypt. Tea leaves, also, are a source of many minerals such as calcium, copper, iron, magnesium, manganese, phosphorous, potassium, titanium, aluminum, strontium, bromine, sodium, iodine, fluorine and zinc. The tea infusion contains very little protein, vitamins and carbohydrates amounts, but may be a source of dietary metals and polyphenols (Srividhya, *et al.*, 2011), and it was found that heavy metal contents were 14.34,

11.34, 0.89, 25.39, 709.0, and 704.0 mg/kg, for Cu, Ni, Pb, Zn, Mn and Cr, respectively, for black tea.

Thus, determination of heavy metal ion levels in the environment is essential and a requisite for human safety (Tuzen and Soylak, 2007; Chuanuwatankul, *et al*., 2008).

On the other hand, tea plays an important role in improving beneficial intestinal micro flora, as well as providing immunity against intestinal disorders and in protecting all membranes from oxidative, damage, lipid depressing activity and the prevention of coronary heart disease and diabetes by reducing the blood-glucose activity (Sushuma, *et al*., 2012).

Metalic constituents in tea leaves are normally different according to the type of tea (green or black) and regional sources (Marcos, *et al*., 1996).

Seenivanson, *et al*., (2007) reported that there were a wide variation in the heavy metal content of black tea collected from different regions of south India due to the difference in agro climatic regions, also, Zhang, *et al*., (2006), reported that there were a relationship between extractable metals (Al, Cu, Cd, Pb, and Zn) in acid soil and metals taken up by tea plants. Many factors such as soil, its organic matter contents, manufacturing process and environmental pollutions, may be contributing to the metal accumulation in the tea leaves. It was confirmed that the content of metals might be an adequate discriminator of tea types and their geographical origin (Maryam and Fereydoon (2010).

The main objective of the present study was to determine the chemical composition and changes in the mineral contents (Pb, Cd, Na, Al, Fe, Zn, K, Mn, and Cu) of black tea drinks as affected by the tested treatment condition (through some home processing).

MATERIALS AND METHODS

Sample collection:

The black tea samples were collected randomly from General Organization for Exports and Imports Control (imported from India, Kenya and Malawi) in Port-Said and investigated (dust black tea: the most imported tea to Egypt).

Tea drinks beverage preparation:

Tea drinks were prepared using three traditional methods of different black tea as following:

T1: (Treatment 1) exactly 2 grams of dust black tea were added to 100 ml cold distilled water, then heated to boil for 2 minutes.

T_2: (Treatment 2) exactly 2 grams of dust black tea were added to 100 ml hot distilled water and then boiling continued for 2 minutes.

T_3: (Treatment 3) exactly 2 grams of dust black tea were added to 100 ml boiled distilled water and stand for infusion for 2 minutes (kushary tea).

All prepared samples of tea drinks were cooled at room temperature and consequently subjected to analysis.

Analytical Methods:

Moisture content, total ash, water soluble ash, water insoluble ash, alkalinity of soluble ash, crude fibers, and total acidity (as acetic acid) were determined according to the methods described in the AOAC (2010).

Mineral content

Minerals content Zn, Fe, Cu, Pb, Al and Mn in the dust black tea samples and black tea infusion before and after preparing were analyzed using Atomic Absorbance Spectrophotometer (AA Analyst, PerkinElmer model 3110). K, Na, were also, determined by Flam photometer.

Total phenolic compounds were determined by the Folin- Cicalteau method as described by (Singleton *et al*., 1999), total flavonoids were extracted and determined according to the method described by (Zhuang *et al*., 1992) and caffeine content was determined according to the method reported by Groisser (1978).

Statistical Analysis

Results were analyzed by analysis of variance (ANOVA) procedure by statistical analysis system (SAS) program, according to (Steel and Torri, 1980). Significant differences were determined at the level $P \geq 0.05$.

RESULTS AND DISCUSSION

1- Proximate composition of black tea types:

The proximate composition of three black tea types is presented in Table (1). From the data shown in Table (1), it could be observed that moisture content was insignificant varied from 2.48 to 2.58%. (Yamanashi, *et al*., 1992) recorded that lower moisture content in the black tea samples, makes them not highly susceptible to microorganisms attack. Which might be advantageous in terms of the shelf life of tea samples.

Table 1. Proximate composition of black tea types (on dry weight basis).

Constituents	Black tea types		
	Indian	Kenyan	Malawian
Moisture (%)	2.58^{a} ±0.11	2.48^{a} ±0.12	2.52^{a} ±0.14
Total ash (%)	5.72^{b} ±0.1	5.32^{c} ±0.05	6.07^{a} ±0.11
Water soluble ash (%)	3.49^{a} ±0.09	3.31^{ab} ±0.07	3.21^{b} ±0.15
Water insoluble ash (%)	2.83^{a} ±0.14	2.01^{b} ±0.11	2.86^{a} ±0.15
Alkalinity of soluble ash (%)	30.53^{c} ±0.16	52.21^{a} ±0.09	32.92^{b} ±0.11
Crude fiber (%)	14.74^{a} ±0.23	10.88^{b} ±0.14	11.08^{b} ±0.10
Total phenolic compounds (mg/100g)	18.05^{a} ±0.21	12.16^{c} ±0.11	12.64^{b} ±0.11
Total flavonoids (mg/100g)	1.18^{a} ±0.07	1.20^{a} ±0.11	1.07^{a} ±0.12
Caffeine (mg/100g)	3.02^{a} ±0.09	2.75^{b} ±0.06	2.79^{b} ±0.08
Total acidity (%)	1.79^{b} ±0.08	1.99^{a} ±0.09	2.10^{a} ±0.04

All values are means of three replicates ± stander deviation (SD). Values in the same raw with different letters are significantly different ($P \leq 0.05$).

From the same Table, it was clear that black tea from Kenya had the lowest ash content (5.32%) as compared to that with Malawian black tea (6.07%). These results agree with that obtained by *Yamanaishi et al.*, (1992) and *Salama* (2000).

On the other hand, the percentage of water soluble ash, water insoluble ash and alkalinity of soluble ash contents were 3.49 , 2.83, 30.53 3.31 , 2.01 , 52.21 and 3.21, 2.86, 32.92% (on dry weight basis), of three black tea types, respectively. However, it could be noticed that the crude fibers ranged from 10.88 to 14.74%, of black tea samples Table (1).

Caffeine plays an important role in determining the tea taste and black briskness of the beverage. The highest amount of caffeine was found in Indian black tea 3.02 mg/100g, followed by Kenyan and Malawian black tea, which contained 2.75 and 2.79 mg/100g. Similar results were obtained by Belitz and Grosch (1987) and *Salama* (2000). The present results confirmed that caffeine content depends on the age of tea leaves and process involved in the production (Barone and Roberts. 1996 and Athayde *et al.*, 2000).

Total phenol compound, also, makeup (12.16 to 18.05 mg/100g) of black tea samples. The data indicated that Indian black tea contained higher amount of total phenol compounds (18.05 mg/100g) than other black tea samples, which differs

depending on manufacturing procedure. The results indicated that the percentage of total flavonoids mg/100g and total acidity (%) were 1.18, 1.79 1.20, 1.99 and 1.07, 2.10 of three black tea types, respectively.

2- Mineral content of different of black tea types.

The concentration of mineral content of different black tea types before preparing drinks were shown in Table. (2) From the data shown in Table. (2) It was observed that the highest contents of both K in Kenyan tea, Na in Malawian tea and Zn in Indian black tea which were 1723.8, 99.3 and 15.2 µg/g, respectively.

Table 2. Minerals content of black tea types (on dry weight basis).

Minerals	**Black tea types**		
	Indian	**Kenyan**	**Malawian**
Potassium (µg/g)	**1492.14**^{c} ±7.04	**1723.8**^{a} ±3.2	**1680.12**^{b} ±1.05
Sodium (µg/g)	**83.72**^{b} ±5.87	**86.25**^{b} ±3.05	**99.30**^{a} ±1.05
Zinc (µg/kg)	**15.20**^{a} ±8.07	**7.50**^{b} ±4.1	**7.90**^{b} ±1.3

All values are means of three replicates ± stander deviation (SD). Values in the same raw with different letters are significantly different ($P \leq 0.05$)**.**

On the contrary, the lowest concentrations were 1492.14, 83.72 and 7.5µg/g in Indian and Kenyan black tea, respectively. Whereas the lowest value of zinc was recorded by Kenyan black tea sample 7.5 µg/kg. These results are in agreement with those reported by Abdolmaleki, *et al.*, (2013) who demonstrated that the potassium content varied from 1700.3 to 2300.2 µg/g, and sodium content ranged from 32.3 to 74.3 µg/g. The high concentration of mineral contents may be due to the varying properties of the growth media nutrients, agro input and soil etc. (Matsuura, *et al.,* 2001).

3- Mineral content of different of black tea types after treatments.

The mineral content in black tea types after the tested preparing methods were determined and illustrated in Table. (3). from these data it could be concluded that the different preparing of black tea types caused a decline in all concentrations of mineral contents (K, Na and Zn).

Table 3. Changes in mineral content of black tea types drinks after treatments (on dry weight basis).

Minerals	**Black tea types**		
	Indian		
	T1	**T2**	**T3**
Potassium (µg/g)	89.05^{c} ±1.2	800.60^{a} ±5.5	96.32^{b} ±2.0
Sodium (µg/g)	43.02^{c} ±6.7	50.20^{b} ±1.2	76.06^{a} ±1.2
Zinc (µg/kg)	3.33^{a} ±1.03	1.95^{b} ±0.55	1.46^{b} ±0.06
	Kenyan		
	T1	**T2**	**T3**
Potassium (µg/g)	566.00^{b} ±5.0	848.00^{a} ±6.0	65.48^{c} ±4.88
Sodium (µg/g)	73.32^{b} ±1.02	44.16^{c} ±1.06	82.80^{a} ±1.04
Zinc (µg/kg)	0.12^{c} ±0.01	2.11^{a} ±0.05	0.54^{b} ±0.05
	Malawian		
	T1	**T2**	**T3**
Potassium (µg/g)	624.80^{c} ±4.0	775.80^{b} ±5.2	891.00^{a} ±5.0
Sodium (µg/g)	48.26^{b} ±2.06	69.50^{a} ±1.4	38.90^{c} ±5.0
Zinc (µg/kg)	4.25^{a} ±2.0	2.11^{b} ±0.06	0.02^{c} ±0.002

T1: Treatment No (1) **T2**: Treatment No (2) **T3**: Treatment No (3)

All values are means of three replicates ± stander deviation (SD). Values in the same raw with different letters (a, b, c and d) are significantly different ($P \leq 0.05$)**.**

Whereas, the (T1) recorded a significantly decrease in all mineral contents under investigation followed by (T3). However, it could be observed that the (T2) recorded lowest decreasing on the value of mineral content (K, Na, and Zn), it was ranged from 46.3 to 49.2%, 16.6 to 40% and 46.2 to 78%, respectively, compared with these results in Table (2) for (K, Na and Zn). These results may be due to the main content of these minerals in the sample and degree of temperature during several treatments.

4- Heavy metals content in black tea types before treatments.

The concentration of heavy metals content in black tea types were determined and illustrated in Table (4). It could be observed that the concentration of both Fe and Cu in Indian black tea was higher than that of other types, which were 53.6 and 28.0 µg/kg, respectively. Meanwhile Malawian black tea had the highest contents of (Pb), which were 2.11 µg/kg. On the other hand, the Kenyan black tea variety contained the highest content of (Al) which was 21.48 µg/kg.

Table 4. Heavy metals content of black tea types before treatments (on dry weight basis).

Minerals	Black tea types		
	Indian	**Kenyan**	**Malawian**
Iron µg/kg	53.60^{a} ±2.2	30.10^{c} ±1.1	43.20^{b} ±2.1
Copper µg/kg	28.00^{a} ±0.8	5.60^{c} ±0.09	8.20^{b} ±0.2
Lead µg/kg	1.86^{b} ±0.05	1.34^{c} ±0.03	2.11^{a} ±0.02
Aluminum µg/kg	17.18^{b} ±0.07	21.48^{a}±0.07	15.7^{c} ±0.06
Manganese µg/kg	125.30^{a} ±4.1	136.00^{a} ±9.0	136.30^{a} ±4.3
Cadmium	ND	ND	ND

All values are means of three replicates ± stander deviation (SD). Values in the same raw with different letters (a, b, c and d) are significantly different ($P \leq 0.05$). ND: not detected**.**

Our results near to the results which given by Lahiji, *et al*., (2013), who demonstrated that mineral contents for infuse tea, Cu (22.75%) Fe (54.43%) and Al (61.8%) None of the black tea samples contained cadmium. Except, Mn which recorded low content compared with our results (19.35%).

Generally, the amount of minerals in the tea infusion depends on extraction efficiencies and total concentration of metals in tea leaves (Marbaniang, *et al*., (2011).These results are in agreement with those reported by Yasmeen, *et al*., (2000), Pedro, *et al*., (2001), Ansari, *et al*., (2007), and Lahiji, *et al*., (2013). The reason for high concentration could be attributed to dust particles during tea processing and solder being used in packaging, and there are many factors may be contributing to the metal accumulation in the tea leaves, such as soil, its organic matter contents, manufacturing process, environmental pollutions and fungicides (Maryam and Fereydoon, 2010).

5- Effect of different preparing treatments of heavy metals of black tea types.

Effect of different preparing treatments on heavy metals concentration in black tea types presented in Table. (5) .The obtained results show that the T1 and T2 treatments were the lower effect than other treatment T3. From the same Table, it could be observed that the T1 and T2 treatments had a clear effect on the heavy metals content lower than treatment T3 in all samples of black tea (Indian, Kenyan and Malawian). The reduction percentage in all heavy metal concentration of black tea may be due to whether the compound is strongly bound to the matrix or more soluble in the solution employed (Costa, *et al*., 2002). It could be attributed to boiling period and source of black tea.

Table 5. Heavy metals content of black tea types after treatments (µg/kg on dry weight basis).

Minerals	Black tea types								
	Indian			Kenyan			Malawian		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
Iron (Fe)	4.36	3.82	8.05	4.44	6.30	3.57	6.56	8.20	7.61
Copper (Cu)	3.87	1.71	1.44	0.85	0.80	0.01	2.79	0.46	2.59
Lead (Pb)	1.10	1.09	0.004	0.14	0.20	0.48	0.27	0.86	0.002
Aluminum (Al)	0.50	0.80	0.70	0.37	0.60	0.96	0.49	0.59	0.69
Manganese (Mn)	9.32	6.41	6.21	9.17	9.08	6.89	8.48	8.81	7.66
Cadmium (Cd)	ND	ND	ND	ND	ND	ND	ND	ND	ND

CONCLUSION

In this study, mineral concentration in black tea drink shows reduction in all samples. Specially, heavy metal for (T1) and (T3) recorded significant by a decrease in all samples under investigation.

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تأثير طرق الأعداد المنزلية لمشروب الشاي الأسود على المحتوى من العناصر المعدنية

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الشاي من المشروبات غير الكحولية، والمشروب الأكثر شعبية في مصر، ويحتوي على العديد من العناصر الغذائية والمعدنية الأساسية الهامة والمفيدة لصحة الإنسان.

ولقد هدفت هذه الدراسة الى تحديد التركيب الكيميائي وتقدير المحتوى من العناصر المعدنية (الزنك، الحديد، النحاس، الرصاص، والألومنيوم والمنجنيز والكادميوم)، وأيضا الصوديوم والبوتاسيوم قبل وبعد بعض طرق الإعداد المنزليه لثلاثة أنواع من الشاي الأسود (الهندي، مالاوى وكينيا). وتم اعداد مشروب الشاى الاسود بثلاثة طرق اعداد تقليدية كالتالى:- المعاملة الاولى بإضافة الماء المقطر البارد والتسخين حتى الغليان لمدة ٢ دقيقة، المعاملة الثانية بإضافة الماء المقطر الساخن ثم التسخين حتى الغليان لمدة ٢ دقيقة ثم المامله الثالثة بإضافة الماء المقطر المغلى ثم يترك لمدة ٢ دقيقة، تركت هذه المشروبات المعده من الشاى الاسود حتى الوصول لدرجة حرارة الغرفة وتم اجراء التحاليل اللازمة. واظهرت النتائج ان عنصر البوتاسيوم هو السائد فى كل العينات وتراوح تركيزه من (١٧٢٣,٨٠-١٤٩٢,١٤) ميكروجرام/جم ، لعينات الشاى الهندى والكينى على التوالى، وسجل اعلى تركيز لعنصر الرصاص فى عينات الشاى الملاوى اذا بلغ (٢,١١ ميكروجرام/كجم) .بينما سجل الشاى الكينى اقل نسبه منه وبلغ (١,٣٤ ميكروجرام/كجم). ، يليه الصوديوم بتركيز ٩٩,٣ ميكروجرام / جرام في الشاي المالاوي.

وسجلت المعادن الثقيلة السامة (كالرصاص) التركيز الأقل في جميع العينات وكانت بتركيز ١،٣٤-٢،١١ ميكروجرام / كجم بالنسبة للشاى الأسود الكيني والمالاوي، ولم تحتو العينات او المعاملات محل الدراسة على عنصر الكادميوم. بينما سجل عنصرى (الالمونيوم والزنك في مشروب الشاي والشاى الناعم) تركيز وتراوح من ١،٥٧ حتي ١٧،١٨ و ٧،٥ حتي ١٥،٢ ميكروجرام / كجم على التوالي. من ناحية أخرى، ولقد خلصت النتائج الى حدوث انخفاض فى تركيز المعادن في الشاي الأسود لجميع العينات خاصة، المعادن الثقيلة فى المعاملة (١) والمعاملة (٣) .