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Assessment of Heavy Metals in Tea Brands in Eastern Region, Saudi Arabia

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Abstract: Tea is common drinks in Saudi Arabia, as in the overall world for its desirable aroma, taste and putative positive physiological functions. According to recent estimates by FAO, approximately 5.35 million tons of tea were produced in the year 2013 with a total of 3.52 million ha land area under tea cultivation. Estimates show that approximately 70 % of the total world population consumes tea infusion (i.e., water extract of made tea). Contaminants may vary in the soil, air, or water in which the plants of tea are grown. There is an abundance of literature demonstrating the adverse health effects of various heavy metal and metalloid elements on the human organism. Our objective in this research is determination the trace metals which have directly effect on the human health and pollution of the environment. The samples were randomly collected from the markets and hyper markets in Eastern region, the collected samples of tea powder were stored at room temperature in dry containers for further process. The diluted digests analyzed by using Inductively Coupled Plasma (ICP-OES)**.** The concentrations of anion groups in the selected samples were high and might affect the health of the consumers of the tea as the result showed; SO_4 was ranged between 16 to 35 mg/L, NO_3 was ranged between 0.1 to 5.8 mg/L, NO_2 was ranged between 0 to 0.012 mg/L, PO_4 was ranged between 0.29 to 1.28 mg/L and NH_3 was ranged between 0.36 to 0.49 mg/L. The concentrations of nontoxic heavy metals in tea samples also were high e.g., Ca concentration (mg/kg) the maximum concentration was 173.31 and minimum concentration was 48.55, Fe concentration (mg/kg) the maximum concentration was 49.861 in some of the samples. K concentration (mg/kg) the maximum concentration was 158.96 to 101.69, Mg concentration (mg/kg) the maximum concentration was 150.24 and minimum concentration was 24.913. About toxic heavy metals in tea samples such as Al concentration (mg/kg) the maximum concentration was 47.276 and minimum concentration was 18.925, Cd concentration (gm/kg) the maximum concentration was 0.0339 and minimum concentration was 0, Cr concentration (mg/kg) the maximum concentration was 1.9132 and minimum concentration was 0, Pb concentration (mg/kg) the maximum concentration was 72.317 and minimum concentration was 0.1185.

Keywords: Tea, Beverage, Heavy metals and Toxic heavy metals.

INTRODUCTION

Tea is one of the most consumed beverages in world that originates from the shrub Camellia Sinensis L. According to recent estimates by FAO, approximately 5.35 million tonnes of tea were produced in the year 2013 with a total of 3.52 million ha land area under tea cultivation. Estimates show that approximately 70 % of the total world population consumes tea infusion (i.e., water extract of made tea). Owing to the color when prepared, teas are commonly grouped into five major categories namely, white, yellow, green, oolong, and black tea. Among these five categories, black tea accounted for around 80 % of global tea production [1].

Tea leaves contain variable levels of essential minerals such as copper, fluorine, iron, iodine, manganese, magnesium, potassium, phosphorous, strontium, sodium and zinc. Upon boiling, mineral elements present in tea leaves are leached into water and could serve as a dietary source to the consumers. Since some of these elements such as iron, manganese and zinc are components of important enzymes and are required for proper functioning of many important physiological and metabolic processes in human body, tea infusion is considered as healthy and non-alcoholic refreshing drink [2, 3].

Accumulation of toxic metals in plants from soils and their bio-magnification in animals and human beings could pose serious threat to their health. Tea plants show relatively better growth in acidic soil conditions. However, low pH of soils could cause manifold increase the availability of elements especially microelements. Therefore it is not uncommon to find excessive levels of certain elements in tea samples and consuming such tea may provide a significant contribution for the intake and accumulation of trace metals in the human body [4].

However, some of the other elements are undesirable or toxic to human health, such as As, Cr, Cd, Co, Ni, and Pb. Previous studies showed that tea can be rich in trace metals classified as human carcinogens by the International Agency for Research on Cancer. These are, in particular, Cd, Co, Cr, and Ni. Determination of trace metals in tea is important for two reasons: to evaluate their nutritional value and to guard against any probable harmful effects they may cause to human consumers [5].

Acidic conditions may result in excess available aluminum and fluoride. An acid or alkali soil pH also enhances leaching of toxic heavy metals from the soil. Increasing pH with soluble calcium would reduce the absorption of fluoride [6].

Environmental pollutants such as fluoride and aluminum have been found in tea in part due to the tea plants absorption and deposition and concentration of these compounds in the leaves. The drinking of more than 5 liters of tea per week may result in dental or skeletal fluorosis [7, 8]. Mercury, lead, arsenic, and cadmium as well as other toxic elements have been found in tea leaves as described in the literature. Lead, arsenic, and cadmium have also been found in brewed black tea [9-12].

There is an abundance of literature demonstrating the adverse health effects of various heavy metal and metalloid elements on the human organism. By numerous mechanisms, including endocrine disruption, cytotoxicity, mitochondrial dysfunction, and oxidative stress, a spectrum of toxic elements is able to disturb cellular and metabolic homeostasis and induce clinical illness [13-17].

The literature is replete with many common disease processes such as carcinogenesis, insulin resistance, neurodegeneration, and immune dysregulation. These may result from exposure to and bioaccumulation of various heavy metals and metalloids. In addition, recent literature has elucidated that various toxic compounds can have epigenetic effects with the potential for trans generational damage [18-21].

In order to simulate household brewing conditions, teas were prepared using an aqueous extraction. Tea samples approximately (1 g) were digested with 5 ml of digested reagent (2 hydrochloric acid:1 nitric acid) after that for completing the digestion may be need a maximum 5 mls of nitric acid boiling with stirring for 10 minutes. Extracts were filtered through a cotton wool, cooled at a room temperature, diluted to 50 ml with distilled water, and use Inductively Coupled Plasma (ICP) for measurements different types of heavy metals according to its toxicity [22-25].

The toxic elements discussed in this paper include lead, mercury, aluminum, and cadmium. The extremely low levels of lead accepted in Proposition 65 during the prenatal period come from our knowledge of the accumulation in the brain and resultant impairment of cognitive development [26, 27].

This study aimed to determination of the Heavy Metals from Selected Tea Brands Marketed in Eastern area, Saudi Arabia and evaluates their potential health impacts among the consumers [28].

Several attempts have been made to assess tea quality by chemical analysis usually with reference to pigmentation and the flavoring characteristics. However, to date little work has been done to identify the metal containing components of tea due to the analytical difficulties associated with both the separation of such components and their quantitative measurement [43]. Metallic constituents of tea leave is normally different according to the type of tea (green or black) and geological sources [40, 41].

In the present study, the content of Mn, Fe, Zn, Cu, Co, Pb, Cr, Ni and Cd in tea samples and in tea aqueous extract has been determined by using acid digestion followed by FAAS. The content of Na and K were determined by Flame Photometer. Objective of the research was to evaluate the overall metal contents in locally available some brands of tea and tea extracts.

However, some of the other elements are undesirable or toxic to human health, such as As, Cr, Cd, Co, Ni, and Pb [10, 13-15]. Previous studies showed that tea can be rich in trace metals classified as human carcinogens by the International Agency for Research on Cancer. These are, in particular, Cd, Co, Cr, and Ni [13, 16-18]. Determination of trace metals in tea is important for two reasons: to evaluate their nutritional value and to guard against any probable harmful effects they may cause to human consumers [3, 6, 10].

In the present study, it has been hypothesized that bagged black tea contains higher amounts of trace metals than leaf tea of the same brand and that the trace metal content in infusion made from bagged tea is higher than made from leaf tea. Therefore, the type of tea chosen by consumers is important in view of intake of toxic metals. To verify the hypothesis, concentrations of Zn, Mn, Cd, Pb, Ni, Co, Cr, Al, and Fe in black tea samples and in tea infusions were determined and compared. [10]

The objective of the study was to evaluate the percentage transfer of the elements tested to the infusion and determine the concentrations of trace metals available in bagged tea and leaf black tea of the same brand.

Sample Collection and Preparation

The samples were randomly collected from the markets and hyper markets in Eastern region, the collected samples of tea powder were stored at room temperature in dry containers for further process. To avoid metallic contamination, nonmetallic tools were used during sample preparation and acid washed glassware and polyethylene containers were used for analysis. The samples were washed with distilled water, then soaked overnight in 6N HNO_3 solution and rinsed several times with ultra-pure water to avoid any contamination from detergent.

The final residue was dissolved in 0.1 M HNO_3 solution and make up to 50 mL. Standard solutions of metals to be determined in tea samples were prepared according to the Shimazdu Perkin Elmer Pure Atomic Spectroscopy Standards guidelines (NIST traceable CRM, Perkin Elmer Corporation, USA and Merck - Germany). Working standard solutions prepared by diluting the stock solution with 0.1 M nitric acid for checking the linearity.

Analytical Procedure for tea

One gram (1gm) of each tea samples were digested using of 5ml digested reagent (2:1) concentrated HCl and HNO_3acids. Analar grade reagents were used for the preparation of the standard solutions of these metals using their nitrate salts (Ca, K, Na Mg, Mn, Pb,Cu, Fe and Zn) [29]. The diluted digests analyzed by using Inductively Coupled Plasma (ICP-OES) was used for Mg, Mn, Ca, Pb, Cu, Fe and Zn. The metal concentrations in the tea samples were read from standard curves by extrapolation. Also, the soluble samples was diluted and determine the physic and chemical parameters and compare between the two types of samples according to trace elements and physical constituents so the determination of physic-chemical characteristics and parameters of preserving teas and coffees in two steps and these parameters which are used for soluble teas according to its high degree of solubility such as [30].

- The physical parameters: such as pH, Conductivity, TDS, and temperature.
- The chemical parameters: Ammonia, Nitrate, Nitrite, Sulfate, Sulfide, and Phosphate,

So, the determination of physic- chemical characteristics and parameters of preserving teas in two steps and these parameters which are used for soluble teas according to its high degree of solubility such as physic and chemical analysis for samples solutions according to the following table:

1- The physical parameters

No	Parameters	Unit	Instrument	References
1	pH	-----------	pH meter (electrode method	Standard Method
2	Conductivity	ms/cm	Conductivity meter (electrode method)	
3	TDS	mg/L	Conductivity meter (electrode method)	
4	Turbidity	NTU	Turbidimeter	
5	Color	CU	Colorimeter	

2- The chemical parameters

No	Parameters	Unit	Instrument	References
1	Alkalinity	mg/L	Titration method	Standard Method
2	Hardness	mg/L		
3	Chloride	mg/L		
4	Ammonia	mg/L	Spectrophotometer	
5	Nitrate	mg/L		
6	Nitrite	mg/L		
7	Sulfate	mg/L		
8	Sulfide	mg/L		
9	Phosphate	mg/L		
10	Total trace elements	ppm	ICP-OES & AAS	

RESULTS AND DISCUSSION

Table-1: Physical Properties of tea samples

Tea Samples	pH	Conductivity ms/cm	TDS mg/L	Color CU	Turbidity NTU
Sample 1	6.69	0.824	404	3175	10.1
Sample 2	5.36	0.705	346	2080	18.5
Sample 3	6.78	0.82	402	1090	2.3
Sample 4	6.39	0.649	318	1448	22.5
Sample 5	6.79	0.924	453	2580	6.6
Sample 6	5.67	0.852	418	1644	6.1
Sample 7	7.59	1.049	514	5853	5.2
Sample 8	6.52	0.757	371	2411	10.3
Sample 9	6.64	0.792	388	5423	5.4
Sample 10	6.79	0.83	410	2608	6
Sample 11	7.8	0.86	422	3985	3.4
Sample 12	6.77	0.764	374	1632	8.7
Sample 13	6.57	0.749	367	4441	7
Sample 14	6.45	0.847	415	2543	5.8
Sample 15	6.56	0.754	370	1436	3.4
Maximum	7.8	1.049	514	5853	22.5
Minumum	5.36	0.649	318	1090	2.3

Table-2: Concentration of anions groups (mg L-1) in tea samples

Tea Samples	Sulfate SO_4	Sulfide S	Nitrate NO_3	Nitrite NO_2	Phosphate PO_4	Ammonia NH_3
Sample 1	32	0.118	0.2	0.005	0.4	0.38
Sample 2	16	0.081	0.3	0.006	0.29	0.37
Sample 3	25	0.155	0.21	0.001	0.48	0.38
Sample 4	18	0.103	0.62	0.008	1.28	0.36
Sample 5	31	0.193	0.91	0	1.22	0.49
Sample 6	33	0.135	0.8	0.001	0.41	0.39
Sample 7	35	0.143	0.3	0.002	0.39	0.45
Sample 8	28	0.19	0.29	0.001	0.46	0.44
Sample 9	26	0.189	0.31	0.001	0.43	0.41
Sample 10	31	0.152	1.5	0.009	0.56	0.39
Sample 11	30	0.151	0.1	0.009	0.84	0.45
Sample 12	28	0.139	0.5	0.001	0.43	0.39
Sample 13	24	0.136	5.8	0.012	0.84	0.43
Sample 14	32	0.134	2.8	0	0.58	0.39
Sample 15	25	0.112	0.7	0.009	0.39	0.39
Maximum	35	0.193	5.8	0.012	1.28	0.49
Minimum	16	0.081	0.1	0	0.29	0.36

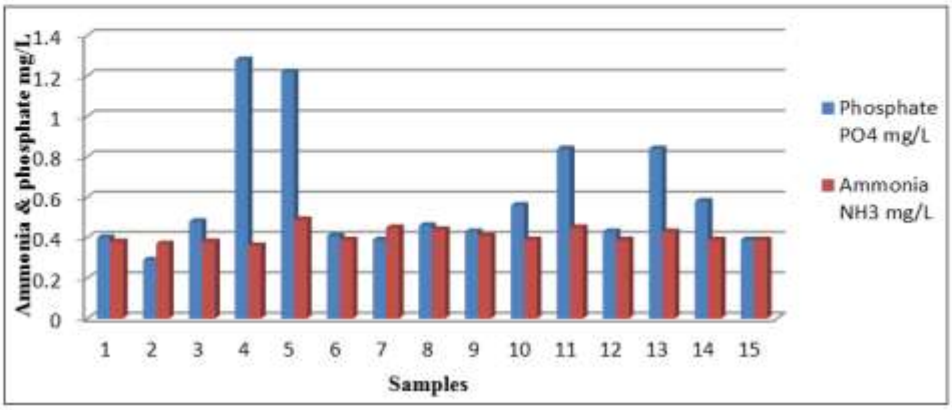

Fig-1: Phosphate and ammonia concentrations between different types of teas

Table-3: Non-toxic heavy metals concentrations in different types of selected samples teas mg/kg in markets of eastern area of KSA.

Sample	Ca	Fe	K	Mg	Mn	Mo	Na
Sample 1	151.2354	44.602658	115.983	122.7	218.967544	0.0154	27.294
Sample 2	138.6397	17.833824	132.235	150.2	151.133018	0	42.178
Sample 3	126.5386	23.877853	158.958	108.2	106.399137	0	52
Sample 4	118.5513	43.866362	124.323	132	125.242718	0	47.11
Sample 5	124.7739	49.860968	109.16	101.1	132.861006	0	17.388
Sample 6	137.2761	40.55219	113.329	107.1	178.424755	0.0028	37.58
Sample 7	121.2372	40.64265	113.608	102.8	98.5345749	0.0046	28.427
Sample 8	150.1405	29.329089	145.249	98.43	129.431929	0	56.562
Sample 9	154.0734	20.521904	152.969	101.3	53.7870472	0	73.346
Sample 10	173.3057	27.799861	142.402	104.7	92.9643248	0.0119	35.178
Sample 11	135.3457	22.4804	102.81	94.6	63.1907056	0	18.254
Sample 12	145.7641	36.292415	101.69	97.93	166.674827	0.002	19.125
Sample 13	162.3267	33.368009	138.104	92.49	40.7737653	0.001	61.673
Sample 14	164.5566	33.182686	147.518	85.07	30.3002913	0.004	18.414
Sample 15	155.0659	7.7190576	145.27	27.91	239.383847	0.001	64.427
Maximum	173.3057	49.860968	158.958	150.2	239.383847	0.0154	73.346
Minimum	118.5513	7.7190576	101.69	27.91	30.3002913	0	17.388
Mean	144.1581	31.1476442	129.66	100.3	123.397272	0.0034	40.57
S.D	16.74053	11.6103363	19.106	26.3	62.1913069	0.00469	18.64

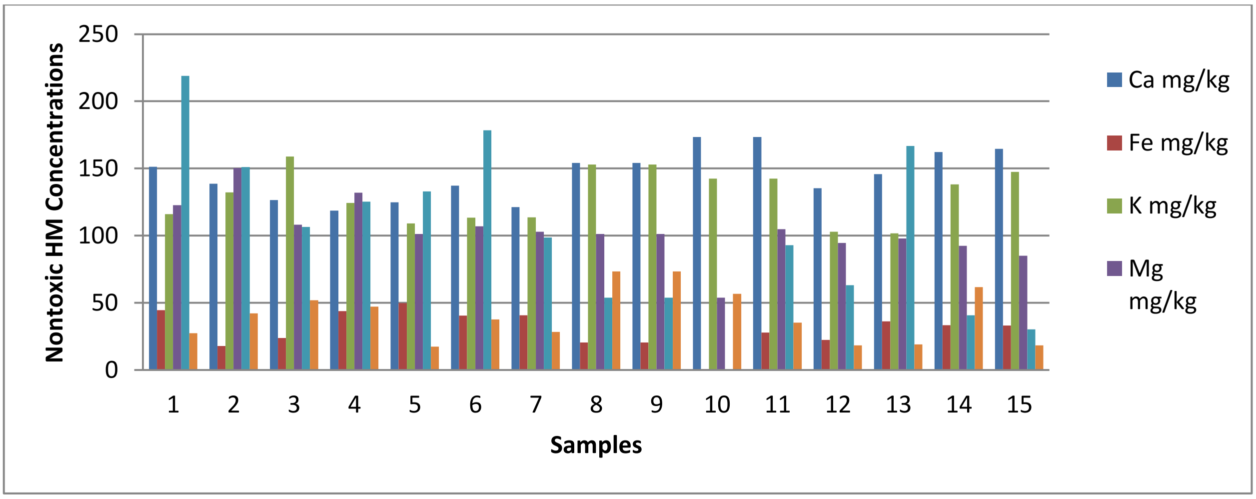

Fig-2: Non-toxic heavy metals concentrations in different types of teas

Table-4: Toxic heavy metals concentrations in different types of teas mg/kg in markets of eastern area of KSA

Sample	Al	As	Cd	Cr	Pb	Ni	Sb
1	45.47509	0.1143658	0.0339	0.52	1.2811	0	0
2	44.15568	0.1004993	0.00384	1.895	3.0399	0	0
3	23.66601	0.0803389	0.00719	0.156	0.4612	0	0
4	47.27584	0.1130782	0.01428	1.913	1.5871	0	0
5	28.46532	0.0647545	0.00571	0.61	0.7637	0	0
6	43.22368	0.0650592	0.00488	0.884	0.3489	0	0
7	18.92459	0.0656388	0.00687	1.466	72.317	0	0.0172
8	32.67875	0.075906	0	0.391	0.2537	0	0
9	30.61571	0.0678575	0	0.16	0.3453	0	0
10	21.69333	0.0606181	0.01043	1.413	37.156	0	0
11	33.90951	0.0802871	0.01984	0.159	0.6763	0	0
12	45.00318	0.0700191	0.00049	0	0.1185	0	0
13	25.90281	0.0911478	0	0.393	1.3202	0	0
14	38.04359	0.0687958	0	0.487	1.0686	0	0
15	28.04036	0.032326	0	0.088	2.1457	0	0
Maximum	47.27584	0.1143658	0.0339	1.913	72.317	0	0.0172
Minimum	18.92459	0.032326	0	0	0.1185	0	0
Mean	33.8048967	0.07671281	0.007162	0.70233333	8.19221333	0	0.00114667
S.D	9.49971649	0.02130979	0.00947336	0.65730257	20.0465424	0	0.00444102

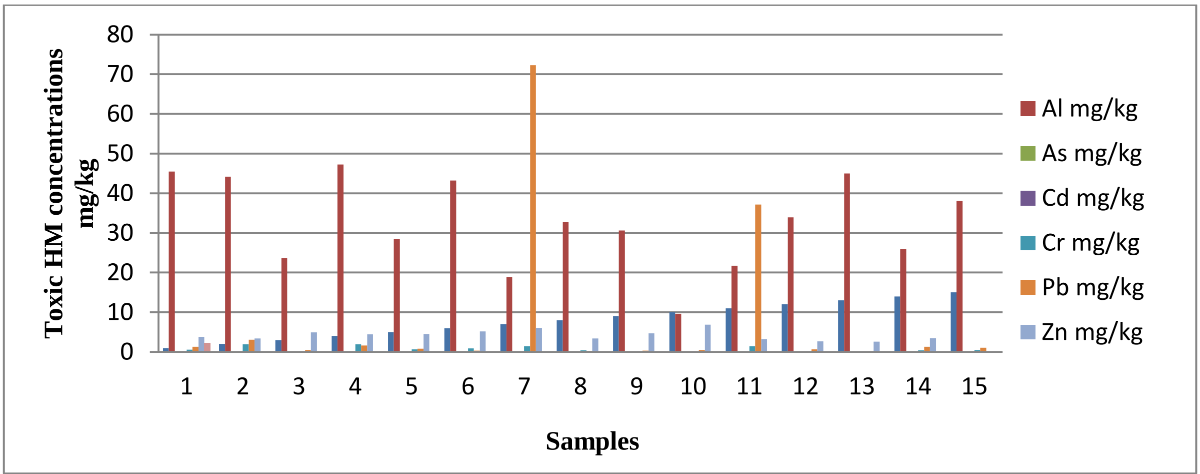

Fig-3: Toxic heavy metals concentrations in different types of teas

Table-5: Levels of non-Toxic Heavy Metals in the Tea Samples (mg/kg) in markets of eastern area of KSA

Metals	Max	Min	Mean	STD
Ag	4.934637262	0.02155067	0.83277071	1.47510017
B	7.321530554	0.03335456	3.21184211	1.5890538
Ba	64.37282657	2.54996485	13.2549045	19.7586312
Be	0.026670283	0	0.00884213	0.0057279
Ca	173.3056743	118.551342	143.922068	16.740525
Fe	49.86096827	7.71905765	31.4619951	11.6103363
K	158.9583916	101.690251	129.573892	19.1066694
Mg	150.2368455	27.9130137	101.777684	26.2967184
Mn	239.3838468	30.3002913	121.871299	62.1913069
Mo	0.015369316	0	0.00284441	0.00469077
Na	73.34597346	17.3884889	39.9305026	18.6360981
Si	79.19717928	0	25.4636597	22.1143776
V	1.594951804	0.37691355	0.95855373	0.49555173

Table-6: Toxic Heavy Metals in the Tea Samples in (mg/kg) in markets of eastern area of KSA.

Metals	Min	Mean	STDEV
Al	18.9245917	33.8048968	9.4997167
As	0.032326	0.07671281	0.02130979
Cd	0	0.0071625	0.00947347
Cr	0	0.70232412	0.65730571
Ni	0	0	0
Pb	0.11849385	8.0654004	20.0935275
Sb	0	0.00114486	0.00443404

RESULTS AND DISCUSSION

Physical and chemical parameters are very important in measurement because these parameters may have impact on human health such as pH, conductivity, TDS, ammonia and phosphate and the high levels concentration cause risks on the human health. The chemical composition of tea varies and largely depends on climatic conditions, horticultural practices, soil, growth altitude, plucking season, sorting, grading, processing, extraction, storage and drying [31, 32], Variability in composition is an important factor that dictates the taste, flavor and health benefits of a specific type of tea [33], There is a direct association between tea quality and the content of tea amino acids, caffeine and polyphenols in tea leaf [34, 35], Table (I) it shows that the physical analysis in the chosen samples of teas the results was as the following: physical parameters such as the pH of tea has been found to correlate with the perceived acidity in teas and that is resulted in correlation between The pH values were ranged between 5.36 to 7.8 it is neutral samples in pH values also we found that there are variation in concentration of total dissolved solids and that is showed in table I the TDS is ranged between 318 to 514 mg/L and we will find that there is some correlation between the increasing of TDS and conductivity with degree in color that shows that beside the health effect of dark tea on human health also the increasing of TDS and conductivity either PO_4, NH_4, and NO_3 concentrations are ranged 0.29-1.28mg/L, 0.36-0.49 mg/L, 0.1-1.5 mg/L respectively.

Table-2 it shows that the concentrations of anion groups such as SO_4 was ranged between 16 to 35 mg/L, NO_3 was ranged between 0.1 to 5.8 mg/L, NO_2 was ranged between 0 to 0.012 mg/L, PO_4 was ranged between 0.29 to 1.28 mg/L and NH_3 was ranged between 0.36 to 0.49 mg/L. Tables-3 & 4 depict a large variation in the heavy metal content of black and green tea. Consumer brand teas are the blend of various individual teas from different estates across country. The results indicated that the non-toxic heavy such as Ca, K, Mg, Mn, Fe, Mo, and Na and toxic heavy metals such as Al, As, Cd, Cr, Ni, Pb, and sb in some teas were different for the different Markets in Eastern regions in Saudi Arabia

In teas and it leaves the potassium is important for reducing blood pressure and also increasing blood circulation as well as preventative aid on general health [31]. Calcium, which is the most common mineral in the body, helps in the transport of long chain fatty acids, which aid in prevention of diseases, high blood pressure and other cardiovascular diseases. In some results of researches The obtained calcium levels with a mean of 3.11 mg/dm^3 ranging from 2.08 mg/dm^3 in Mambilla samples to 4.58 mg/dm^3 in China samples with a coefficient of variation of 18.2 percent. These concentrations were lower than those reported by Kazi, and were higher than those reported by Syed and Qadiruddin [37, 36].

The levels of sodium in the tea leaf samples range from 0.61 to 4.14 mg/dm^3, with a mean of 2.50 and coefficient of variation 26.6 percent which were lower than those described in the literature (Syed and Qadiruddin. Sodium is the major cation in blood and extracellular fluid (Syed and Qadiruddin [37].

Magnesium works with calcium to help transmitting nerve impulse in the brain. Both elements give relief in patients having depression [38] Fig-4 shows the distribution pattern for Mg in the tea leaf samples with a mean of 9.12 mg/dm^3, range of 9.03 to 9.19 mg/dm^3 and coefficient of variation 1.70 percent. The results obtained for the magnesium compares favorably with the values reported by Kazi [36].

Zinc is important in metabolic function and for growth in man. It forms part of the teeth [36] Fig-5 shows the distribution pattern for Zn in the tea leaf samples with a mean of 2.17 mg/dm^3, range of 0.85-3.07 mg/dm3 and coefficient of variation of 21.6 percent. Mambilla sample had the lowest content while China sample had the highest content comparing with the results of Tahir [39], the results obtained were generally higher.

Manganese is present in all the tea leaf samples, ranging from 3.00 to 3.84 mg/dm^3 with a mean 3.38 mg/dm^3 and coefficient of variation 8.00 percent. The distribution pattern shows low concentration in sample Mambilla and India and high concentration in sample China Fig-6 and were found to be lower than those described in other studies (Powell [38, 40-42].

However the values are higher than those reported by Tahir [39], who reported a range from 0.52 to 1.9 mg/dm^3). On the other hand, these values were within the range limit (1.95-4.5 mg/dm^3) reported by Saud and Al - Qud) [43].

Many elements present in food at major, minor and trace levels are reported to be essential to man's well-being. However, their ingestion in excessive amount can cause severe health problems [44-49].

In this research the random samples were chosen according to the famous of drinking teas in Saudi Arabia and some samples were specially as Arabic and Turkish coffees and we has got observed results in obvious samples not only but also, in some samples the heavy metals were high [50].

From Table-3 & 4 According to the correlation between the heavy metals and types of teas Table-2 shows that some different types of purchase of the teas, and heavy metal contents in the 15 samples of teas used in the investigation. We founded that some heavy metals were founded high concentrations of metals such as Ca, Fe, K, Mg, Mn, Mo, and Na the concentrations were ranged the first one Ca concentration (mg/kg) the maximum concentration was 173.31 in sample 10 and minimum concentration was 48.55 in sample 4, the second metals Fe concentration (mg/kg) the maximum concentration was 49.861 in sample 5 and minimum concentration was 7.7191 in samples 15, the third metals K concentration (mg/kg) the maximum concentration was 158.96 in sample 3 and minimum concentration was 101.69 in sample 15, the fourth was Mg concentration (mg/kg) the maximum concentration was 150.24 in sample 2 and minimum concentration was 24.913 in sample 15, Mn concentration (mg/kg) the maximum concentration was 239.38 in sample 15 and minimum concentration was 30.3 in sample 14, Mo concentration (mg/kg) the maximum concentration was 0.0154 in sample 1 and minimum concentration was 0 in samples 2-5, 8-9,11, and Na concentration (mg/kg) the maximum concentration was 73.346 in sample 9 and minimum concentration was 17.388 in sample 5 respectively on beside that toxic heavy metals such as Al, As, Cd, Cr, Cu, Ni, Pb and Sb, As is the first one Al concentration (mg/kg) the maximum concentration was 47.276 in sample 4 and minimum concentration was 18.925 in samples 7, As concentration (mg/kg) the maximum concentration was 0.1144 in sample 1 and minimum concentration was 0.0323 in sample 15, Cd concentration (gm/kg) the maximum concentration was 0.0339 in sample 1 and minimum concentration was 0 in samples 8-9, 13-15, Cr concentration (mg/kg) the maximum concentration was 1.9132 in sample 4 and minimum concentration was 0 in samples 11, Pb concentration (mg/kg) the maximum concentration was 72.317 in sample 7 and minimum concentration was 0.1185 in samples 12 and sb concentration (mg/kg) the maximum concentration was 0.0172 in sample 7 and minimum concentration was 0 in all samples except sample no 7 the concentration was 0.0172 (mg/kg).

CONCLUSION

The concentrations of anion groups in the selected samples were high and might affect the health of the consumers of the tea as the result showed; SO_4 was ranged between 16 to 35 mg/L, NO_3 was ranged between 0.1 to 5.8 mg/L, NO_2 was ranged between 0 to 0.012 mg/L, PO_4 was ranged between 0.29 to 1.28 mg/L and NH_3 was ranged between 0.36 to 0.49 mg/L.

The concentrations of anion groups in the selected samples were high and might has affecting on the health of the customers of tea as showed; PO_4 was ranged between 0.29 to 1.28 mg/L and NH_3 was ranged between 0.36 to 0.49 mg/L but moderate in SO_4 was ranged between 16 to 35 mg/L, NO_3 was ranged between 0.1 to 5.8 mg/L, NO_2 was ranged between 0 to 0.012 mg/L,

The concentrations of nontoxic heavy metals in tea samples were high in Ca concentration (mg/kg) the maximum concentration was 173.31 in sample 10 and minimum concentration was 48.55 in sample 4, the second metals Fe concentration (mg/kg) the maximum concentration was 49.861 in sample 5 and minimum concentration was 7.7191 in samples 15, the third metals K concentration (mg/kg) the maximum concentration was 158.96 in sample 3 and minimum concentration was 101.69 in sample 15, the fourth was Mg concentration (mg/kg) the maximum concentration was 150.24 in sample 2 and minimum concentration was 24.913 in sample 15, Mn concentration (mg/kg) the maximum concentration was 239.38 in sample 15 and minimum concentration was 30.3 in sample 14, Mo concentration (mg/kg) the maximum concentration was 0.0154 in sample 1 and minimum concentration was 0 in samples 2-5, 8-9,11, and Na concentration (mg/kg) the maximum concentration was 73.346 in sample 9 and minimum concentration was 17.388 in sample 5 respectively.

In table-4 it refers to toxic heavy metals in tea samples such as Al concentration (mg/kg) the maximum concentration was 47.276 in sample 4 and minimum concentration was 18.925 in samples 7, As concentration (mg/kg) the maximum concentration was 0.1144 in sample 1 and minimum concentration was 0.0323 in sample 15, Cd concentration (gm/kg) the maximum concentration was 0.0339 in sample 1 and minimum concentration was 0 in samples 8-9, 13-15, Cr concentration (mg/kg) the maximum concentration was 1.9132 in sample 4 and minimum concentration was 0 in samples 11, Pb concentration (mg/kg) the maximum concentration was 72.317 in sample 7 and minimum concentration was 0.1185 in samples 12 and sb concentration (mg/kg) the maximum concentration was 0.0172 in sample 7 and minimum concentration was 0 in all samples except sample no 7 the concentration was 0.0172 (mg/kg)

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