

Assessment of Potential Health Risks Associated with Dry *Camellia sinensis* (Black Tea) in Nairobi's Markets

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ABSTRACT

Tea stands as the most globally consumed beverage, and its consumption is known to be beneficial to human health due to its diverse essential components. The scrutiny of trace levels of heavy metals in tea has gained significant attention, given their potential health implications. The focus of this study is to assess the health risk associated with *Camellia sinensis* (black tea) with a view on their heavy metal concentrations. To collect information regarding the occurrence of heavy metals in *C. sinensis*, a comprehensive survey was conducted in the tea markets of Nairobi. A total of 36 samples of black tea were analyzed for the presence of heavy metals. The average levels of heavy metals were Pb (1.92 ± 0.67 mg/kg), Cu (9.4 ± 1.51 mg/kg), Zn (13.625 ± 1.82 mg/kg), and Fe (81.15 ± 18.52 mg/kg). The results indicated that all levels of heavy metals fell within acceptable ranges, posing no potential risk associated with tea consumption. The data within this database could be utilized to establish acceptable limits for additional heavy metals in tea

Keywords: Black tea, *Camellia sinensis*, Health risks, Heavy metals, Nairobi

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INTRODUCTION

Tea is one of the world's most popular beverages, and its health advantages are well known including medicinal properties (Brimson *et al.*, 2021). Tea may be a good source of manganese, and the high potassium content may be advantageous for hypertensive people (Am *et al.*, 2021). Heavy metal contamination in food and beverages is damaging to human health, and numerous nations have enacted food rules to limit heavy metal concentrations in food and beverages. The potential health effects of trace metals in tea have been examined in many papers, as the tea bush is known to acquire those (Tao *et al.*, 2021).

The contents of numerous elements in several portions of the tea plant, such as the shoot, mature leaf, small stem, tick wood, and root, in black tea prepared by the crush-tear-curl and orthodox procedures, and in the tea brew, were examined by Bajaj (2021). There are a few papers on the presence of heavy metals in tea and the analytical challenges connected with separating them from tea leaves (Nnabuife *et al.*, 2022).

Heavy metals are mostly found in plants' growth media, nutrition, agro inputs, and soil. Pesticides and fertilizers are possible additional sources. Plants are harmed by high heavy metal levels, which result in delayed flowering, decreased chlorophyll content, and a reduction in the number and quality of shoots (Asif *et al.*, 2019).

We don't have a lot of information on the heavy metal content of black tea from south India, which produces roughly 230 million kg of tea per year and exports nearly half of it. About a hundred tea samples were collected and evaluated for heavy metals such as nickel, chromium, lead, cadmium, and copper in different factories in southern India. Many components have an important role in human metabolic processes and overall health. Copper in trace amounts is necessary for human health. Zinc, manganese, iron, copper, magnesium, titanium, aluminum, strontium, bromine, sodium, potassium, phosphorus, iodine, and fluorine are all found in tea leaves. The tea infusion is low in protein, vitamins, and carbs; however, it may include important dietary metals and metal binding polyphenols (Ghuniem *et al.*, 2019).

MATERIALS AND METHODS

Sample collection

A total of 36 black tea samples were collected from different markets in Baghdad city. Collection was used numeric plastic bags full size 500 gram for 1 month of work.

Samples were brought to the laboratory and kept to analyst.

Sample preparation

The glassware containers used in the study were washed with tap water before being immersed overnight in 6 N HNO₃ solutions and rinsed with ultra-pure water multiple times to remove detergent absorption (Cabrera *et al.*, 1994). The standard approach outlined in Official methods of analysis of Association of Official Analytical Collaboration (AOAC) (2000) was used to prepare samples for heavy metal analysis. Before 5 ml of 6 M HCl was poured into the crucible, a prepared tea sample was carefully weighed (0.5 g) and placed in a silicon crucible that was heated in a muffle furnace for 3 hours at temperature 450°C for aching.

It was ensured that every ash particle came into contact with the acid. To achieve a clean solution, the crucible containing the acid solution was heated and digested. Dissolving the final residue in 0.1 M HNO₃ solution yielded up to 50 mL. To create standard solutions, Perkin-Elmer Pure Atomic Spectroscopy Standards (NIST traceable CRM, Perkin-Elmer Corporation, USA and Merck – Germany) were utilized. Working standard solutions were prepared by diluting the stock solution with 0.1 M nitric acid to confirm the linearity (Hadi and Thalij, 2019; Soylak and Narin, 2005).

Analytical procedure

Cu, Pb, Zn, and Fe in tea samples were evaluated using an atomic absorption spectrophotometer (AA Analyst 800, Perkin-Elmer Corporation, USA) with flame and graphite furnace. An air-acetylene flame was used to determine the metal content. For Cu, Pb, and Zn, the instrument was operated in flame mode with acetylene 2 ml/min and air 17 ml/min, and in graphite furnace mode (Pb and Fe), the manufacturers' inert argon gas flow and temperature parameters were followed.

Data from triplicate measurements were rounded off to the nearest tenth of a standard deviation. Metal content in black tea samples was determined using the described approach. 1 g of tea was put to a mixture of 9 mL concentrated HNO₃ and 3 mL concentrated HCl in a beaker to digest these samples. With distilled water, the sample volume was increased to 25 mL after digestion. Blanks were made in the same way as the sample and went through the same pre-concentration technique as the sample.

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RESULTS AND DISCUSSION

The results of analysis of the *Camellia sinensis* sample are summarized in (Table 1). In *C. sinensis*, Pb was (1.9200 ± 0.70158) ppm, Cu was (9.400 ± 1.5736) ppm, Zn was (13.625 ± 1.9046) ppm, and Fe was (81.150 ± 19.3415) ppm.

The results of this study showed that all tested metals in all samples of the study were under the warning level, which mean that consuming the tea is safety for the human health (Table 2). Pb level recorded in tea samples by this

study found to be less than recorded in Turkey, but it was more than recorded in KSA and Japan. Cu, Zn, and Fe levels receded in tea samples in this work found to be less than those recorded in Turkey, KSA, and Japan (Table 3). In general, the levels of Fe were recorded in more levels than the other elements. The Pb content of all of the made tea samples in our study was less than 10 mg kg⁻¹, which was the limit set by the PFA Act (Fig. 1).

Table 1: Descriptive statistics of heavy metals levels recorded in tea samples by atomic absorption spectrophotometer

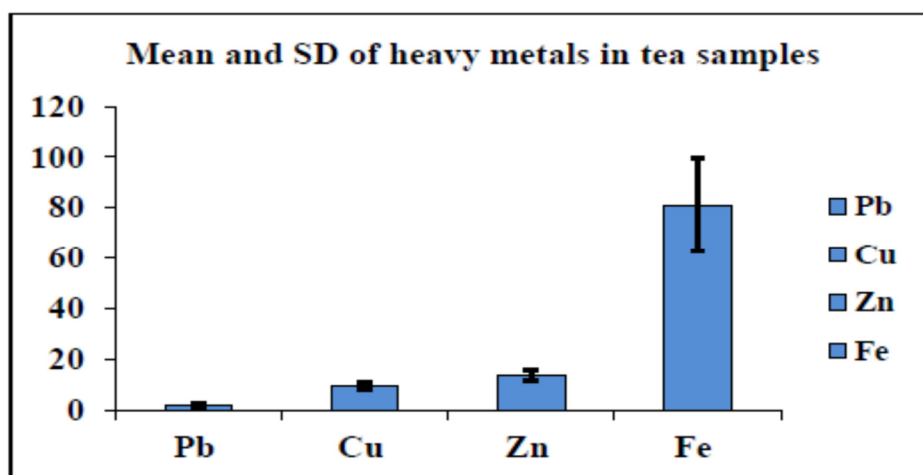
Descriptive Statistics						
Metal	N	Range	Minimum	Maximum	Mean	Std. Deviation
Pb ppm	12	1.69	1.31	3.00	1.9200	0.70158
Cu ppm	12	6.6	5.7	12.3	9.400	1.5736
Zn ppm	12	6.9	10.3	17.2	13.625	1.9046
Fe ppm	12	53.3	54.7	108.0	81.150	19.3415
Valid N (listwise)	12					

Table 2: Normal and warning levels of heavy metals recorded in tea samples by atomic absorption spectrophotometer

No.	Pb ppm	Cu ppm	Zn ppm	Fe ppm
1	3.0	8.7	11.4	108.0
2	1.87	9.6	13.2	93.0
3	1.52	10.2	12.4	61.4
4	1.31	9.3	13.2	54.7
5	1.35	10.5	16.2	62.0
6	1.45	9.9	13.9	66.7
7	1.52	10.2	17.2	88.0
8	1.35	5.7	10.3	66.7
9	1.32	9.3	13.4	70.7
10	2.85	12.3	13.6	100.0
11	2.55	9.0	15.2	96.0
12	2.95	8.1	13.5	106.6
Mean $\pm$ SD	1.92 $\pm$ 0.67	9.4 $\pm$ 1.51	13.625 $\pm$ 1.82	81.15 $\pm$ 18.52
Range	1.31-3	5.7-12.3	10.3-17.2	54.7-108
Normal level (A) (mg/kg/day)	20	20	-	-
Warning threshold (mg/kg)	50	100	20	
Normal level (B) (mg/kg/day)	0.3	73.3	-	-
RfD (Mgkg ⁻¹ Element Bwday ⁻¹)	3.5 $\times$ 10 ⁻³	4 $\times$ 10 ⁻²	3 $\times$ 10 ⁻¹	0.7

Table 3.: Heavy metal levels in tea recorded in different countries comparing with our study

Metal	This study	Iraq (Hadi and Karkaz 2016)	KSA	Turkey	Japan
Pb	1.92 ± 0.67	0.37±0.03	1.7± 0.8	8.3±0.1	0.71±0.02
Cu	9.4±1.51	1.53±0.06	18.1±6.9	24.8±1.4	27.7±0.7
Zn	13.6±1.8	4.02±0.67	65.7±31.3	140.9±9.1	36.6±0.7
Fe	81.1±18.5	NA	250.5±199	NA	134±48

Fig.1: Mean and SD of heavy metals recorded in *Camellia sinensis* samples collected from Nairobi markets

The amount of heavy metal in black teas collected from various locations of Baghdad city varied significantly. The amounts of Pb, Cu, Zn, and Fe in tea varied depending on the agroclimatic zone, according to the findings. Tea is consumed in around 3 billion cups each day around the world (Chen, 2002).

The daily average intake of tea in Iraq is roughly 0.5 liters of black tea (Hashim et al., 2019). Tea consumption per capita in the United States was estimated to be 7.3 gallons in 1988 (Tipton et al., 1990). Although the use of copper in small amounts poses no health or environmental risk, excessive use will result in undesirable copper levels in black tea. According to the investigation, copper concentrations in prepared tea samples ranged from 15.9 to 32.2 mg kg⁻¹. Copper is a naturally occurring metal found in tea that is required for the polyphenol oxidase enzyme to function. Along with Al and Zn, it is one of the most significant components in tea. Nilgiris tea samples had the lowest copper levels, whereas Gudalur tea samples had the highest (Xie, 1998). Researchers were reported on the

content of copper in produced tea (Ferrara et al., 2001). All of the produced tea samples had a Cu level of less than 30 mg kg⁻¹, well below the 150 mg kg⁻¹ allowed by India's Prevention of Food Adulteration Act. Potassium fertilizers, phosphate fertilizers, N-P-K mixes, manganese, zinc, boron, and magnesium sources all contain lead (Franklin et al., 2005).

Zinc is used as a foliar spray to feed zinc, which is the only micronutrient that is frequently deficient in tea. Pb may penetrate the tea plant when foliar applied zinc sulphate tainted with lead. Copper fungicides sprayed with heavy metal impurities may promote the accumulation of Pb and Cd in tea. One of the most common sources of Pb contamination is copper oxychloride (Semu and Singh, 1996). Because tea soils are acidic, heavy metals dissolve more easily. Tea bushes in high traffic areas are exposed to Pb and Cd from automotive exhaust and dust (Tsushida and Takeo, 1977). The average Pb level in Chinese black tea samples was 1.42 mg kg⁻¹. (Xie, 1998).

CONCLUSION

Copper and Lead levels in black tea from south India were below the PFA limit of 150 and 10 mg kg⁻¹, respectively, according to a database created for heavy metals in black tea. The data produced could be used to set tolerance limits in tea for other heavy elements as chromium, nickel, and cadmium.

AUTHOR'S CONTRIBUTION

HANON, D., OBAIDI, A.R and OBAIDI, J.D.: Wrote the manuscript, design carried out the research in the Laboratory

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CONFLICT OF INTEREST

The authors declare that there is no any conflict of interest in whatever manner with this research

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