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DETERMINATION OF SOME ESSENTIAL METALS IN DIFFERENT TEA LEAVES MARKETED IN KANO, NIGERIA

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ABSTRACT

This research was conducted to assess the level of some metals in varieties of tea leaves marketed in Kano, Nigeria using atomic absorption spectrophotometric technique. Six brands of tea leaves were obtained and analyzed for their metal concentrations. The tea leaves samples were coded as ATL, STL, DCL, YTL, GTL, TTL to conceal the original source. The analyzed metals include copper (Cu), iron (Fe), manganese (Mn), calcium (Ca) and magnesium (Mg). The results obtained for the metals were 8.50±0.04 – 20.55±0.06 mg/kg; 10.34±0.01 – 24.02±0.07 mg/kg; 41.15±1.03 –167.45±1.41 mg/kg; 53.30±0.06 –71.20±0.03 mg/kg and 61.57±1.75 – 370.75±1.04 mg/kg respectively. Generally, the levels of iron, manganese, calcium and magnesium (except for ATL) were below the values set by World Health Organization (WHO), United State Pharmacopeia (USP) and Standard Organization of Nigeria (SON).The concentration of copper in almost all the samples was slightly above the permissible limit of 10.00 mg/kg. Results from this study show that all the tea leaves analyzed are good sources of essential metals and are safe for human consumption.

Key words: Essential Metals, Tea leaves, Atomic Absorption Spectrometry, Standard Organizations.

INTRODUCTION

Tea (*Camellia sinensis* L.) is one of the most popular non alcoholic beverages, consumed by over two-thirds of the world's population for its medicinal, refreshment and mild stimulant effects (Sabukola *et al.,* 2010). Tea leaves contain polyphenols such as epigallocatechin 3-gallate, which has many medicinal properties, including antioxidant cholesterol-lowering (He *et al*., 2003), hepatoprotective (Nain, 2004) and anticancer activities (Karimi *et al.,* 2008).

Moreover, its detoxifying properties are essential in the elimination of alcohol and toxics (Nain, 2004). However, considering that an estimated 18 billion cups of tea are consumed daily worldwide (Sabukola *et al.,* 2010), its economic and social importance is unprecedented. In fact, tea has been reported to be valuable in the treatment and prevention of many diseases (Zaidi *et al.,* 2005). Ideally, tea should be free from contaminants such as metals, which are toxic and harmful to the human body because of their non-biodegradable nature, long biological half-lives and persistent accumulation in different body parts (Sahito, 2005). Tea is consumed in all of Nigeria throughout the year, and Nigeria is one of the tea producing and exporting countries in the world (Al-Othman, 2012).

Although essential metals are required for human health, excessive intake can be toxic at the same time. For example, excessive intake of copper can impair organs and systems in the human body, possibly causing serious symptoms including nauseas, vomiting, kidney failure and central nervous system depression (Hashemi *et al.,* 2011). Other essential metals like manganese can cause neurotoxic side effects when the homeostatic range is exceeded (WHO, 2012).

Musa *et al.* (2017) examined that tea is very popular beverage in the world and contains several essential nutrients as well as toxic metals. Their study indicated concentration of metals in tea cultivated soil and tea leaf determined by atomic absorption spectroscopy (AAS) as of Cr > Ni > Pb > Cd.

Satsanana (2016) also reported the amount of metals in green tea at concentrations higher than the permissible level. The researchers used flame atomic absorption spectrometric technique to determine the concentrations of Co, Cd, Cu and Pb in five different green tea samples.

This research was conducted to assess the levels of some metals in different varieties of tea leaves in order to provide information on the concentrations of these elements in the tea leaves and to compare the results found with values provided by Standard organizations, hence evaluate the compositional suitability of the analyzed tea leaves.

MATERIALS AND METHODS

All reagents used were of analytical grade. Distilled water was used as solvent to prepare the solutions, and all glassware's were washed, cleaned and dried.

Sample Collection

Six different tea leaves samples commonly consumed in Kano state, Nigeria were obtained from Sabon Gari market in Kano metropolis. The tea leaves samples were labeled as:
ATL = Alhimiliya tea leaves; STL = Sultan tea leaves; DCL = Dala city leaves; YTL = Yellow label tea leaves; GTL = Glove tea leaves and TTL = Top tea leaves.

Sample Pre-Treatment (Drying and Grinding)

The tea leaves were dried at 70^{o}C for 2 hr in an oven and ground using pestle and mortar until a powder was produced which was stored in an air-tight plastic container.

Digestion of Tea Leaves Samples

One gram (1.0 g) of each dried powdered tea leaves was weighed into a Pyrex beaker of 250 cm^3 capacity and 10 cm^3 of 1M nitric acid was added. The mixture was digested on hot plate for about 1 hr until completion and filtered into a 50 cm^3 volumetric flask. The precipitate left was washed with nitric acid (1M) and transferred to the 50 cm^3 volumetric flask and made up to the level with distilled water before analysis using atomic absorption spectrophotometer (Saud, 2008).

RESULTS AND DISCUSSION

The results in Table 1 show the concentration of metals in tea leaves samples, the mean and the permissible values set by standard organizations.

Table 1: Metal concentrations in various tea leaves samples analyzed

S/N	Sample	Cu (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Ca (mg/kg)	Mg (mg/kg)
1.	TTL	8.50±0.04	15.26±0.03	125.75±0.95	53.30±0.06	61.57±1.75
2.	GTL	17.55±0.13	23.40±0.07	41.15±1.03	59.70±0.07	294.70±0.59
3.	YTL	10.35±0.01	13.05±0.01	167.45±1.41	66.00±0.00	261.88±0.92
4.	DCL	20.55±0.06	14.54±0.02	109.68±1.51	56.00±0.00	239.54±2.19
5.	STL	18.25±0.05	10.34±0.01	BDL	71.20±0.03	126.02±0.89
6.	ATL	12.85±0.03	24.02±0.07	108.25±1.01	69.10±0.02	370.75±1.04
	Average	14.70±0.40	16.77±0.02	92.04±0.3	62.55±0.001	225.75±2.33
	WHO/FAO & USP	10.00	25 & 18	200	800 & 1000	350

BDL = below detection limit

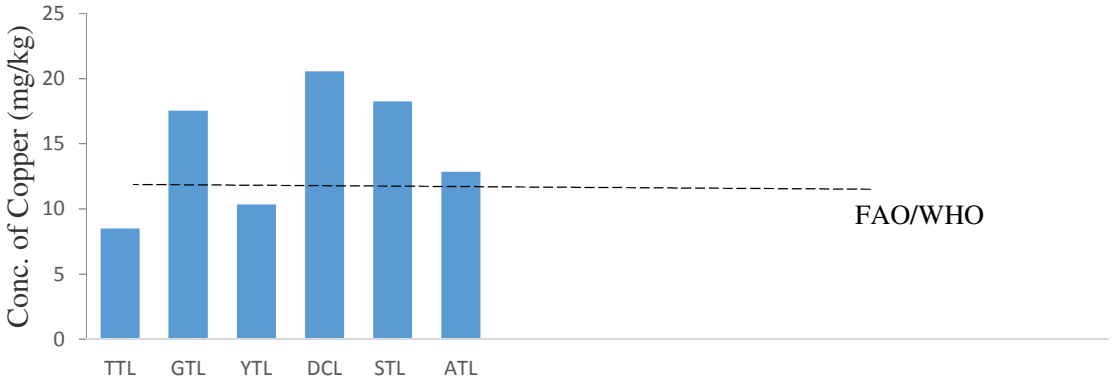

Figure 1: Distribution of Copper in Tea leaves

The copper levels obtained are shown in Figure 1 with a mean of 14.70±0.40 and values ranging between 8.50±0.04 – 20.55±0.06 mg/kg. Malik (2008) reported copper levels in the green tea from India and Japan as ranging from 23.1 mg/kg to 36.5 mg/kg which is quite above the concentration obtained in green tea for this study (17.55 mg/kg). In another study, Soylak (2007) reported that copper levels in varieties of tea leaves ranged from 6.39 mg/kg to 9.84 mg/kg indicating much lower copper levels than some samples examined in the present study. The mean concentration of Cu determined was higher than the recommended value of 10.00 mg/kg each (FAO/WHO, 2002).

However, according to Ning (2011), the regulations imposed upon tea in Japan of 100 mg/kg and the United States (150 mg/kg), the Cu levels in the tea samples studied were all below the limits.

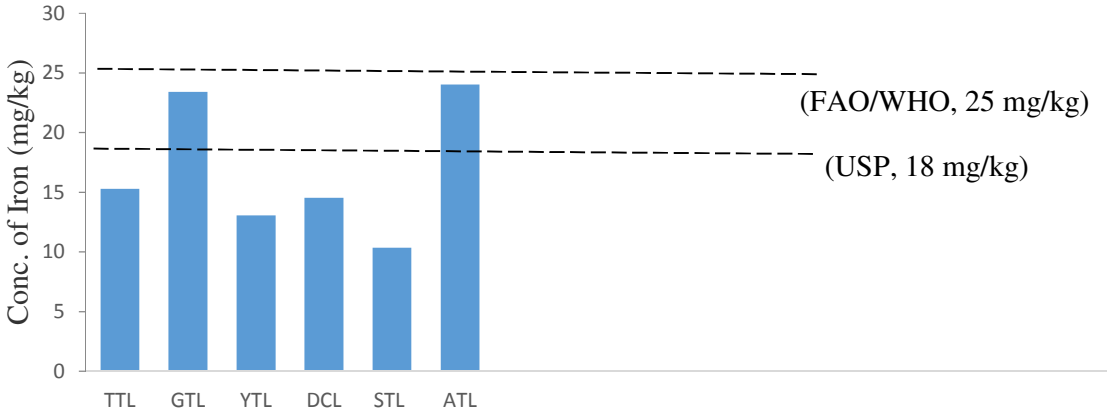

Figure 2: Distribution of Iron in Tea leaves

Figure 2 shows the distribution pattern of iron which ranged from 10.34 ± 0.01 – 24.02 ± 0.07 with a mean of 16.77±0.02 mg/kg. The Alhimilaya tea (ATL) has highest iron content of 24.02 mg/kg. The mean concentration of Fe (16.77±0.02 mg/kg) was below the World Health Organization which is 25 mg/kg. In a similar finding Street *et al.* (2006) reported lower average value of 13.40 mg/kg for different tea leaves.

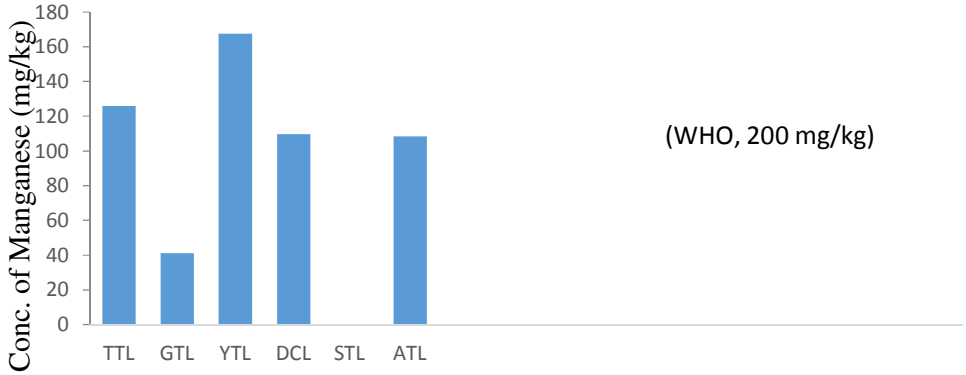

Figure 3: Distribution of Manganese in Tea leaves

Manganese is detected in all the tea leaves analyzed (Figure 3). The highest content of manganese was found in Yellow tea leaves (167.45 mg/kg). The tolerance limit of Mn in tea leaves stipulated by WHO is 200 mg/kg (WHO, 2002). The mean value of Mn determined in this study (92.04±0.30 mg/kg) was below the WHO limit and the proposed limit reported for Mn by Street *et al.* (2006) and Nain (2004) as 250 mg/kg and 300 mg/kg respectively.

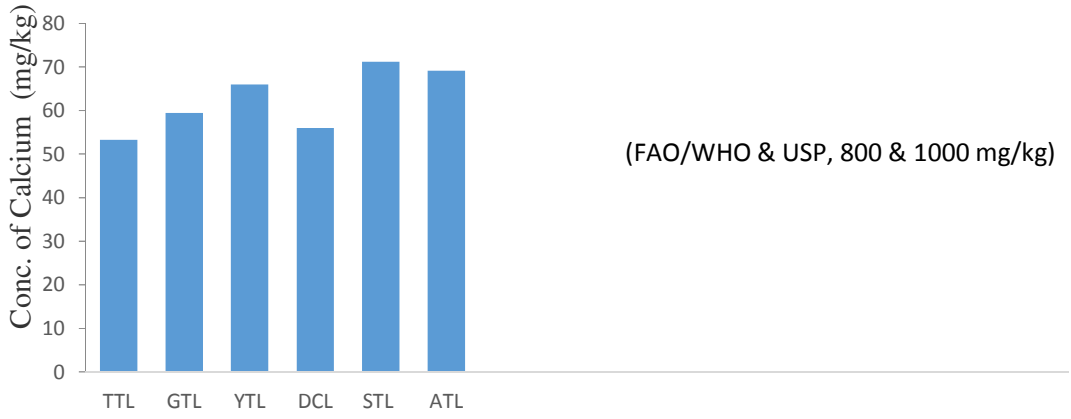

Figure 4: Distribution of Calcium in Tea leaves

Calcium appeared to be the third most abundant essential elements found in the different brand of tea leaves in this study. Figure 4 shows that the calcium content in tea sample varied between 53.30 to 71.20 mg/kg with a mean of 62.55±0,001 mg/kg. The concentrations of calcium in all the tea brands are within the maximum allowable limit of 800 and 1000 mg/kg set by World Health Organization (FAO/WHO, 2012).

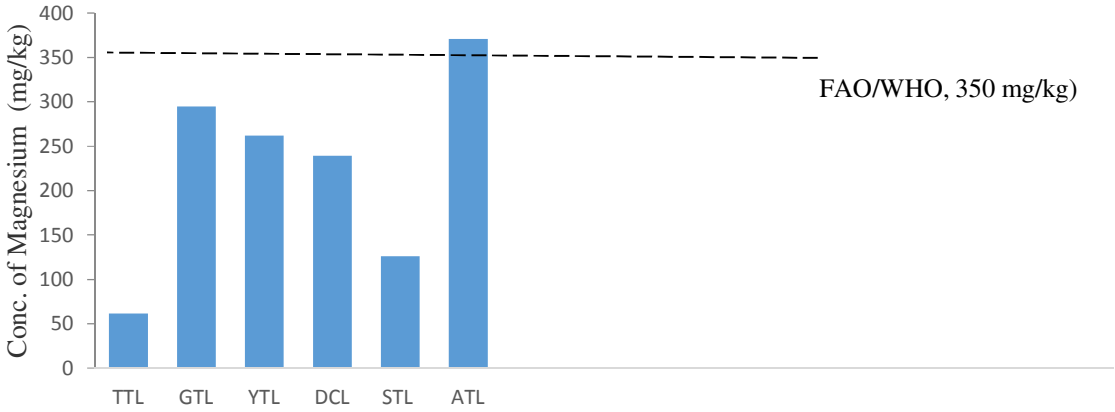

Fig. 5: Distribution of Magnesium in Tea leaves

The content of magnesium in tea leaves are below the permissible limit with the exception of ATL. The average magnesium content was 225.75±2.33 mg/kg which is below the limit set by FAO/WHO of 350 mg/kg. Magnesium emerged to be the most abundant of the metals determined. The concentration of magnesium ranged from 61.57±1.75 – 370.75±1.04 mg/kg. These values show that, tea is a good source of this essential element.

CONCLUSION

Results from this study indicated that the levels of the metals (Cu, Fe, Mn, Ca and Mg) in tea leave samples widely vary among different tea brands and types. The concentrations of iron, manganese, calcium and magnesium in most of the samples were lower than the value set by World Health Organization in order of 25, 200, 800 and 350 mg/kg respectively. However, copper was found to be above the limit (10 mg/kg) set by the standard organizations. Conclusively, the tea leaves analyzed are good sources of essential metals and are safe for human consumption.

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