ASSESSMENTS OF HEAVY METALS IN HIGHLAND GREEN TEA LEAVES IN KAKARA DISTRICT OF TARABA, NIGERIA

Supported by tetfund

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Received: March 09, 2020 **Accepted:** November 14, 2020

Abstract: The levels of heavy metals were determined in green tea leaves samples collected from Kakara tea estates, Taraba State. The concentrations of heavy metals were determined by the use of AAS. The concentration of Ca, Cd, Co, Cu, Fe, K, Mn, Ni, Pb, and Zn in all the green tea leaves samples collected across the season ranged from [0.982-3.566], [0.014-0.029], [0.010-0.071], [0.059-0.204], [0.066-0.755], [19.98-38.66], [0.106-0.369], [0.008-0.031], [0.006-0.099] and [0.080-0.199] mg/kg, respectively. The result analysis showed that the mean concentration of heavy metals were higher in wet season than in dry season in green tea leaves, among the metals analyzed K, Ca and Fe were the most abundance in all the samples. The concentrations of all the metals were low and within the international statutory safe limits.

Keywords: Tea leaves, dry season, heavy metal, Mambilla plateau, wet season

Introduction

Tea is prepared from the leaves of the shrub *Camellia sinensis*. Tea is a perennial plant and once planted can last over 100 years of economic production when good agronomic and cultural practices are carried out (Owuor *et al.*, 2008). Its cultivation is restricted to subtropical regions and mountainous areas of the tropics, where altitudes are in the range of 1200 – 1800 m above sea level with temperature regimes of 10 – 27^{0}C without frost. This explains why tea can only be grown at very few locations in West Africa (Asogwa, 2007).

The quality of tea depends on its cultivation conditions, the soil in which it grows, the degree of contamination, and numerous meteorological conditions (Brzezicha-Cirocka *et al.*, 2016). In Nigeria, Tea is successfully produced in the Mambilla plateau of Taraba State where a substantial quantity is produced by the native out-growers. Tea thrives well only in this area because of the favorable climate.

Tea leaves contain polyphenols such as epigallocatechin 3-gallate, which has many medicinal properties, including antioxidant cholesterol-lowering hepatoprotective and anticancer activities, it detoxify alcohol and toxins. About 18 billion cups of tea are consumed daily worldwide from estimation. Drinking tea is considered beneficial to human health. Besides beneficial healthy function, the fascinating aroma and comfortable taste attract people to enjoy tea, especially young people. Since tea is valuable in the treatment and prevention of many diseases, tea should be free from contaminants such as heavy 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 (Rashid *et al.*, 2016; Chen *et al.*, 2017).

The quality of tea is important for the development of the tea industry, tea farmers' income, and the health of tea drinkers. In particular, heavy metals in tea are important indicators in the process of tea quality evaluation, as they can be transferred into tea infusions through the process of brewing tea, then enter the human body by means of tea consumption, and thus pose potential risks to human health. Hence the chemical components in tea, particularly heavy metals, have received great attention because they are related to human health. According to the national food safety standard (GB 2762-2017), tea heavy metals limited standards, the standard limit values are 5.0, 30, 2.0, 0.3, 1.0, and 5.0 mg kg 1 for Pb, Cu, As, Hg, Cd, and Cr, respectively. It was reported that heavy metals (Pb, Cd, Cr, As, Mn, Hg, and Cu) pollution has occurred in some tea garden soils in recent years as a result of high soil background values, the application of pesticides and chemical fertilizers containing heavy metals, and industrial activities (Parviz *et al*., 2015 ; Jian *et al*., 2018).

Heavy metal contaminants might accumulate during tea growth, transportation, packaging, and processing. Heavy metals are harmful to human health. Lead (Pb), for instance, has carcinogenic properties, and it impairs both the respiratory and digestive systems and suppresses the immune system; this metal is particularly harmful in children, damaging their intelligence and nervous systems. Cadmium (Cd) accumulates easily in the circulatory system, kidney (especially the renal cortex), lung, and heart, and is toxic to bones and gonads. Chromium (Cr) can exist in several oxidation states. Hexavalent chromium (VI) is highly soluble and mobile and is harmful to the skin, liver, kidney, and respiratory organs causing various diseases, such as dermatitis, renal tubular necrosis, perforation of the nasal septum, and lung cancer. Excessive copper (Cu) intake can cause nausea, vomiting, kidney failure, blood cell damage, and central nervous system inhibition. Nickel (Ni) is primarily accumulated in the spinal cord, brain, and organs due to its mutability and carcinogenicity (WHO, 1994; Zhong *et al.*, 2016).

Interest in green tea is on increased recently. Besides many biologically active substances such as polyphenols and tannins, tea also contains bio elements as well as toxic metals such as cadmium (Cd) and lead (Pb). Therefore, it is important to monitor the concentration of these metals, especially in view of permissible limits for growth and good health (Brzezicha-Cirocka *et al.*, 2016). Several attempts have been made by many researchers to assess tea quality by chemical analysis with reference to pigmentation and flavorings characteristics in other places. However, the objective of this investigation is to assess the heavy metals concentration in tea leaves grown at Kakara village of Sardauna Local Government Area of Taraba State, Nigeria.

Material and Methods

The study was carried out in the Mambilla plateau in Sardauna Local Government Area of Taraba State (Fig. 1) which has an altitude of 1,800 m above sea level' the plateau forms part of the chain of the Adamawa and Mandara mountains is located between altitude 5º30º to 7º18ºN and longitudes 10º18º to 11º to 37ºE has a land mass of 8,3865 km. Kakara tea estates situated on the floor of North east left valley in Nigeria. Green tea leaves were collected in

according to standard methods described by Nath, (2013). A total of about twelve (12) green tea leaves were collected from four (4) cultivated tea farms, the research was conducted monthly from September, 2015 to February, 2016. The map of the study areas are given in Fig. 1 and heavy metals (Cd, Fe, Pb, Ni, Zn, Mn, Co, Cu, Ca and K) in green tea leaves samples were then estimated by AAS after proper digestion and analytical procedure (Joseph *et al.*, 2009).

W 1: Mouth of the Dam; W 2: Mid of the Dam; W 3: Outlet of the Dam; W 4: Tap water (Irrigation Farm); T S. 1-10 are Tea Farms

Fig. 1: Map of the study area (showing the tea leaves sampling station)

Result and Discussion

Figure 2 shows the result of heavy metals in tea leaves samples analyzed during wet and dry seasons at different locations. For wet season the concentration of Ca, Cd, Co, Cu, Fe, K, Mn, Ni, Pb and Zn ranges from 2.311 to 3.566 mg/kg, 0.017 to 0.029 mg/kg, 0.022 to 0.071 mg/kg, 0.087 to 0.204 mg/kg, 0.139 to 0.755 mg/kg, 16.02 to 38.666 mg/kg, 0.127 to 0.369 mg/kg, 0.017 to 0.031 mg/kg, 0.006 to 0.099 mg/kg and 0.088 to 0.199 mg/kg for different farms, respectively. And for dry season the concentrations of Ca, Cd, Co, Cu, Fe, K, Mn, Ni, Pb, and Zn ranges from 0.982 to 2.680 mg/kg, 0.014 to 0.021 mg/kg, 0.010 to 0.022 mg/kg, 0.059 to 0.132 mg/kg, 0.066 to 0.409 mg/kg, 19.989 to 23.066 mg/kg, 0.106 to 0.360 mg/kg, 0.008 to 0.012 mg/kg, 0.008 to 0.022 mg/kg and 0.080 to 0.170 mg/kg for different farms, respectively.

The result shows the ability of these samples accumulating with heavy metals. The concentration of pollutants was maximum in wet season, thus indicating an increase in heavy metals levels in the rainy season over those in the dry season. This may be attributed to the possibility of the runoff from the surrounding farm containing metal salts being washed into the sample site, or application of fertilizes, animal wastes and herbicides to improve the tea productivity during rainy season (Rao, 1998; Zaharaddeen *et al.*, 2015).

From the result obtained the concentration of Ca in tea leaves with a mean of 2.790 ± 0.550 mg/kg, during wet season. Also in dry season from the result obtained Ca in tea leaves with a mean of 2.018±0.550 mg/kg. These concentrations were lower as reported by Kazi *et al*. (1999). Similarly, for Cd the highest concentration 0.023 ± 2.105 mg/kg recorded in tea leaves during wet season, also dry season, the value recorded was 0.018 ± 1.276 mg/kg for tea leaves. In this research it was observed that the concentration of Cd is lower than that of Bansal (2004).

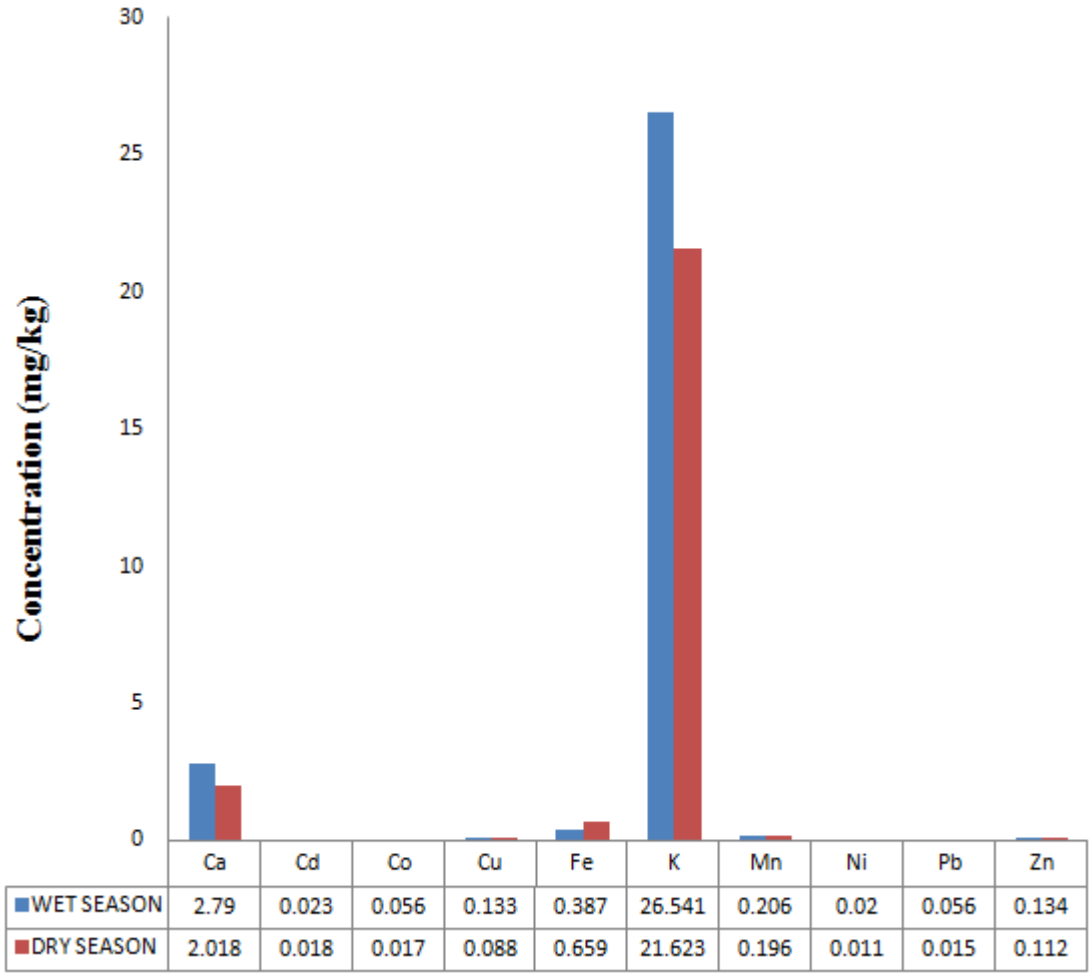
The level of Co in the samples were shown, from the result obtained Co has the highest concentration in wet season with means concentration of 0.017 ± 2.025 mg/kg in tea leaves. Similar for dry season Co recorded 0.056±0.025 mg/kg tea leaves. The result obtained is lower than that of Xing and Chen (2004).

The result show that the concentration of Cu was highest in wet season with a mean concentration of 0.133 ± 0.52 mg/kg leaves, comparing the season in all the samples, the mean concentration during dry season was recorded 0.088 ± 0.031 mg/kg in tea leaves. The result obtained showed lower value than those values reported by Saud Al-Qud (2003).

The result obtained show that the mean concentration of Fe in the samples during a wet season was 0.387 ± 0.279 mg/kg in Tea leaves. However, in dry season the mean concentration of Fe was 0.659 ± 0.113 mg/kg in tea leaves. Potassium which is the most common from this finding, K has mean concentration of 26.54 ± 2.35 mg/kg in tea leaves during wet season, while the mean concentration of K in dry season was 21.623 ± 1.82 mg/kg in tea leaves.

The result obtained from this analysis show that Mn has a mean concentration of 0.206 ± 0.113 mg/kg in tea leaves during wet season. Also the mean concentration of Mn was 0.196 ± 0.112 mg/kg in tea leaves during dry season. Comparing the values of Mn in wet and dry season from this research, it was found that the concentration is higher in wet season and also when compared with Ansari *et al.* (2007), it was lower.

The average concentration of Ni was determined in this research as 0.020 ± 2.676 mg/kg in tea leaves was analyzed during wet season, while in dry season the average concentration of Ni was observed as 0.011 ± 1.916 mg/kg in tea leaves. The comparison of Ni in two seasons, show that the average of Ni in wet season is higher than that of dry season. Results obtained were lower than those described in the literature (Nath, 2013).



	Ca	Cd	Co	Cu	Fe	K	Mn	Ni	Pb	Zn
WET SEASON	2.79	0.023	0.056	0.133	0.387	26.541	0.206	0.02	0.056	0.134
DRY SEASON	2.018	0.018	0.017	0.088	0.659	21.623	0.196	0.011	0.015	0.112

Fig. 2: Seasonal variation of heavy metals in Tea leaves samples collected from Kakara tea estates

The level of Pb in the samples were observed at a mean concentration of 0.056 ± 0.045 mg/kg in a tea leave during wet season, while during dry season the mean concentration of Pb 0.015 ± 2.318 mg/kg in tea leaves. In study by (Sreenivasan *et al.*, 2010) have found that Cd and Pb in tea were 0.14 ± 0.06 and 0.81 ± 0.32 mg/kg in tea sample collected from different areas. The result of Zn was 0.134 ± 0.052 mg/kg in tea leaves during wet season, while in dry season the average concentration of Zn is 0.112±0.041, lower than the result obtained by Ansari *et al.* (2007).

However the average concentration of metals was determined as mean values which appear to be quite high in wet season. Furthermore from the results obtained, generally increase in heavy metals levels were observed in the samples during the wet season. The study shows that the level of heavy metal analyzed seasonally are within a safe limits or permissible limit as specified by the U.S FDA for edible plants part similar to food, soil and water from other part of the world ECDG (2010).

Conclusion

The result shows that the heavy metals concentration in all the samples analyzed were found to be higher in wet season than in dry season, the level of heavy metals in the sample analyzed was below the permissible limit. Toxicity of food materials is of much great concern today than ever before, hence the maximum allowance and safe concentration of each heavy metals in tea leaves is urgently needed. It is recommended that more locations (Tea estates) in Taraba State should be monitored.

Conflict of Interest

Authors declare that there is no conflict of interest related to this work.

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