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INVESTIGATION OF HEAVY METALS IN SELECTED SAMPLES OF CIGARETTE BRANDS SOLD IN ANYIGBA MARKET AND TOBACCO LEAVES GROWN IN ANYIGBA, KOGI STATE, NIGERIA.

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ABSTRACT

Selected heavy metals in popular cigarette brands sold in Anyigba and tobacco leaves grown in Anyigba, Kogi State were determined by Atomic Absorption Spectrophometer (AAS). Average Concentration of Cadmium (Cd), Zinc (Zn) and Lead (Pb) in different cigarette brands and tobacco leaves were determined as; Zn: 6.11 – 22.35 mg/kg, Cd: 1.01 – 2.07 mg/kg and Pb: <0.01 mg/kg for cigarettes while tobacco leaves are Zn: 90.1 mg/kg, Cd: 3.4 mg/kg and Pb: <0.01 mg/kg.

Key Words: Heavy Metals, Chronic Exposure, Tobacco Plants, Cigarette.

INTRODUCTION

Tobacco product consumption and the number of smokers have been increasing steadily all over the world. The use of cigarettes constitutes one of the major causes of morbidity and mortality in the world. Herbicides, insecticides and fungicides are used to control the various parasites and tobacco plant diseases. Tobacco smoke has toxic, genotoxic and carcinogenic properties.

International Agency for Research on Cancer (IARC, 1986) discovered that cigarette smoke contains both organic and inorganic human carcinogenic compounds, containing 4000 identified chemical compounds which is very harmful and toxic to human health of these toxic materials are heavy metals, particularly cadmium, zinc and lead.

Heavy metals also accumulate in tissues and fluids through smoking (Eneje *et al.,* 2013). The most important source of Cd exposure in the general population is through Tobacco smoking. Al-Bader, *et al.,* (1999) stated that the most important source of cadmium (Cd) in humans are smoking and food. According to him, it causes kidney damage, fragile bones, stomach irritation, vomiting and diarrhea and finally cancer risk.

Lead is a highly toxic metal and is capable of causing serious effects on the brain, nervous system and red blood cell (Idejhe *et al.,* 2016). An increase in lead level is associated with a decrease in the intelligence quotient (IQ) levels and potential behavioral problems (Zhang *et al.,* 2005). According to Shaper *et al.* (1982), a survey of middle-aged men in 24 British towns showed a strong association between blood Pb concentrations and alcohol and cigarette smoking (Elinder *et al.,* 1993). WHO, (1997), estimates that 2 – 6% of Pb in cigarettes is inhaled by the smoker which has also been associated with impaired fetal growth and brain development (24).

Table 1: Results obtained in the level reference materials together with certified values.

S R M	Element	Certified value (Ugg-1)	Measured value
Pine needles	Pb	0-167 ± 0.013	0.161 ± 0.102
NIST – SRM 1575a	Cd	0.233 ± 0.009	0.214 ± 0.013
Spinach leaves	Pb	0.200 ± 0.006	0.198 ± 0.012
NIST – SRM 1570	Cd	2.890 ± 0.070	2.830 ± 0.095

The heavy metals are widely dispersed in the environment and at excessive levels, thus making it very toxic to humans (Jarup, 2003). Chronic exposure to these substances may also be hazardous, although these metals occur naturally, exposure may be increased by human activities that releases them into the air, soil, water, food and by-products that contain heavy metals. Certain plants also have the ability to accumulate heavy metals that have no known biological functions (Memo *et al.*, 2001).

In many countries, cigarette smoking has been identified as a major serious health issue and contributor to high mortality and morbidity rate of both smokers and passive smokers. Some surveys clarified that the content of certain chemicals especially cadmium in fats (Hynees, 2007), blood (El – Agha and Gorkmen, 2002) and livers of tobacco smokers are much higher than those of non-smokers. Studies have shown that each 3000 non-smoking adults die of lung cancer as a result of breathing the second hand smoke from other’s cigarette (Hynees, 2007). Rodgman and Perfetti, (2009) reported that cigarette smoke has seven thousand, three hundred and fifty-seven (7,357) chemical compounds and many pose environmental contamination problems. Since tobacco smoking is associated with several diseases, it will be erroneous to conclude that single component of the plant is the causative agent, hence there is need to study the heavy metal content to tobacco which is believed to contribute to human ill-health.

The environmentalists and government health organisations are much more worried about the high presence of lead and cadmium as non-essential elements. These metals are potentially hazardous and carcinogenic even in small concentration. They are also toxic trace metals that has no biological function in humans and plants but also has an accumulated metabolic poison (bio-accumulated) with physiological and neurological effects (Andrade *et al.*, 2009; Regassa, 2007 and WHO, 1977 – 1989). Tobacco plants is amenable to absorb and accumulates heavy metal species from the soil into leaves (Myers, 1990). Tobacco plants transport metal ions from the soil through the roots into the leaves (Lougon-Moulin *et al.,* 2004; Tso, 1990). Trace amounts of heavy metals accumulate in leaves and are known to transfer in trace quantities from the cured and processed tobacco to main stream cigarette smoke. These metals include Zn, Cd and Pb (Hoffman *et al.,* 2000; Smith *et al.,* 1997 and Stohs *et al.,* 1995). The most abundant redox inactive metals in cigarette smoke generally are cadmium and lead.

Cigarettes are produced from tobacco leaves cultivated in different parts of the world. The concentration of heavy metals in the soil to a great extent affects the amount of heavy metals available for accumulation by plants grown on them. The factors governing the speciation, absorption and distribution of heavy metals in soil are; pH, presence of organic and other metal ions, soluble organic matter content and soil type (Noler, 2006). We can therefore expect

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tobacco grown in different areas with different soil properties to have different concentrations of heavy metals.

Again, the increase in tobacco consumption as snuff and more often as cigarette is alarming. Tobacco cigarette are widely used throughout the world by men, women and children. A great number of people here become victims of environmental tobacco smoke (ETS) as they participate passively. The presence of additive compound like nicotine is the main reason for cigarette habituation. In spite of all warnings from health authorities, tobacco cigarette is yet consumed by many in large quantities as encouraged by mass production, social acceptance, availability, relative cheapness and its light weight. This research paper therefore intends to study the – quantity of some of the heavy metals (Zn, Cd and Pb) present in tobacco leaves and some selected brands of cigarette purchased from the local markets in Anyigba and its environs, since not much work has been done in this area of study even though much tobacco is grown in different parts of Kogi State.

MATERIALS AND METHODS

Sampling

Tobacco leaves were randomly collected from four different areas in Anyigba, Dekina Local Government Area of Kogi State in a black polythene bag and transported to the laboratory. The leaf samples were washed with distilled water carefully and allowed to dry in oven for three days at 105^{o}c. The dried leaves were pounded using mortar and pestle and sieved with the mesh sieve. About 0.5g of ground tobacco leaves was weighed into a clean 125 L Erienmeyer flask. A mixture of 4 mL of $HClO_4$, 25 mL conc. HNO_3 and 2 mL conc. H_2SO_4 was added to the flask (Noler, 2006). The mixture was heated gently on a hot plate under a fume-hood for 30 min. The flask was allowed to cool and 2 mL of conc. HNO_3 was further added. The mixture was finally heated strongly to medium heat for 3 min. and allowed to cool. The solution was completely filtered (using Whatman No 42 filter, 9 cm) into a 100 mL volumetric flask and made up to the mark with distilled water. The filtrate was stored in the refrigerator waiting for heavy metal analysis using AAS.

Cigarette

Five different brands of cigarettes were purchased from Anyigba local markets and coded as follows: C_1, C_2, C_3, C_4 and C_5 respectively. The raw tobacco leaves was coded T_1. Composite sample of each brand were made by removing the papers and filters of the cigarette taken randomly from a pack of 20 cigarettes. About 0.5g of finely ground plant tissue of the cigarette was placed into a quartz crucible. This was then placed in a muffle furnace set at 500^{o}c for 2hr. The ignited residues were moistened with water and 5.0 mL of 4NHCl was carefully added. The mixture was filtered through Whatman No. 40, 9cm filter paper into 50 mL Volumetric flask and diluted to the mark awaiting analysis using AAS.

Qualitative and Quantitative Analysis

All samples were analysed for heavy metals (Zn, Cd and Pb) by Atomic Absorption Spectrophotometer (thermo scientific series model). The various metal concentrations from the sample solution were determined from the calibration, based on the absorbance obtained from the unknown.

Statistics

The original data were processed by one way ANOVA Analysis. Student’s T-test was used for the statistical analysis of the difference in heavy metals between the different brands of cigarette and the tobacco leaves grown in Anyigba in Kogi State at 95% confidence interval.

RESULTS

Table 1: Mean Value of Metals in Ashed Cigarette Brands

Parameters	Cigarette brands codes				
	C_1	C_2	C_3	C_4	C_5
Zinc (Zn) (mg/kg)	19.55±0.12	6.11±0.02	8.05±0.07	22.35±0.10	8.11±0.02
Cadmium (Cd) (mg/kg)	1.01±0.02	1.02±0.02	2.0±0.02	2.07±0.07	1.02±0.02
Lead (Pb) (mg/kg)	ND	ND	ND	ND	ND
Blank (C_6)	0.00	0.00	0.00	0.00	0.00

Key: ND = Not detectable, C_1 = Aspen C_2 = Rothmans C_3 = Benson and Hedges C_4 = St. Moritz C_5 = Dorchester

Table 2: Mean Value of Metals in Tobacco Leaf Sample

Parameter	T_1	T_2 (Blank)
Zinc (mg/kg)	90.1±0.24	0.00
Cadmium (mg/kg)	3.40±0.65	0.00
Lead (mg/kg)	ND	0.00

ND = Not detectable

T_1 = Tobacco leaf sample, T_2 = Blank

Table 3: Mean Concentration with Standard Deviation of Different Metals Per Cigarette (mg/kg)

S/No	Sample Code	Zn	Cd	Pb
1	C_1	19.55±0.12	1.01±0.02	ND
2	C_2	6.11±0.02	1.02±0.02	ND
3	C_3	8.05±0.07	2.01±0.01	ND
4	C_4	22.35±0.10	2.07±0.07	ND
5	C_5	8.11±0.02	1.02±0.02	ND

Table 4: Mean Concentration with Standard Deviation (SD) of Different Heavy Metals in Tobacco Leaves (mg/kg)

Parameters	Concentration with SD
Zn (mg/kg)	90.1±0.25
Cd (mg/kg)	3.4±0.65
Pb (mg/kg)	ND

Table 5: WHO/FAO/JECFA for Heavy Metals Daily and Provisional Tolerable Weekly Permissible Intake

Metal	Provisional tolerable weekly intake (mg/kg per week)	Per day intake (mg/kg/day)	For a 60kg individual (mg/kg)	Ref.
Pb	25	5	300	FAO/WHO
As	15	3	180	FAO/WHO
Cd	3 – 5	0.2 – 1	30	WHO/JECFA
Cu	500	100	600	FAO/WHO
Zn	500	50	-	FAO/WHO

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DISCUSSION

Lead (Pb). Apart from being absorbed by tobacco plants through the soil as a result of the fallout from the atmosphere, lead is also absorbed into the soil by accidental means or by deliberate dumping of lead – laden waste, the addition of pesticides and fertilizers that contain lead and also through the processing stages of cigarettes (Smith, 1972). Attention – deficit hyperactive disorder (ADHD), a condition with symptoms that include inattentiveness, hyperactivity and impulsiveness etc has been linked to lead exposure. Also pregnant women exposure to lead at high amount of concentration could lead to foetal miscarriage, stillbirth, premature birth, low birth weight and other malformations (IARC, 2006., IPCS, 1995).

The lead content of tobacco and cigarettes found in Kogi State were not detectable. (Table 1 and 2). The WHO/FAO recommended value for daily and provisional tolerable weekly intake is 5 mg/kg and 25 mg/kg respectively. It was found that six samples, C_1, C_2, C_3, C_4, C_5 and T_1 have lead contents which were well below WHO/FAO permissible daily intake of 5 mg/kg and therefore are safe for human consumption.

Zinc (Zn). The mean concentration of Zn in the digested tobacco leaves was 90.10 mg/kg. Sample code C_4 recorded the highest concentration (22.35 mg/kg) while code C_2 recorded the least (6.11 mg/kg) among the already processed brands. The concentration is above NAFDAC permissible limit for food as well as the WHO/FAO recommended value for daily and provisional tolerable weekly intake of 5 mg/kg and 25 mg/kg respectively. Zn is considered to be relatively non-toxic. However, excess amount can cause system dysfunction that result in impairment of growth and reproduction (Nolan, 2003). The clinical signs of Zinc toxicity includes: vomiting, diarrhea, bloody urine, liver and kidney failure among others (Nolan, 2003).

Cadmium (Cd). The mean concentration was 3.40 mg/kg in the digested tobacco leaf. Sample code C_4 recorded the highest value of Cd concentration (2.07 mg/kg) while code C_1 recorded the least concentration (1.01 mg/kg). Generally, the mean concentration of Cd was lower than that of Zn in all samples investigated. However, the level is higher than JECFA limit for weekly intake (2.5 mg/kg body weight). The concentration of cadmium is however within NAFDAC permissible limit in food. Accumulation of Cd in the body can cause diseases such as damage to Kidney and bones. Cd is best known for its association with itai – itai disease (WHO, 2000). The reason could be attributed to the nature as well as physiochemical properties of the soil where the tobacco leaves were grown. Memon *et al.*, (2001) reported that some species of plant have been observed to accumulate high concentration of metals most especially Cd in leaf tissue rather than in roots. The processing, packaging and other technological processes including use of additives used to bring raw food materials to consumers can significantly increase heavy metals contents in cigarettes tobacco (Stephene' *et al.*, 2003). The concentration of cadmium however, is within NAFDAC permissible limit in food.

Generally from the results of the study, the concentration of metals in both cigarette brands group follows almost the same trend: Zn > Cd > Pb. Concentration between imported and local tobacco leaves grown in this area is statistically significant at 95% confidence level. Really, there was relatively a wide range of variation in mean concentration of the metals in imported brands (e.g. 19.55±0.12 mg/kg and 6.11±0.02 mg/kg for Zn and 1.01±0.02 mg/kg and 1.02±0.02 mg/kg for Cd as shown in table 1). In comparison with local tobacco leaves e.g. 90.10±0.024 mg/kg for Zn. However these variations could possibly be related to agricultural soil contents of trace metals which tobacco leaves were cultivated. (Sheikh *et al.*, 1992 and Kuzi *et al.,* 2009). Farming fields close to roads and residential areas (Pappas *et al.,* 2007), the chemistry of tobacco leaves and finally to its processing.

From the study, it has not been possible to get any evidence to explain whether differences are related to the areas of production or the extent of industrial development of the area.

It was realized from the research conducted that lead (Pb) is below detection limit both in the tobacco leaves and cigarette samples analysed. However, Zinc (Zn) and Cadmium (Cd) have higher concentration in the tobacco leaves than all the cigarette brands. This may be attributed to a possible reduction in the course of producing the cigarettes and may also be due to the environmental conditions prevalent at the time of growing, cultivation and subsequent processing of the tobacco or indeed types of fertilizer used. The concentration of cadmium (Cd) in the tobacco leaves is above FAO/WHO/JECFA weekly intake per body weight limit of 2.5 mg/kg. The same case applies to the cigarette brands coded C_4. All other brands of cigarettes studied have Cd concentration below FAO/WHO/JECFA standard weekly intake. Accumulation of cadmium (Cd) can have serious health effect such as brain damage. Zinc is required by the body and its toxicity is lower than that of lead (Pb) and cadmium (Cd).

It is recommended that Government should;

(i) Ban the production and sales of cigarettes and other consumed tobacco products.

(ii) If (i) above is not feasible in the immediate time, public smoking should be banned.

(iii) Where tobacco is grown for use as insecticide, decoration or medicinal plant, restriction should be placed on the type of fertilizer used to avoid environmental pollution with heavy metals.

(iv) Public enlightenment campaign should be intensified.

(v) The community should support government in her quest to stop tobacco consumption.

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