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Investigation of Heavy Metals in Selected Samples of Cigarette Randomly Purchased from Local Markets in Anyigba and its Environment and Tobacco Leaves Grown in Kogi State, Nigeria

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Abstract :*Increase in tobacco smoking has been associated with health implications, hence the need for research into the heavy metal content of tobacco. In this study five (5) brands of cigarettes commonly smoked in Kogi State and purchased randomly from the local market and a sample of tobacco leaves grown in Kogi State were investigated. Samples collected were analysed for heavy metal concentration using an Atomic Absorption Spectrophotometer (AAS) of the model thermo scientific S Series. The metals determined are zinc, cadmium and lead. Their presences, concentration and permissible limit have been carefully considered. The result obtained showed that zinc (Zn): samples from 6.11 – 22.35 mg/kg, cadmium (Cd) ranges between 1. 01 – 2.07 mg/kg and lead (Pb): <0.01 mg/kg for the cigarettes while the tobacco leaves showed Zn; 90.1 mg/kg , Cd: 3.4 mg/kg and Pb: < 0.01 mg/kg respectively.*

KEY WORDS: *Heavy Metals, Chronic Exposure, Tobacco Plants, Cigarette*

Introduction

Some of the trace metals in biological samples derive from their essentiality, as well as from their potentially toxic effects living organisms, i.e. pollution due to heavy metals has acquired importance since these metals are highly toxic for humans and for the whole ecosystem.

The heavy metals are widely dispersed in the environment, and at excessive levels, thus making it very toxic to humans (Jarup, et al, 2003). Chronic exposure to these substances may also be hazardous. Although these metals occur naturally, exposure may be increased by human activities that release 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 function (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, et al, 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 Petri (2009) reported that cigarette smoke has seven thousand, three hundred and fifty seen (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 a single component of the plant is the causative agent. Hence there is need to study the heavy metal content of 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-accumulate) with physiological and neurological effects (Petruceli, et al, 2007, Andrade, et al, 2009, Regassa, et al, 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 the leaves, and they are known to transfer in trace quantities from the cured and processed tobacco to main stream cigarette smoke. These metals include zinc, cadmium and lead. (Hoffman, et al, 2000., Smith, et al, 1997., & 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. A number of researches have shown that plants including tobacco are amenable to absorb and accumulate heavy metals from the soil into their leaves. The concentration of heavy metals in the soil to a great extent affects the amount of heavy metals available for accumulation by plant grown on them. The factor governing the speciation, adsorption 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 tobacco grown in different areas with different soil properties to have different concentration of heavy metals.

Heavy metals are dangerous because they tend to bio-accumulate i.e. increase in concentration in a biological system over time, compared to the amount present in the environment (Elinder, 2010). These metals have been confirmed to be associated with several illness and diseases in both human and animals. In humans, long exposure is associative with renal dysfunction. High exposure can lead to obstructive lung diseases and has been linked to lung cancer. Cadmium may also lead to bond effects (Ostomalacia, Osteoporosis) in humans and animals (Zhang, et al, 2005). These and many other health challenges have been directly or indirectly linked to heavy metals as a basic causative agent.

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. The 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, Kogi State, Nigeria, since not much work has been done in this area of study even though much tobacco is grown in different parts of the Kogi State.

Materials and Methods.

Study Area:

The study area is Kogi State Nigeria, popularly known and called the Confluence State because the Confluence of Rivers Niger and Benue. It has its Capital in Lokoja and is the first Administrative Capital of the Modern Day Nigeria. Kogi State was created in the year 1991. It is located between latitude 7.49^0 N and longitude 6.45^0E and bounded by the Federal Capital Territory to the North, Nassarawa State to the North–East, Benue State to the East, Enugu State to the South–East, Ondo and Ekti States to the West and Kwara State to the North-West. The State has three senatorial districts; Kogi East, West and Central Senatorial Zones.

Agriculture is the mainstay of the State's economy and the principal cash crops includes: cocoa, coffee, palm oil, cashew, groundnuts, maize, cassava, yams, beniseed, rice and Tobacco. Tobacco is grown in many parts of the State. The farmers mostly claim they grow it for medicinal purposes but accepted that some people come to buy them in bulk. The vegetation of the State consist of mixed leguminous (guinea), woodland, to forest savannah, with a landmass of about 29,833km^2 and a population approximately more than 3,314,043 people made up of gender distribution of 1,672,903 male and 1,641,140 females. (National Population Commission release, 2011).

The State was choosen as the study area because its climatic condition can encourage farmers to produce tobacco in large quantities even though they are ignorant of its adverse effect. Moreover, tobacco consumption as cigarette, snuff etc, is at an alarming rate in their areas.

Population.

Five(5) brand's of cigarette are commonly smoked in Kogi State and samples of tobacco leaves were collected from the seventy-five local farmers farms in the State (Kogi State (KGADP), 2010). The collected leaves were used as samples.

Sampling.

Five (5) samples of brands cigarette were purchased from the local markets. The raw tobacco plant leaves were sampled from ten (10) tobacco farmers in the three Senatorial Zones of Kogi State randomly. The five different brands of cigarettes were coded as C_1, C_2, C_3, C_4, and C_5 respectively and were purchased from Anyigba, the University Village Market.

Preparation and Digestion of Tobacco Leaves for Analysis.

The leaves were washed with distilled water carefully and allowed to dry in open air in the laboratory for 14 days. It was then oven dried for nine hours at a temperature of 105^0C. The dried leaves were then pounded using pestle and mortar, sieved with mesh sieve.

A 1g of the samples was weighed and placed into 125ml Erlenmeyer beaker. A mixture of 4ml concentrated $HCLO_4$, 25ml concentrated HNO_3 and 2ml concentrated H_2S0_4 was added to the beaker content (Noler, 2006). The mixture was placed on a hot plate in the fume chamber and heated, starting at 85^0C and then temperature raised to 150^0C, heating continued until the production of red NO_2 fumes ceased. The contents were further heated until volume was reduced to 3 – 4ml and became colorless or yellowish, but not dried. This was done to reduce interference by organic matter and to convert metal associated particulate to a form (the free metal) that could be determined by the Atomic Absorption Spectrophotometer (AAS). Contents were cooled and the volume made up with distilled water and filtered through Whatman 1 acid-washed filter paper. The solution was preserved at 4^oC, used for spectrophotometer determination of the various metal analysis (Noler, 2006, Godfred, et al, 2014).

Cigarette Preparation and Digestion for Analysis

Composite samples of each brand were made by removing the papers and filters of the cigarette taken randomly from a pack of 20 cigarettes. 1g of the finely grounded plant tissue (the cigarette) was placed in a quartz crucible, placed in a muffle furnace set at 500^oC for two hours. The ignited residues were moistened with water and placed into 500ml beaker. 10ml of di-acid mixture of HNO_3 and $HCLO_4$ with ratio 9:4 was added and the content was heated and filtered thoroughly with Whatman 42 filter paper into 100ml Volumetric flask and diluted to the mark awaiting analysis using Atomic Absorption Spectrophotometer (AAS).

Qualitative and Quantitative Analysis

All samples were analysed for heavy metals (Zn, Cd and Pb) by Atomic Absorption Spectrophotometer (Thermo Scientific S Series Model). The various metal concentrations from the sample solution were determined from the calibration, based on the absorbance obtained from the unknown (AOAC, 2006).

Statistics

The original data were processed by One Way ANOVA Analysis. Student's test was used for the statistical analysis of the differences in heavy metals between the different brands of cigarette and between the brands and tobacco leaves grown in Kogi State at 95% confidence interval.

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 or 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 5mg/kg and 25mg/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 5mg/kg and therefore are safe for human consumption.

Zinc (Zn). The mean concentration of Zn in the digested tobacco leaves was 90.10mg/kg. Sample code C_4 recorded the highest concentration (22.35mg/kg) while code C_2 recorded the least (6.11mg/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 5mg/kg and 25mg/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 3.40mg/kg in the digested tobacco leaf. Sample code C_4 recorded the highest value of Cd concentration (2.07mg/kg) while code C_1 recorded the least concentration (1.01mg/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 (2.5mg/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% confluence level. Really, there was relatively a wide range of variation in mean concentration of the metals in imported brands (e.g. 19.55±0.12mg/kg and 6.11±0.02 mg/ kg for Zn and 1.01±0.02mg/kg and 1.02±0.02mg/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 pm 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 (Verma & Yadav, 2010).

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.

Conclusion

It was realised 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 body weight limit of 2.5mg/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).

Recommendations

Heavy metal bio-accumulation can cause serious health problems to smokers and non-smokers. It can also affect our nation income by increasing expenditure on health services and facilities. Therefore, it is recommendable that:

(a) Government should
- (i) Band 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.
- (vi) Non-smokers are advised to keep the good habit and avoid passive smoking by staying away from environment polluted with cigarette smoke.

(b) The authors recommend that further studies on the soil and fertilizers used for the growing and cultivation of tobacco with a view to ascertain the presence and contacts of these and more heavy metals. This would help initiate the adoption of more appropriate and effective methods for cultivation and processing of the tobacco plant.

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

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

Table 2: Means 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

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

References

[1]. Andrade, F.O., Nascentes, C.C., Costa-leticia, M. (2009). Cadmium and lead cloud point preconcentration and determination in tobacco samples by thermospray flame furnace atomic absorption spectrometry. *J. Braz Chem. Soc.,* 20: 1460 – 1466.

[2]. EL-Agha, O. and Gorkmen, I.G. (2002). Smoking habits and cadmium intake. *Turkey biological trace element research*. 88(1): 31 – 43.

[3]. Elinder, C.G., Kjellstom, T., Lind, B., Linnman, I., Piscator, M., Sundstedt, K. (1983). Cadmium exposure from smoking cigarettes; variations with time and country where purchased. *Environ Res*. 32: 220 – 227.

[4]. Elinder, O. (2010). Smokeless tobacco and oral cancer. Journal of Botany, 10: 230.

[5]. FAO/WHO (1998). Expert Committee on Food Additives. *http://www.inchem.org.*

[6]. Hoffman, D., Hoffman, I., EL-Bayoumy, K. (2001). The less harmful cigarette: a controversial issue. A tribute to Ernst, L. Wynder. Chem. Res Toxicol. 14: 767 – 790.

[7]. Hynes, D.R. (2007). Trace element in vegetable and soil in domestic gardens around smelting complex. *Environmental pollution*. 9: 211 – 221.

[8]. IARC (2006). Summaries and evaluations: inorganic and organic lead compounds lyon, International Agency for Research on Cancer (IARC Monographs for the-Evaluation of Carcinogenic Risks to Humans. Vol. 87.

[9]. IPCS (1995). Inorganic lead. Geneva, World Health Organisation, International Programme on Chemical Safety (Environmental Health Criteria 165; http//www.inchem.org/documents/ehc/ehc/ehc165.htm).

[10]. Jarup, L. (2003). Standard for permissible limit of heavy metals in food. Joint expert committee on food additives report.

[11]. Kazi, T.G., Jacbani, N., Arain, M.B., Jamali, M.K., Afridi, H.I., Sargraz, R.A. and Shah, A.O. (2009). Toxic metals distribution in different components of Pakistan and imported cigarettes by electrothermal atomic absorption spectrometer. *J. Hazardous Materials* 16: 302 – 307.

[12]. Kogi State Agricultural Development Poject (2010). The growth of tobacco by rural farmers in Kogi State. Its problems and prospects. ADP bulletin. No. 2. Pages 16 – 24.

[13]. Lougon – Moulin, N., Zhang, M., Gadani, F., Rossi, L., Koller, D., Kauss, M. and Wagner, G.J. (2004). Critical review of the science and options for reducing cadmium in tobacco (Nicotiana Tabaccum L.) and other plants. In: Sparks, D. (ed.) Advances in Agronomy of Academic, New York. 111 – 180.

[14]. Memon, A.R., Aktoprakligul, D., Demur, A., Vertii, A. and Butak, T.A. (2001). Heavy metal accumulation and detoxification mechanism in plants. *Turk. J. Bot. 25*: 111 – 121.

[15]. Myers, J.A. (1990). "The Hazards of Smoking". *The Pharmaceutical Journal*. 12: 14.

[16]. NAFDAC (2008). Permissible limit of heavy metals in fruits and vegetables.

[17]. Nolan, K. (2003). Copper toxicity syndrome. *J. orthonol psychiatry*. 12(4), 270 – 282.

[18]. Noler, B.N., Mayes, T.L., Raite, U.Y. and Sail, S.S. (2006). Quality assessment of contamination of water and air in heavy metals. African Journal of Biotechnology. 8: 67 – 77.

[19]. Pappas, R.S., Polzin, G.M., Watson, C.H. and Ashley, D.L. (2007). Cadmium, lead and thallium in smoke particulate from counterfeit cigarettes compared to authentic US brands. Food chem. toxicol. 45: 202 – 209.

[20]. Regassa, G. (2007). Investigation of metals in Ethiopian tobacco leaves and processed tobacco. Ethiopia: Addis Ababa University.

[21]. Rodgman, P.P., and Perfetti, O.L. (2009). Heavy metals toxicity: consequences and elimination. Journal of Plants Nutrition. 6(5), 44 – 55.

[22]. Shackh, A.N., Khandekar, R.N., Anand, S.J.S. and Mishra, U.C. (1992). Determination of some toxic trace elements in Indian tobacco and its smoke. J. Radional Nucl. Chem. 163: 349 – 353.

[23]. Smith, C.J., Livingston, S.D., Doolittle, D.J. (1997). An International Literature Survey of "IARC Group I Carcinogens" reported in mainstream cigarette smoke. Food chem. toxicol. 35: 1107 – 1130.

[24]. Smith, R.G. (1972). Metallic contaminants and human health in: 1st ed. Academic Press: New York. 149 – 153.

[25]. Stephens, W.E., Calder, A., Newton, J. (2005). Source and health implications of high toxic metal concentrations in illicit tobacco products. *Environ Sci Technol*. 39: 479 – 488.

[26]. Stohs, S.J., Bagchi, D. (1995). Oxidative mechanism in the toxicity of metal ions. Free Radio Biol. Med. 18: 321 – 336.

[27]. WHO (2001). Report on the tobacco epidemic: 123.

[28]. WHO (2008). Report on the global tobacco epidemic. 134.

[29]. Zhang, V.B., Xenon, F.O., Flow, A.A. (2005). Quality Assessment of Worldwide Contamination of Air, Water and Soil with Pb, Cd, Hg and Cr. *Pakistan Research Journal*. 132m 144 – 160.