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Analysis of Heavy Metals Content of Tobacco Cigarette Brand Sold in Samaru Area of Zaria, Nigeria

Oladunni Nathaniel*, Mairiga Ambina Ayuba, Agbele Idowu Elijah, Galadima Ehud Bulus

Department of Science Laboratory Technology, Nigerian Institute of Leather and Science Technology, Zaria, Nigeria

Email address:
nathola2010@gmail.com (O. Nathaniel)

*Corresponding author

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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 cigarettes. In this study, five brands of cigarettes commonly consumed were analyzed. The sample preparation procedures were based on the method of Campbell (1998). Five packets of different brands of tobacco cigarette were purchased from samaru market in Zaria and were labeled A, B, C, D and E respectively. Five sticks from each packet of the cigarette were randomly selected for homogenous representation, making a total of 25 samples (5 for each brand of tobacco). These cigarette were analysed for the presence of four heavy metals, namely Cadmium (Cd), Zinc (Zn), Cadmium (Cd) and lead (Pb) Using Atomic Absorption Spectrophotometry (AAS). The concentration of Cadmium (Cd), Zinc (Zn), Cadmium (Cd) and lead (Pb) in A was found to be 10.20, 0.06, 12.30, 2.80mg/kg respectively. The concentration of Cadmium (Cd), Zinc (Zn), Cadmium (Cd) and lead (Pb) in B was found to be 10.22, 0.06, 17.86, 3.20mg/kg respectively. The concentration of Cadmium (Cd), Zinc (Zn), Cadmium (Cd) and lead (Pb) in C was found to be 23.18, 0.06, 13.44 and 3.08mg/kg respectively. The concentration of Cadmium (Cd), Zinc (Zn), Cadmium (Cd) and lead (Pb) in D was found to be 14.82, 0.40, 14.58 and 3.08mg/kg respectively while the concentration of Cadmium (Cd), Zinc (Zn), Cadmium (Cd) and lead (Pb) in E was found to be 8.54, 0.00, 16.10 and 2.76mg/kg respectively. The physicochemical analysis of these cigarette brand was also carried out and The moisture content of brand A, B, C, D and E was found to be 0.91, 0.88, 0.94, 1.85 and 0.79 % respectively with the order of variation as D > C > A > B > E. The ash content of brand A, B, C, D and E was found to be 11.15, 10.45, 10.15, 5 and 11.35 % respectively with the order of variation as E > A > B > C > D. The pH value of brand A, B, C, D and E was found to be 5.86, 5.91, 5.67, 5.58 and 5.36 respectively From this study, it was observed that cadmium (Cd) concentration is within permissible limit of 0.05 mg/kg in all the tobacco cigarette samples analysed, with sample E having no trace of Cadmium in it. Zinc (Zn) and Chromiuim (Cr) concentrations in all the tobacco cigarette samples analysed is higher than the WHO/FAO permissible limit of 25 and 0.5 mg/kg respectively. The concentration of Pb in all the tobacco cigarette samples analysed was found to be above the WHO/FAO permissible limit of 0.05 mg/kg, and could cause serious health problem like lead poisoning, low fertility, cancer and so on.

Keywords: Heavy Metals, Cigarette, WHO/FAO Permissible Limit, AAS

1. Introduction

A cigarette is a narrow cylinder containing psychoactive material, ussually tobacco, which is rolled into thin paper for smoking [1]. 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 [2]. It is therefore expected that tobacco grown in different areas with different soil properties have different concentration of heavy metals.

Cigarette smoking leads to an estimated 6 million deaths per year worldwide and more than 5 million of those deaths are the result of direct tobacco use while more than 600,000 are the result of non-smokers being exposed to second-hand smoke [3].

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 [4]. These metals have been confirmed to be associated with several illnesses and diseases in both human and animals [5]. These and many other health challenges have been directly or indirectly linked to heavy metals as a basic causative agent.

Smoking related diseases are ultimately the result of nicotine addiction which leads to the repeated inhalation of a variety of toxicants in cigarette smoke, including volatile organic compounds, and several toxic heavy metals. Among these toxicants, there have been comparatively fewer studies conducted on the role of heavy metals as causes of smoking related diseases and there is a need for basic studies on the levels of heavy metals in cigarette and other tobacco products. The presence of trace amounts of metals in tobacco smoke has been known [6]. The most common of these metals that pose threat to health include, Cadmium (Cd), Chromium (Cr), Zinc (Zn), and Lead (Pb) as well as Nickel (Ni) compounds. Some of these metals are designated as carcinogenic to humans by the International Agency for Research on Cancer [2].

2. Experimental

2.1. Materials

Volumetric flask (250 ml), Beaker (250 ml), Filter paper (whitman), Mortar and Pestle, Test-tubes, Weighing balance, Crucibles (porcelain), Watch glass, Samples container, Desiccator, Oven, funnels, Kjeldahl apparatus, Round bottom flask, Spatula, pH meter, Muffle furnace, Atomic Emission Spectrophotometer, Distilled water, HNO_3, HCl and buffer solution.

2.2. Method

Five packets of different brands of tobacco cigarette were purchased from Samaru market in Zaria and were labeled A, B, C, D and E respectively. Five sticks from each packet of the cigarette were randomly selected for homogenous representation, making a total of 25 samples (5 for each brand of tobacco). The paper wrapper and filter enclosing the main component of the cigarette were removed and the cigarette was subjected to analysis [7].

2.2.1. Sample Preparation

Each brand of the dried tobacco was ground to fine powder using a mortar and a pestle to simplify weighing and to facilitate organic matter digestion. The mortar and pestle were properly cleaned before proceeding to the next sample to avoid contamination [8].

2.2.2. Digestion of Samples

About 3g of each cigarette brand sample was weighted into a round bottom flask and the solution of aqua regia was added. The mixture was heated for 20 minutes at 60^0C with Kjeldahl apparatus until a light colored solution was obtained. The digested sample was allowed to cool and filtered into 100 ml measuring cylinder and made up to mark by using distilled water [9].

2.2.3. Samples' Analysis for Heavy Metal Content

The digested samples were analyzed for the selected heavy metals using Atomic Absorption Spectrophotometer.

2.3. Determination of Physicochemical Properties of the Samples

2.3.1. Determination of Moisture Content

A clean, dried crucible was weighed as W_1. 2 g of the sample was transferred into the crucible and reweighed as W_2. The crucible and its content were then dried to constant weight in an oven at 105°C and finally reweighed as W_3. The percentage moisture content was calculated as below.

$$\%\, moisture = \frac{W_2 - W_3}{W_2 - W_1} \times \frac{100}{1} \qquad (1)$$

Where, W_2 = weight of crucible + sample before drying
W_3 = weight of crucible + sample after drying
W_1 = weight of empty crucible.

2.3.2. Determination of Ash Content

The porcelain crucible was dried in an oven at 100°C for 10 minutes, cooled in a desiccator and weighed. 2 g of the sample was then placed in the previously weighed porcelain crucible and weighed again. The sample was first ignited and then transferred into the furnace, which was set at 850°C. The sample was left in the furnace for 8 hours to ensure proper ashing. The crucible containing the ash was removed, cooled in the desiccator and weighed. The percentage ash content was calculated using the formula [10].

$$Ash\ content = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100 \qquad (2)$$

2.3.3. Determination of pH

5 g of the sample were weighed and dissolved in distilled water in a 100cm³ volumetric flask. The electrode of the pH meter was inserted into the sample solution and the pH reading was recorded [11].

3. Results and Discussion

Zinc (Zn)

Zinc content of the five brands of cigarette was found to be 10.20, 10.22, 23.18, 14.82 and 8.54 mg/kg for A, B, C, D and E respectively. The order of variation in Zinc concentration is represented as C > D > B > A > E. Iwuoha *et al* (2013) reported the concentration of Zinc in Dorchester, Benson and Hedges, St. Moritz and Rothmans to be 27.48, 64.29, 43.92 and 36.29 mg/kg respectively, Adam and Bhagwan (2017) also reported the concentration of Zinc in Marlboro Light, Benson, Rothmans, Kent to be 39.50, 27.75, 38.70 and 31.15 mg/kg respectively. The vast difference in the results obtained may be due to the difference in Zinc content of the soil upon which the tobacco leaves were grown, difference in location, and difference in environmental activities within the cultivated area of the tobacco plant.

Cadmium (Cd)

Cadmium concentration was found to be the lowest in each of the five brand of the cigarettes which are 0.06, 0.06, 0.06, 0.40 and 0.00 mg/kg for A, B, C, D and E respectively. The order of variation of the cadmium concentrations shows that D is having the highest concentration, while A, B, and C are all having same concentrations which were all above the WHO/FAO threshold limit of (0.05 mg/kg), except for E which shows no trace amount of cadmium. Onojah *et. al.,* (2014) reported the concentration of Cadmium in Aspen, Rothmans, Benson and Hedges, St. Moritz and Dorchester to be 1.01, 1.02, 2.0, 2.07 and 1.02 mg/kg respectively, Iwuoha *et al* (2013) reported the concentration of Cadmium in Dorchester, Benson & Hedges, St. Moritz and Rothmans to be 0.53, 0.59, 0.59 and 0.59 mg/kg respectively, Adam and Bhagwan (2017) also reported the concentration of Cadmium in Marlboro Light, Benson, Rothmans, and Kent to be 2.43, 2.40, 7.60 and 2.00 mg/kg respectively. The vast difference in the result obtained may be due to the factor governing the speciation, adsorption and distribution of heavy metals in soil which are: pH, presence of organic and other metal ions, soluble organic matter content, and soil type. Chronic exposure to cadmium can result in chronic obstructive lung disease, renal disease, and fragile bones. Cadmium had also been implicated for the low sperm density among smokers.

Chromium (Cr)

The concentration of Chromium in each of the five brand of cigarettes was found to be 12.30, 77.86, 13.44, 14.58 and 16.10 mg/kg for A, B, C, D and E respectively. The order of variation in Chromium concentration is represented as B >, E >, D >,C > A, which shows that the Chromium concentration in each of the five brands was above the WHO/FAO permissible limit of daily intake (0.01-1.2 mg/kg). Iwuoha *et al (*2013) reported the concentration of Chromium in Dorchester, Benson & Hedges, St. Moritz and Rothmans to be 21.21, 22.82, 16.82 and 25.69 mg/kg respectively. The vast difference in the results obtained may be due to the difference in Chromium content of the soil upon which the tobacco leaves were grown, difference in location, and difference in environmental activities. Chromium at toxic level is known to cause lung cancer and allows cancer causing chemicals to stick more strongly to DNA and damage it [14].

Lead (Pb)

Lead concentration was found to be 2.80, 3.20, 3.08, 3.08 and 2.76 mg/kg for A, B, C, D and E respectively. The highest value of lead was observed in C and D, followed by B and A. Sample E was found to contain the lowest value of lead. Generally, the five brand of cigarettes were found to have lead concentration higher than the WHO/FAO permissible limit (0.05 mg/kg). Iwuoha *et al* (2013) reported the concentration of Lead in Dorchester, Benson and Hedges, St. Moritz and Rothmans to be 7.99, 5.98, 8.02 and 3.22 mg/kg respectively, Adam and Bhagwan (2017) also reported the concentration of Lead in Marlboro Light, Benson, Rothmans, and Marlboro Red to be 10.78, 6.10, 5.96 and 1.54 mg/kg respectively, and also Ola (2014) gave report on the range of Lead (Pb) present in tobacco cigarette sold and smoked in Palestinian market to be from 2.21 to 5.06 mg/kg, with the mean to be from 3.12± 1.33 mg/kg. The wide gap in the results obtained may be due to the difference in Zinc content of the soil upon which the tobacco leaves are grown, difference in location, difference in environmental activities, and due to the factor governing the speciation, adsorption and distribution of heavy metals in soil which are; pH, presence of organic and other metal ions, soluble organic matter content, and soil type. Continuous accumulation of lead in the body is known to be harmful and may lead to what is described as lead poison, a disease condition which is characterized by blindness, deafness, hypertension, impairment of kidney function and neurological disorder [16].

Table 1. *Concentration of the heavy metals in the Five Brand of Cigarettes and WHO/FAO Permissble limit.*

Brands	Zn mg/kg	Cd mg/kg	Cr mg/kg	Pb mg/kg
A	10.20	0.06	12.30	2.80
B	10.22	0.06	17.86	3.20
C	23.18	0.06	13.44	3.08
D	14.82	0.40	14.58	3.08
E	8.54	0.00	16.10	2.76
WHO/FAO Permissible Limit	25.00	0.05	0.50	0.05

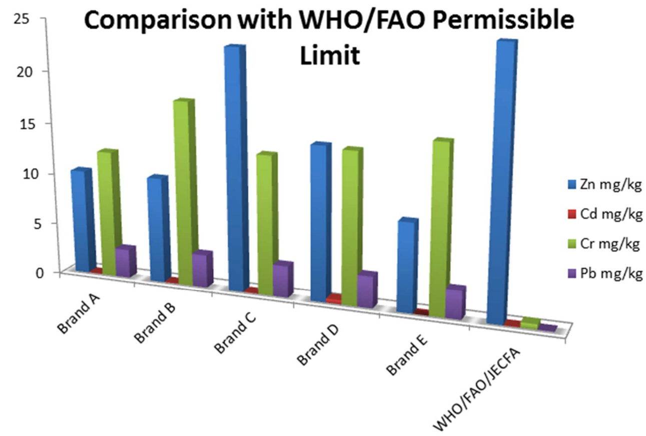

Figure 1. *Comparison with WHO/FAO Permissible Limit.*

Moisture Content, Ash Content and pH Of Tobacco Cigarettes

The moisture content of brand A, B, C, D and E is 0.91, 0.88, 0.94, 1.85 and 0.79 % respectively as shown in table 3.2. The order of variation is D > C > A > B > E. The result obtained differ from the finding of Atiqurrehman *et al.,* (2014) which shows that the moisture content of five different brand of Cigarettes in Pakistan (Marlbro, Benson and Hedges, Dunhill, Captain Black and Silk Cut) to be 9.08, 12.31, 8.48, 8.91 and 8.49% respectively. The reason for the difference in result could be due to difference in the methods of production and volume of rain fall per year. The ash content of brand A, B, C, D and E is 11.15, 10.45, 10.15, 5 and 11.35% respectively with the order of variation as E > A > B > C > D. The ash content in this study is similar to the finding of Atiqurrehman *et al*., (2014), which shows the value for the ash content from different brands (Marlboro, Benson and Hedges, Dunhill, Captain Black and Silk Cut) as 11.54, 9.89, 11.46, 14.85 and 11.45% respectively. The pH value of brand A, B, C, D and E is 5.86, 5.91, 5.67, 5.58 and 5.36 respectively as shown in table 4.6 The order of variation is B > A > C > D > E. The pH value in this study is in accordance with the study conducted by Atiqurrehman *et al.,* (2014).

Table 2. *Moisture content, Ash content and pH of five brand of cigarette.*

S/No	Brand of cigarettes	Moisture Content (%)	Ash content (%)	pH
1	A	0.91	11.15	5.86
2	B	0.88	10.45	5.91
3	C	0.94	10.15	5.67
4	D	1.85	5	5.58
5	E	0.79	11.35	5.36

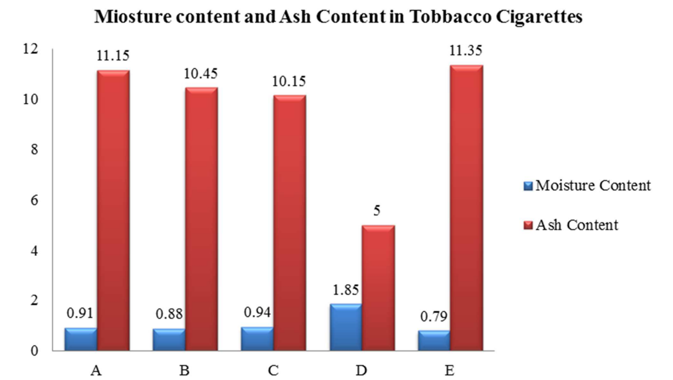

Figure 2. *The Moisture Content and Ash Content of the Different Brand of Cigarettes.*

4. Conclusion

From this study it was observed that cadmium (Cd) concentration is within permissible limit of 0.05 mg/kg in all the tobacco cigarette samples analysed, with sample E having no trace of cadmium in it. Zinc (Zn) and Chromiuim (Cr) concentration in all the tobacco cigarette samples analysed is higher than the WHO/FAO permissible limit of 25 and 0.5 mg/kg respectively. The concentration of Pb in all the tobacco cigarette samples analysed is above the WHO/FAO permissible limit of 0.05 mg/kg., and could cause serious health problem like lead poisoning, low fertility, cancer and so on.

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