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Research Article

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Heavy Metal Levels Determination and Pollution Index Status of Smoke Based and Smokeless Tobacco and Cannabis Products Sold within Enugu Metropolis, Enugu State, Nigeria

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Abstract Studies were carried out to determine the heavy metal levels and pollution index states of smoke based and smokeless tobacco and cannabis products sold within Enugu metropolis, Enugu State using standard analytical procedures and instrumentation. The samples were ground, digested and analyzed for Pb, Cd and Cu levels using atomic absorption spectrophotometer. The range of mean values of Pb, Cd and Cu in the smoke based tobacco (D_O, B_H, L_M, R_O, S_M and M_B) samples were 0.05 – 0.39, 0.05 – 0.18 and 0.14-2.43µg/g respectively. The mean values of Pb, Cd and Cu in the smokeless tobacco (S_f) samples were 0.57, 0.13 and 8.04 µg/g respectively. The range of mean values of Pb, Cd and Cu in the cannabis (C_L and C_S) samples were 0.34 – 0.61, 0.10 – 0.59 and 7.32 – 12.11µg/g respectively. The mean levels of Pb in the S_f and C_L samples and Cd and Cu in the C_L samples were above the recommended permissible limits. The levels of the investigated metals in the smoke based and smokeless tobacco and cannabis samples showed significance at $p < 0.05$. The C/P index values showed that S_f and C_L samples were slightly polluted with Pb while the C_L samples were slightly polluted with Cd and Cu. This study therefore was of the view that as long as government across every level in Nigeria still allow the consumption of smoke based and smokeless tobacco and cannabis products, there should be a strict monitoring and supervision of the sources, cultivation, processing and packaging of especially the locally produced tobacco and cannabis products with a view to minimizing the level of exposure to heavy metals by those smoking these products.

Keywords Smoke based tobacco products, smokeless tobacco product (snuff), cannabis leaves, cannabis seeds, heavy metal levels and pollution

Introduction

Cigarettes are produced from tobacco leaves cultivated in different parts of the world. A cigarette is a narrow cylinder containing psychoactive material, usually tobacco which is rolled into thin paper for smoking [1].

Tobacco is one of the most cultivated plants in all geographical regions of the world [2]. Tobacco is used in a variety of ways, mostly smoke-based (cigarettes) and smokeless, which comes in two forms, snuff (finely ground or cut tobacco leaves that can be dried or moisten) and chewing tobacco (loose leaf in porches of tobacco leaves) [2].

Dry snuff is usually sniffed or swallowed, where as moist snuff is placed between the gum and the lip or cheek and slowly absorbed. Equally, according to [3], cannabis leaf or seed can be smoked in pipes or can be sniffed or added to food.

Cannabis products are the most widely trafficked drugs worldwide and practically all countries of the world are affected by cannabis trafficking [4]. Snuff is usually scented or flavoured, with many blends of snuff requiring months to years of special storage to reach the required maturity [5]. Common flavours used include coffee, chocolate, bordeaux, honey, vanilla, cherry, orange, apricot, camphor, cinnamon, rose, spearmint, cola and whisky.

Smokers claim that cigarette is a social drug that helps them to relax and serve as an anti-depressants but this comes at a high price.

In economically developed countries, about 10% of death could be attributed to the diseases associated with inhaling products from combustion of tobacco plant, *Nicotiana tobaccum* and *Cannabis sativa* (indian hemp) respectively [6]. Smoking is a major risk factor for cardiovascular diseases, as well as a range of cancers, stroke and other disabling conditions.

According to [7], approximately half of all people who smoke regularly will eventually be killed by their smoking. In addition to causing morbidity and premature mortality, smoking significantly reduces quality of life and places a huge financial drain in the health sector, as well as the broader community [8].

Women who smoke or sniff snuff would suffer reduced fertility and menstrual problems and if they indulge in any of these activities during pregnancy could have increased risks of miscarriage, problems with the placenta, still birth, complications during labour and a baby with low birth weight [9].

For males, tobacco or hemp use has been identified as an important risk factor for impotence [10].

Heavy tobacco or cannabis use is associated with an increase of post – operative complications, including post – operative cardiopulmonary complications, infections, impaired wound healing and post-operative intensive care admission [11]. Tobacco and cannabis contains over 60 known carcinogens including radio isotopes from the radon decay sequence, nitrosamine, benzopyrene, nicotine, cannabiol carbon monoxide, hydrogen cyanide, formaldehyde and heavy metals [5,12].

Users of tobacco and cannabis products take in substantial levels of heavy metals in their body via inhalation and ingestion [3,13].

A wide range of toxic metals is found in tobacco and cannabis products depending largely on the soil content where they are grown [3,14]. A number of researches have shown that plants including tobacco and cannabis are amendable to absorb and accumulate heavy metals from the soil unto their leaves, seeds and stems [15]. 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, adsorption and distribution of heavy metals in the soil are pH, soluble organic matter content, presence of organic and other metal ions and soil type [16].

The high concentration of heavy metals in soils is reflected by higher concentrations of metals in plants and consequently in animals and human bodies [17]. The uptake mechanism is selective; plants preferentially acquire some metals over others [18]. According to [4], heavy metals such as lead, cadmium, nickel and mercury have been found in cannabis and tobacco products in Nigeria and indeed almost all countries of the world.

Heavy metals can directly influence behaviour by impairing mental and neurological function, influencing neuro-transmitter production and utilization and altering numerous metabolic body processes [19].

Systems in which toxic metals can induce impairment and dysfunction include the blood and cardiovascular eliminative pathways (colon, liver, kidney and skin), endocrine, energy production pathways, enzymatic gastrointestinal, immune and nervous co-ordination [14].

The presence of toxic substances such as heavy metals in tobacco and cannabis products and their toxicity has drawn a lot of toxicological research and controversy about whether changes in their design and production can change their toxicity.

It is an already established fact that tobacco and cannabis products contain varying levels of heavy metal depending on their type, source and concentration. Although products from tobacco and cannabis are widely consumed by young to elderly persons in the South Eastern Nigeria and Enugu State in particular, investigation of levels of

toxicants like heavy metals in these psychoactive products has attracted fewer attentions of environmental health scientists in the state. This therefore necessitated the study on selected heavy metals determination and pollution index status of smoke based and – smokeless tobacco and cannabis products sold and consumed within Enugu metropolis – Enugu state, Nigeria.

Materials and Methods

Sample Collection and Preparation

One packet each of the six brands of cigarettes samples (Dorchester, Benson and Hedges, London menthol, Rothmans and Marlboro) were purchased in market outlets within Enugu metropolis, Enugu State.

The cigarette samples, were denoted Do, B_H, L_M, Ro, S_M and M_B to represent Dorchester, Benson and Hedges, London Menthol, Rothmans, St. Moritz and Marlboro respectively, this is to make for easier representation and simplification during discussion and interpretation of findings.

A small container of snuff and six wraps each of dried cannabis leaves and cannabis seeds were purchased from local markets and hideout markets within the metropolis. S_f, C_L and C_S were used to represent the snuff, cannabis leaf and cannabis seed samples for simplification. Each brand of tobacco cigarettes, the cannabis leaf and cannabis seed samples was ground to fine powder using a properly cleaned mortar and pestle to simplify weighing and to facilitate organic matter digestion.

Heavy Metal Determination

1g of each determined sample was weighed into a 250ml beaker and 2ml of conc. $HClO_4$ and 10ml of conc. HNO_3 was added. The mixture was swirled to ensure even mixing and the beaker was placed on to a hot plate at a temperature of between 120 to 150 ºC for 20 minutes until a clear digest was obtained. The beaker was then removed from the hot plate, cooled and filtered into a 100ml conical flask and made up to the mark with distilled water. The same procedure was applied to the investigated tobacco cigarette, snuff, cannabis leaf and cannabis seed samples.

The sample digests were taken for elemental analysis using atomic absorption spectrophotometer (PYE UNICAM SP 2900 model).

Quality Control

All reagents used were of pure analytical grade and checked for possible trace metal contamination. All glass wares used for the metal analysis were soaked for 24 hours in 14% HNO_3, washed and rinsed with de-ionized water.

Statistical Analysis

The data obtained were expressed in means and standard deviation and subjected to one way analysis of variance (ANOVA) at 5% level of confidence using SPSS version 22.0.

Contamination/pollution index (C/P) of metals

The contamination/pollution index of the studied metals in the tobacco and cannabis samples was calculated using the scheme formulated by (Lacatasu, 2000).

$$C/P = \frac{A}{B} \quad \text{----------} \quad (1)$$

Where A represents concentration of the metals in the in the plant materials

B represents target value

Contamination/pollution index value greater than 1 defines the pollution range but when it is less than 1, it defines the contamination range.

Table 1: Significance of intervals of contamination/pollution (C/P) values

C/P	Significance
< 0.1	Very slight contamination
0.10 – 0.25	Slight contamination
0.26 – 0.50	Moderate contamination
0.51 – 0.70	Severe contamination
0.76 – 1.0	Very severe contamination
1.1 – 2.0	Slight pollution
2.1 – 4.0	Moderate pollution
4.1 – 8.0	Severe pollution
8.1 – 16.0	Very severe pollution
>16	Excessive pollution

Source, [20].

Table 2: Mean levels of heavy metals in the smoked based, smokeless tobacco and cannabis samples sold within Enugu metropolis, Enugu State.

Metal / Sample	Pb (µg/g)	Cd (µg/g)	Cu (µg/g)
Do	0.08±0.01	ND	0.576±0.16
B_H	0.17±0.04	0.05±0.01	2.43±0.31
L_M	0.39±0.01	0.18±0.02	0.64±0.10
Ro	ND	ND	1.78±0.24
S_M	0.31±0.09	0.07±0.01	0.92±0.11
M_B	0.05±0.01	ND	0.14±0.02
S_f	0.57±0.10	0.13±0.06	8.04±-.45
C_L	0.66±0.13	0.51±0.12	12.11±0.53
Cs	0.34±0.07	0.10±0.04	7.32±0.41
F test p value	0.01	0.00	0.01
Permissible limits [21]	0.5	0.5	10

ND = non – detected.

Lead

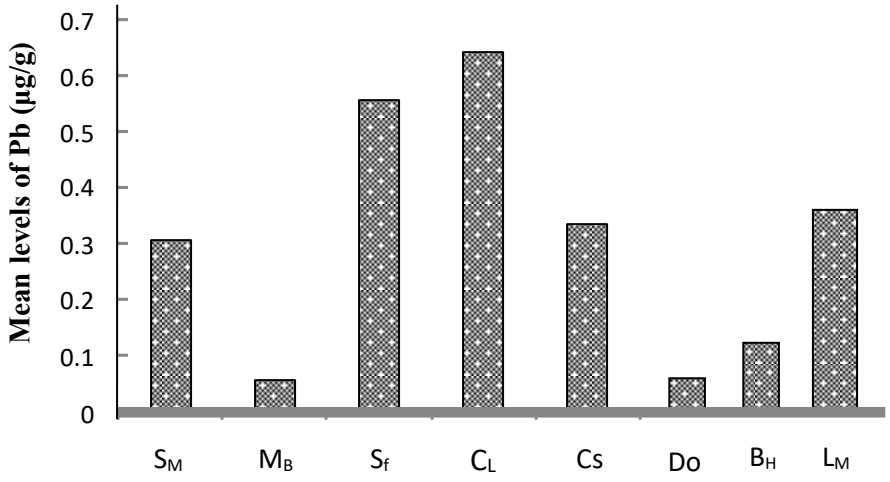

Figure 1: Bar chart representation of the mean levels of Pb in the smoke based and smokeless tobacco and cannabis samples sold within Enugu metropolis, Enugu State

Results of Table 2 show that the mean levels of Pb in the Do, B_H, L_M, S_M, M_B, S_f, C_L , and Cs samples were, 0.08±0.01, 0.17±0.04, 0.39±0.01, 0.31±0.09, 0.05±0.01, 0.57±0.10, 0.66±0.13 and 0.34±0.07µg/g respectively.

The smoked based and smokeless tobacco and cannabis samples harboured Pb in the following decreasing order; $C_L > S_f > C_s > L_M > B_H >$ Do $> M_B$ as shown in Fig. 1.

The mean levels of Pb in the smoke based and smokeless tobacco and cannabis samples were statistically significant. The different sources of these samples and methods of processing could have accounted for the variation in the levels of Pb in the samples.

With the exception of S_f and C_L samples, the mean levels of Pb in the other investigated samples were above the recommended threshold limits. This observation appeared highly probable because of the less hygienic processing techniques that follow the production, processing and packaging of these samples (Sf and C_L) and the indiscriminate cultivation and sourcing of the sample materials which could have followed anthropogenic heavy metal pollution.

[3] reported higher mean values of 1.58±0.02 and 0.42±0.03µg/g for Pb in cannabis leaves and cannabis seeds respectively sold in Asaba, Delta state than what was obtained for the metal in the C_L and Cs samples in this study.

[22] obtained a higher mean value of 2.93±0.17µg/g for Pb in selected brands of smoke based tobacco sold in Samaru area of Zaria, Kaduna State than what was reported for the metal in the investigated smoke based tobacco of this study.

The mean levels of Pb in the S_f samples of this study was higher than 0.082±0.01µg/g reported by [2] in local snuff samples consumed in Benue South, Benue state, Nigeria. The significant variations in the levels of Pb in the determined smoke based and smokeless tobacco and cannabis samples with the compared literature reports could be attributed to differences in sources, processing and packaging of the sample materials.

Pb was not detected in the investigated Ro samples. 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 liver and kidney and neurological disorder [2].

Cadmium

Result of Table 2 show that the mean levels of Cd in B_H, L_M, S_M, S_f, C_L and C_S samples were 0.05±0.01, 0.18±0.02, 0.07±0.01, 0.13±0.06, 0.59±0.12 and 0.10±0.04µg/g respectively. From figure 2 it can be observed that the samples contained Cd in the following decreasing order; $C_L > L_M > S_f >$ Cs $> S_M > B_H$.

The levels of Cd in the investigated smoked based and smokeless tobacco and cannabis samples were statistically significant. With the exception of the C_L samples, the mean levels of Cd in the other investigated samples were within the WHO recommended permissible limits.

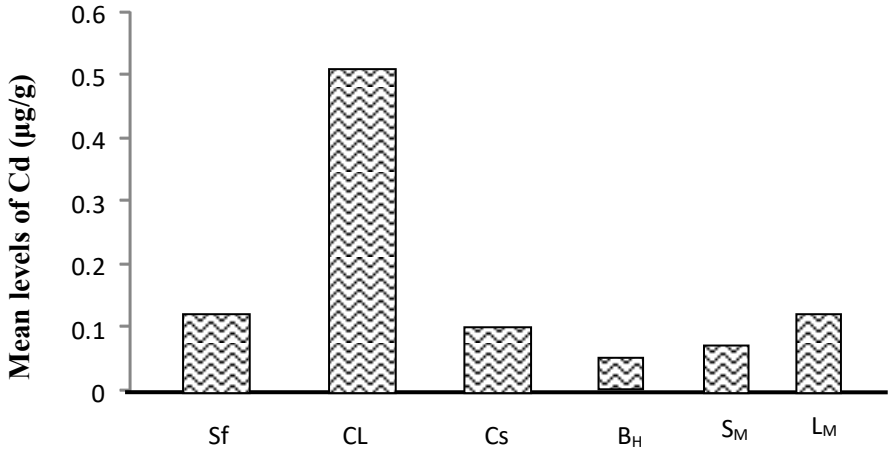

Figure 2: Bar chart representation of the mean levels of Cd in the smoke based and smokeless tobacco and cannabis samples sold within Enugu metropolis, Enugu State

The mean values of 0.06µg/g reported by [22] for Cd in selected smoked-based tobacco brands sold in Samaru area of Zaria, Kaduna State, Nigeria, compared very well with was obtained for the metal in the investigated S_M and B_H samples of this study.

[14] obtained a higher mean value of 2.48±0.32µg/g for Cd in smoke based tobacco brands sold in Addis Adaba, Bahir Dar and Shewa Robit cities in Ethiopia than what was reported for the metal in the investigated smoke based tobacco samples of this study. The reported mean values of 4.40±0.03 and 2.40±0.02µg/g by [3] for cannabis leaf and seed samples respectively, sold in Asaba, Delta state was higher than the mean values obtained for the metal in the C_L and Cs samples of this study.

[2] reported lower mean value of 0.063±0.01µg/g for Cd in snuff samples sold in Benue South, Benue State, Nigeria than the obtained mean value of the metal for S_f samples in this study. According to [22], chronic exposure to cadmium can result in chronic obstructive lung diseases, renal disease and fragile bones and suggested that the metal had also been implicated for the low sperm density among smokers.

Copper

Results of Table 2 show that the mean levels of Cu in the Do, B_H, L_m, Ro, S_M, M_B, S_f, C_L and Cs samples were 0.571±0.16, 2.43±0.31, 0.64±0.10, 1.78±0.24, 0.92±0.11, 0.14±0.02, 8.04±0.45, 12.11±0.53 and 7.32±0.41µg/g respectively.

The smoke – based and smokeless tobacco and cannabis samples harboured Cu in the following decreasing order; $C_L > S_f > Cs > B_H > Ro > S_M > L_M > Do > M_B$ as shown in Figure 3.

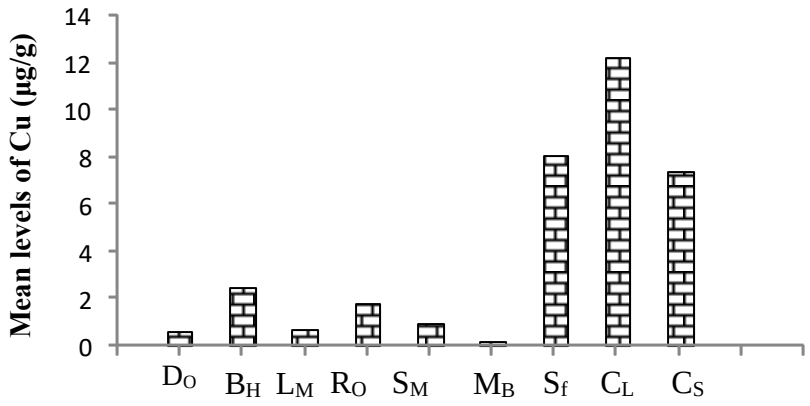

Figure 3: Bar chart representation of the mean levels of Cu in the smoke based and smokeless tobacco and cannabis samples sold within Enugu Metropolis, Enugu State

The levels of Cu in the investigated smoke based and smokeless tobacco and cannabis samples were statistically significant. With the exception of the C_L samples, the mean levels of the other investigated smoke based and smokeless tobacco and cannabis products sold within Enugu metropolis were within recommended permissible limits.

[2] reported a lower mean value of 3.40±0.33µg/g for Cu in the snuff samples sold in Benue South, Benue state than what this study obtained for Cu in the snuff samples sold within Enugu Metropolis.

The mean value of Cu obtained for the investigated smoked based tobacco samples was lower than the reported mean value of 10.20±3.11µg/g by [14] in tobacco cigarette samples sold in Addis Ababa, Bahir Dar and Shewa Robit cities in Ethiopia.

According to [23], the mean metal contents of cigarettes varied markedly depending on the area of production. Although Cu is a trace element required by the body for biochemical and enzymatic body processes, it could result in damages to especially the liver on high dietary exposure.

Table 3: Heavy metal pollution index status of smoke based and smokeless tobacco and cannabis samples sold within Enugu metropolis – Enugu state.

Metal / Sample	Pb	Cd	Cu
Do	0.02	-	0.06
B_H	0.34	0.1	0.24
L_M	0.78	0.36	0.06
Ro	-	-	0.18
S_M	0.62	0.14	0.09
M_B	0.1	-	0.01
S_f	1.04	0.26	0.80
C_L	1.32	1.02	1.21
Cs	0.68	0.20	0.73

Results of Table 3 show that the index value of Pb in Do samples was 0.02 indicating that the samples had very slight Pb contaminating as described in Table 1.

The index values of M_B and B_H samples shows that they had slight to moderate Pb contamination while S_M, Cs and L_M samples had severe to very severe Pb contamination.

S_f and C_L samples had their index values greater than I indicating therefore that they had slight Pb pollution as the significance of C/P intervals in Table 1 suggests. This is a worrisome development because in many Nigerian environments today the consumption of snuff and cannabis products has increased tremendously.

The use of chemical fertilizers in growing tobacco and cannabis products, the heavy metal levels in the soils where these plant materials are sourced, unhygienic processing and packaging of the locally produced S_f and C_L samples could have significantly contributed to their high Pb pollution index values.

The index values of B_H, S_M, and C_S which were 0.1, 0.14 and 0.20 shows that these samples had slight Cd contamination as described in Table 1. L_M and S_f samples had moderate Cd contamination while C_L samples had slight Pb pollution.

Results of Table 3 show that samples Do, L_M, S_M and M_B had very slight Cu contamination since their index values were less than 0.1 as described in Table I. Samples B_H and Ro were slightly contaminated with Cu while Cs samples had severe Cu contamination. S_f samples with an index value of 1.21 indicates slight Cu pollution as described in Table 1.

Conclusion

The mean levels of Pb, Cd and Cu in smoke the based tobacco (Do, B_H, L_M, S_M and M_B) samples sold within Enugu metropolis were within the WHO recommended permissible limits and their C/P values suggests very slight to very severe contamination with the investigated metals.

The mean value of Pb in the smokeless tobacco (S_f) samples sold within Enugu metropolis, Enugu State was above the WHO recommended permissible limits and the C/P value suggests slight Pb pollution.

The mean levels of Pb, and Cd and Cu in the C_L samples sold within Enugu metropolis, Enugu State were above their respective recommended permissible limits and the C/P value suggests slight pollution with these metals.

The levels of Cd, and Cu in both the smoke based and smokeless tobacco and cannabis samples were respectively statistically significant.

The study therefore concludes by opining that the sources of locally produced smokeless tobacco (snuff) samples and smoke based cannabis (C_L) samples, the application of chemical fertilizers during the growth of the plant materials, unhygienic processing and packaging techniques may have contributed significantly to its high mean levels of the determined metals compared to the more refined, processed and packed smoke based tobacco samples.

It is therefore very important that health regulatory agencies in the control of the consumption of tobacco and cannabis products should formulate and standardize the processing and packaging of especially locally produced smokeless tobacco and cannabis products available for consumption by the country's adult population with a view to minimizing the levels of exposure to pollutants like heavy metals through tobacco and cannabis smoking.

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