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Evaluation of Some Heavy Metals Contents in Soil and Tobacco Grown in Sokoto, Nigeria

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Abstract
Tobacco is among the major determinants of morbidities and mortalities in many parts of the world due to its content compounds such as heavy metals. Therefore, it is needful to evaluate heavy metals embedded in the tobacco plant and soil in our localities to divulge information to stakeholders and the public. The objective of this study is to determine the concentrations of copper, nickel, iron, manganese, zinc, chromium, lead, and cobalt in soils and tobacco parts (root, stem, and leave) from Gwadabawa, Illela, and Sokoto; therewith, atomic absorption spectroscopy analysis using standard methods was carried out. The results indicate, the levels of metals increase from stem to leaves to roots to soils. Generally, the ranges of heavy metals determined in soils, and tobacco are: 0.10 ± 0.001-0.62 ± 0.002 ppm (copper), 0.01 ± 0.001-0.52 ± 0.001 ppm (nickel), 0.002 ± 0.0001-150.0 ± 0.05 ppm (iron), 0.20 ± 0.002-101.5 ± 0.1 ppm (manganese), 0.20 ± 0.005-6.20 ± 0.0001 ppm (zinc), 0.01 ± 0.0001-101.02 ± 0.0001 ppm (chromium), 0.01 ± 0.001-2.0 ± 0.002 ppm (lead), and 0.00-1.20 ± 0.0001 ppm (cobalt). Thus, continuous or acute exposure to tobacco through consumption or inhalation or the likes can subject the people to many detrimental effects.
Keywords: *Heavy metals, Absorption, Lead, Tobacco, Biomagnification, Root, Leaves*

INTRODUCTION

Reports had conveyed that, in several modes such as pipes, cigars, and cigarettes, tobacco is utilized across the continents of the world. Nowadays, the consumption of tobacco has continuously skyrocketed all over the world; and consequently, leading to increased morbidities, and mortalities among users and passive smokers (Iwuoha et al., 2013); (Garba et al., 2013). It is indeed certain, that the environmental pollution coupled with increased demand had continuously pollute the soils where crops including tobacco are grown, and in turn contributing to the levels of aggregate toxic chemicals absorbed and accumulated by tobacco plant (Garba et al., 2013); (Sarkingobir et al., 2022); (Sidarta et al., 2022).

That is why, tobacco in its fold or smoke has revealed over 400 chemicals that are toxic to humans and other living systems. Among the chemicals found in tobacco or its products are the heavy metals such as copper, zinc, iron, nickel, manganese, cobalt, chromium, and lead to state a few (Garba et al., 2013). Metals in their respective forms play an important unavoidable role in animals and plants. Insufficiency of some metals spur diseases such as anemia due to lack of enough metal iron, low growth due to low zinc levels, heart disease owing to low copper intake; therefore, the availability and utilization of certain specific metals in the body must be optimum and has to be examined on routine basis in the food and other materials being consumed to safeguard public health (Sodhi et al., 2019). The needs for some metals in the biological system is born-out of the unique traits such as redox activity, catalytic function, interaction with organic molecules (Sodhi et al., 2019); (Aliu et al., 2021). However, even the essential metals are needed by biological system in trace amounts; let alone the non-essential toxic metals like lead and quasi (Aliu et al., 2021).

Previous researches about heavy metals in soil and tobacco grown are limited. However, some heavy metals, such as copper, iron, zinc, are essential to the body at certain amounts; their insufficiency is coupled with diseases or abnormalities in the biological system (Aliu et al., 2021); other heavy metals such as chromium, lead, and the likes are regarded as elements with unknown biological benefit. Therefore, it has been reported that, even a little intake of heavy metals is meted with possibility of toxicity when they come in contact with biological systems of humans, animals, and plants. For instance, chromium in large amounts causes cancer and reproductive effects; lead inflict harm on liver, kidney, reproductive system, brain, and cardiovascular systems; zinc toxicity causes kidney effect, liver, and pancreas effects; copper overload causes toxicity in proteins; intake of nickel in bulk amount is a pattern that causes cancer in lung, prostate, lung, nose, larynth, and birth defects; excess manganese causes a derangement of the neurological system in animals; and cobalt metal can instigate neurological problem, and endocrine lesion (Saeed et al., 2011); (Avila et al., 2013); (Mahurpawar, 2015); (Suganya et al., 2016); (Aliu et al., 2021); (Quds et al., 2021). The Sokoto state is a place that have lands that supports the cultivation of various types of crops including the tobacco plant. More especially, in the Fadama areas. Impliedly, Sokoto, Gwdabawa, and Illela are famous with fertile soils and water that are utilized for cultivation of tobacco for commercial and domestic purposes. Thus, the objective of this study is to determine the concentrations of for copper, nickel, iron, manganese, zinc, chromium, lead, and cobalt in soils and tobacco parts (root, stem, and leave) from Gwadabawa, Illela, and Sokoto towns, Sokoto state, Nigeria.

MATERIALS AND METHODS

Study area

This study was carried out in Sokoto state, Nigeria. The map of the area was revealed in figure 1.

Elemental and data analysis

Samples of soils and tobacco were brought from Illela, Gwadabawa, and Sokoto tobacco plantations. They were converted into tiny pieces. The pieces were thoroughly washed with distilled water. 1g of dried sample was placed into beaker, then 5ml of sulfuric acid was and 2ml of perchloric acid (70% of $HCLO_4$) were added. The preparation was heated to dryness. Then 15ml of water was added, filtered using filter paper into volumetric flask. Filter paper was washed with water, then diluted with deionized water. The preparation was taken to AAS machine for analysis(Sarkingobir et al., 2022).

AAS Analysis

The final processed samples were analyzed by Perkins-Elmer 500 Atomic Absorption Spectrophotometer (AAS). The instrument was firstly calibrated by using stock solution provided by MerCk. In the instrument, cathode lamp for metal to be analyzed was installed, desired wavelength was set. Lamp current was set and allowed to warm up. Then, burner was installed. Hence, standard and sample solutions were aspirated (converted to gas by the machine). Then the instrument showed the actual concentration of the metal in question (Sarkingobir et al., 2022).

The AAS is a spectro-analytical method for the quantitative determination of chemical elements in digested samples down to parts per million (ppm) in a sample. Quantitatively measures the concentrations of elements present in a liquid sample. It utilizes the principle that elements in the gas phase absorb light at very specific wavelengths which gives the technique excellent specificity and detection limits. In AAS principles, the sample may be an aqueous or organic solution, indeed it may even be solid provided it can be dissolved successfully. The liquid is drawn in to a flame where it is ionized in the gas phase. Light of a specific wavelength appropriate to the element being analyzed is shone through the flame, the absorption is proportional to the concentration of the element. Statistical analysis was performed. Triple samples were treated to determine every heavy metals for any given single use plastics. The trio results for each element were added and mean was obtained. Then standard deviation was computed. And data analysis of variance (ANOVA) at 5% level of significance(Sarkingobir et al., 2022).

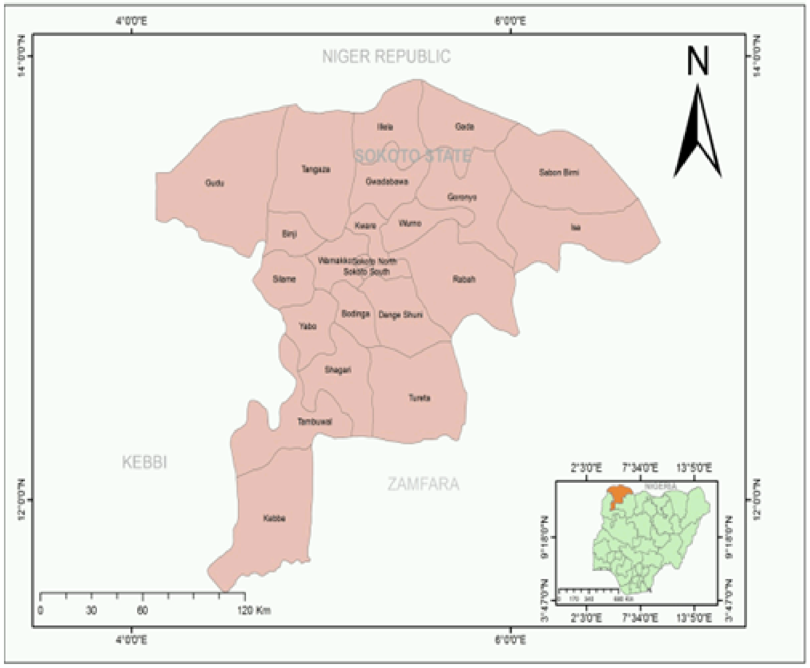

Figure 1: *Map of the study location; Source: GIS Laboratory, Department of Geography Usmanu Danfodiyo University Sokoto (UDUS), 2022.*

RESULTS AND DISCUSSION

Table 1: Showing the levels of some heavy metals in tobacco and soil from Illela of Sokoto, Nigeria

Location: Illela

Samples	**Cu (ppm)**	**Zn (ppm)**	**Fe (ppm)**	**Ni (ppm)**	**Co (ppm)**	**Mn (ppm)**	**Pb (ppm)**	**Cr (ppm)**
Stem	0.15±0.005	0.20±0.0005	1.2±0.005	0.03±0.0001	0.04±0.0001	0.20±0.001	0.2±0.0001	0.10±0.0001
Leave	0.16±0.005	0.30±0.0001	1.01±0.005	0.05±0.0001	0.06±0.0001	0.60±0.001	0.4±0.0001	0.12±0.0001
Root	0.17±0.005	0.40±0.0001	0.02±0.0001	0.06±0.0001	0.07±0.0001	0.30±0.001	0.6±0.0001	0.15±0.0001
Soil	0.25±0.001	6.20±0.0001	10.11±0.005	0.52±0.0001	0.80±0.0001	101.50±0.1	2.0±0.0001	3.20±0.1

Key: Values are expressed as mean± standard deviation; F-statistic value=1.5499, and p-value=0.28104.

Table 2: Showing the levels of some heavy metals in tobacco and soil from Sokoto, Nigeria

Location: Sokoto

Samples	**Cu (ppm)**	**Zn (ppm)**	**Fe (ppm)**	**Ni (ppm)**	**Co (ppm)**	**Mn (ppm)**	**Pb (ppm)**	**Cr (ppm)**
Stem	0.4±0.002	0.31±0.003	10.0±0.2	0.4±0.002	Not detected	0.20±0.002	0.01±0.001	0.01±0.001
Leave	0.5±0.001	0.34±0.001	11.0±0.2	0.6±0.002	Not detected	0.21±0.002	0.01±0.001	0.03±0.001
Root	0.6±0.001	0.36±0.001	11.0±0.2	0.7±0.002	0.01±0.002	0.30±0.002	0.01±0.001	0.08±0.001
Soil	10.0±0.5	10.20±0.2	120.0±1.2	0.9±0.002	0.02±0.002	20.00	1.11±0.001	101.02±0.5

Key: Values are expressed as mean ± standard deviation; F-statistic value= 1.111, and P-value=0.3883.

Table 3: Showing the levels of some heavy metals in tobacco and soil from Gwadabawa of Sokoto, Nigeria

Location: Gwadabawa								
Samples	**Cu (ppm)**	**Zn (ppm)**	**Fe (ppm)**	**Ni (ppm)**	**Co (ppm)**	**Mn (ppm)**	**Pb (ppm)**	**Cr (ppm)**
Stem	0.10±0.001	0.20±0.005	3.5±0.005	0.01±0.001	0.04±0.0005	0.11±0.001	0.2±0.001	0.01±0.0001
Leave	0.11±0.001	0.23±0.005	6.8±0.005	0.01±0.001	0.01±0.0001	0.11±0.001	0.4±0.001	0.02±0.0001
Root	0.20±0.001	0.23±0.005	9.1±0.005	0.01±0.001	0.01±0.0001	0.12±0.001	0.4±0.001	0.02±0.0001
Soil	0.62±0.002	1.25±0.001	150.0±0.05	0.52±0.0001	1.20±0.0001	0.14±0.0001	0.7±0.0001	1.00±0.0001

Key: Values are expressed as mean ± standard deviation; F-statistic value=1.3499, and p-value=0.27104.

The tables 1-3reveal the contents of heavy metals (iron, copper, manganese, zinc, nickel, chromium, lead and nickel) found in different tobacco plants and their plantation soils obtained from different areas in Sokoto Nigeria (namely, Illela, Gwadabawa, Sokoto). The levels of heavy metals found were varied across the different examined soils used for tobacco plantation and parts (root, leaves, and stems) of the tobacco plants. It was also indicated in the tables 1-3 that the levels of metals increase from stem to leaves to roots to soils. Of all the heavy metals measured, the ranges of heavy metals determined in soils, and tobacco (root, leave, and stem) are: 0.10±0.001-0.62±0.002 ppm (copper), 0.01±0.001-0.52±0.001 ppm (nickel), 0.002±0.0001-150.0±0.05 ppm (iron), 0.20±0.002-101.5±0.1 ppm (manganese), 0.20±0.005-6.20±0.0001 ppm (zinc), 0.01±0.0001-101.02±0.0001 ppm (chromium), 0.01±0.001-2.0±0.002 ppm (lead), and 0.00-1.20±0.0001 ppm (cobalt).The displayed disparity by the different levels of the heavy metals in the soils and parts of the studied plant could be accounted by the diverse factors of soil compositions, moisture, temperature, pH, and differences in inherent natures of the plants (Olowoyo et al., 2012).

However, the elevated concentrations of metals in soil belter than plant parts are accounted for the soil pollution due to contaminants such as waste disposals, and application of agricultural chemicals (Rahman et al., 2019); (Sarkingobir et al., 2022). Therefore, the soil had to accumulate more metals than the plants. In this line, the study had also pointed (in the Tables 1-3) that roots had more heavy metals generally than leaves and stems. The diffusion factored could be responsible, since the certainly accumulated heavy metals in soil have much tendency to traverse to the roots, where the roots act as a reservoir for the compounds being absorbed from the environment. Additionally, leaves act through the avoidance feature of plant by immobilizing heavy metals via sorption by the roots. Roots also disgorge ligands that bind heavy metals, exclusion is also another factor that is among the reasons that cause accumulation of heavy metals in the root more than others (Olowoyo et al., 2012); (Agbandi et al., 2020); (Shafiq et al., 2020). Likewise, the comparatively lowest content of heavy metals observed in stems of the tobacco could be due to the fact that, stems re meant to perform translocation of products or substances, rather than storage; therefore, they could not have garnered much heavy metals in consonant with soils, roots, and leaves (that show elevated levels). Leaves of the examined tobacco plants divulge heavy metals concentrations more than the stem, a situation that is expected to be due to the function of leaves as a processing or production house where substances are produced or modified. Therefore, the absorbed heavy metals had to be shuttled to the power house, and in due course processing could lead to bioaccumulation and increased in concentration (biomagnification). Leaf is an important tool applied in sequestration/ detoxification strategy of heavy metals, for instance storing heavy metals in areas like leaf petioles, trachomes, and sheath with the view to reduce/avoid damage to very sensitive parts of the plant. Similarly, the leaves might have extra metals that traverse through their stomata (Olowoyo et al., 2012);(Agbandi et al., 2020).

Notably, the effects of heavy metals in tobacco, a commonly abused drug in many forms is at least coupled with two folds' consequences. The first fold is that, the metals affect growth of the plant (Shafiq et al., 2020). Additionally, the other fold of the presence of heavy metals in soils (for tobacco plantation) and tobacco is, these toxic metals are consumed by active drug users (through tobacco), and spread in smoke (or relations) to the passive smokers as well and lead to health problems such as inflammation, cancers, and sensitivity (Agbandi et al., 2020);(Fresquez et al., 2013).

Meanwhile, when comparing the levels of the determined heavy metals, it was deduced that, Manganese, iron, chromium, lead, zinc, nickel, copper, and nickel found in the tobacco parts are below the WHO permissible limits reported by (Iwuoha et al., 2013) and all these values are very little compared to those reported in different cigarette brands in Rivers state, Nigeria (Iwuoha et al., 2013).

Heavy metals are compared with the limits set by regulators. Zinc levels determined in soils (as shown in Tables 1-3) were above the 0.6 set by WHO, one location shows Cu above WHO limit (10.0), only one location had Cr lower than 10 limit set by WHO. Similarly, all the Co and Ni determined were lower than the WHO limit; but all the Pb, Mn, and Pb in soils were higher than the set limits by WHO (Nazir et al., 2015); (Hasnine et al., 2017); (Kinuthia et al., 2020); (Mahey et al., 2020). Therefore, the Zn, Pb, Mn, and Cr determined in the soils could invariably make the soil not befitting for plantation (especially that of tobacco). The levels of the elements have the potential to harm the plants and can be taken up through the food chain or food web as well (Hasnine et al., 2017); (Kinuthia et al., 2020). In this streak, the Zn, Pb, Ni, Cr, and Cu determined in the tobacco plant (as shown in Tables 1-3) are lower than the limits set by WHO. This could be attributed to the avoidance mechanisms of the plant that screened the heavy metals during intake and might be linked to the reported views of using tobacco for phytoremediation (Nazir et al., 2015); (Hasnine et al., 2017); (Kinuthia et al., 2020); (Mahey et al., 2020).

However, their presence in soil yield a platform that pollute water, air, and food. Therewith, plants such as tobacco take in heavy metals that when consumed by drug users or inhaled by non-smokers detrimental effects are inflicted upon humans (Mafuyai et al., 2020). Parable, lead toxicity is linked to many problems such as effects on nervous system, gastrointestinal system, bone fragility, and anemia (Suganya et al., 2016). Zinc excesses in humans are linked with issues such as anorexia, kidney disorder, liver abnormalities, diarrhea etc (Suganya et al., 2016). Exposure to surplus copper is associated with cancer, growth defect, reproduction abnormalities, decreased weight and size and delay in bon formation (Mahurpawar, 2015). Exposure of elevated nickel levels is meted with consequences such as birth defects, asthma, itching, sensitivity, allergy, heart disorder, and increased cancer risks (Mahurpawar, 2015). Excessive intake of manganese is coupled with the consequence of neurotoxicity (Avila et al., 2013). People exposed to excess chromium are inflicted with cancer, skin ulcers, dermatitis, among others. Therefore, it is pertinent to take appropriate measures to control the abuse of drugs and pollution of environment by heavy metals or relations.

CONCLUSION

Some heavy metals are useful, while other are toxic at any slight provocation. However, the rising trend of anthropogenic processes had causes pollution of our environment in many instance including the agricultural farms. On the other hand, tobacco utilization has been on the rise. However, there is a concern about the nature of chemicals that are present in tobacco either advertently or inadvertently. On this current spate, it is worthy to determine the levels of heavy metals in soils and tobacco plants grown in Sokoto, Nigeria. It was then, revealed that the soils examined have being contaminated with heavy metals and in turn has led to their importation in parts of the tobacco plant (stem, leave, and root); therewith, continuous or acute exposure to tobacco through consumption or inhalation or the likes can subject the people to many detrimental effects. Therewith, the highest levels of heavy metals were determined in soils (due to pollution), followed by tobacco roots, then tobacco leaves, and lastly tobacco stems. People of that region should stay away from tobacco consumption because it contains toxic heavy metals that are detrimental to health. Alternatively, bioremediation should be achieved before planting any tobacco to be consumed by humans to avoid subsequent public health tragedy.

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