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Research Paper

Human Health Risk Prospecting Against Lead, Chromium, and Cadmium in Consumed Herbal Snuffs in Sokoto State, Nigeria

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Abstract: Nowadays, there is much attention on the utilization of herbal medicines among many parts of the world including Sokoto. However, there are concerns that the current trend in pollution could lead to an uptake of lead, cadmium and chromium by herbal plants and in turn can harm the consumers. Therefore, the objective of this paper was to assess cadmium, chromium, and lead in some herbal snuffs consumed in Sokoto, Nigeria and estimate human health risk. Standard methods and materials of analytical grade were used for this work. The assessed concentrations ($p < 0.05$) of Cd, Cr, and Pb in some common herbal snuffs consumed in Sokoto, Nigeria show ranges of Cd, Cr, and Pb respectively as follows: 0.07± 0.001 to 0.13 ± 0.005 ppm, 0.06 ± 0.001 to 0.13 ± 0.006 ppm, and 0.03 ± 0.001 to 0.11 ± 0.005 ppm respectively. Health risk assessment of these concentrations shows that all the values are below 1 and hence can only pose little or naught non-cancer/cancer risk to the consumers. However, people need to take caveat in consumption of herbal stuffs and agencies need to routinely check for quality of these stuffs to safeguard public health.
Keywords: *Herbal snuff, lead, cadmium, chromium, risk, plant, food*

Introduction

Humans and other biota evolved in an ecosystem along with abiotic components consisting of metals (including heavy metals. Some of the metals are categorical examples of inorganic entities essential to the life of plants and animals in the ecosystem. Parable, Zn, Cu, Se, Fe, are (heavy) metals required by plants, and animals (including humans) for health, growth, and development (Iwuoha et al., 2013; Mafuyai et al., 2020). They are essential metals. The presence of useful (essential) metals in the environment encourage their uptake by plants from soil, and water more especially, for performing physiological roles, and other functions (Umar et al., 2023). Therewith, humans depend on plants for various purposes. Humans need plants to obtain food that provides nutrients (carbohydrates, lipids, vitamins, proteins, water, and minerals including metals as well, for instance) (Hashim et al., 2017; Horowilz et al., 2023). And on another basis, humans need plant-based products as source of medicines or bioactive substances that alter the human biological system in many respects such as physiological, morphological, *etc.* (Balamurugan et al., 2019; Sarkingobir *et al.*, 2023). Current world spectrum characterized with a mixture of challenges affecting human existence, such as rising cost of living, rising rate of chronic diseases, rising rate of antibiotic resistance, and other misadventures; especially in developing countries like Nigeria, where healthcare is still at the verge of developing (Tukur et al., 2023). People in Nigerian rural areas are battling with poor health services, have to rely on alternative or traditional therapy (Muhammad *et al.,* 2021; Sarkingobir *et al*., 2022).

Globally, the role of herbs/ phytochemicals in prevention and curing of diseases cannot be overemphasized. Actively, more than 2/3 of the world inhabitants pay much attention to herbal therapy for their healthcare needs because of properties such as lesser side effects, cost-effectiveness, and efficiency (Quds *et al*., 2021; Al-thani *et al*., 2023). There is a growing increase in utilization of herbs/ plant substances for various therapeutic applications especially in rural areas due to urbanization, and globalization among other reasons (Benson et al., 2017; Sarkingobir *et al*., 2022). Many people believed in therapy with the application of herbs/plants and advocate on the cause parading the effectiveness, safety, cheapness, and accessibility of these products relying on empirical facts sand natural origin (Saeed *et al*., 2011; Duburska *et al*., 2022).

Certainly, worldwide, about 300 million people or more are using snuff products, in every ten adults, at least one is using snuff products in low-income countries (Salifu *et al*., 2023). It was reported

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that, from 113 countries, use of snuff products has led to about six million disability adjusted life years (DALYs) and spurred about 266, 592 cancers and heart disease and in turn leading to deaths (Salifu *et al.*, 2023). Snuff is a product made after pulverizing ingredients from herbs or plants (such as tobacco), other ingredients may be added deliberately or through contaminations (Muhammad *et al.*, 2021; Ajayi et al., 2023). Snuffing has been utilized as an alternative therapy for cold, pain, aches, grief, tiredness, etc. The utilizations of snuffing have been linked to effects such as cardiovascular diseases, and cancers (Salifu *et al*., 2023). Prabahar (2012) in an Indian study shows that, tobacco-based snuffs contain heavy metals levels that may pose health risks. Owusu-Asante *et al*. (2022) determined levels of arsenic, cadmium, and lead in snuff in Shanti region, Ghana. The leaves were potentially toxic to humans. Investigation of chromium and cadmium in cigarette-based snuff shows potentially toxic levels in Rivers state, Nigeria (Ndokiari *et al*., 2021). In a study in Ghana, consisting of 272 respondents, there was high intake of snuffs among the participants coupled with high lack of knowledge about hazards of snuff (Salifu et al., 2023. Ajayi et al. (2023) in a study in Ebonyi Nigeria analyzing snuffs for metals, show that, exposure to these snuffs may cause non-cancer health risks. Muhammad et al. (2021) reported in their experimental study in Jos that, certain snuff products cause oxidative stress in rat brain.

However, due to the growing concern about the rise in environmental pollution, chemicals including essential and non-essential heavy metals (such as lead, cadmium, and chromium) find ways into soil, water, air, food, and other environmental components and it is now imperative to monitor lead, chromium, and cadmium in herbal snuffs (Sarkingobir *et al.*, 2023). More prominently, heavy metals present in water and soil are taken up along with minerals and other nutrients (despite the strategies for abating pollutants in plants) for upward deposition in plant parts (Dahlawi et al., 2021; Quds et al., 2021; Ngumah *et al*., 2022).

Consequently, when these plants are utilized as food or any other thing there is every possibility that the embedded heavy metals could be shuttled along the food chain and harm humans when certain exposure is ensured. Parable lead is a forefront toxic metal, capable of eliciting high blood pressure, and effects kidney and brain at slightest concentration. Cadmium too at low levels can elicit cardiac and kidney disorders. Similarly, chromium is toxic and is associated with human cancer (Duruibe *et al*., 2007; Saeed *et al*., 2011; Benson et al., 2017; Murphy et al., 2021). However, there is information scarcity about the levels and types of contaminants in herbal snuff being taken in Nigeria and Sokoto in particular. Therefore, the objective of this paper was to assess cadmium, chromium, and lead available in herbal snuff consumed in Sokoto, Nigeria and estimate human health risk.

Materials And Methods

Study area

The study was carried out in Sokoto state, Nigeria. Sokoto State is located in the Northwest Zone of Nigeria between longitude 11″ 30–13″ 50 and latitude 4″–6″. It borders Niger Republic to the north and Benin Republic to the northwest, Kebbi State to south and Zamfara State to the east. It has a land mass area of about 32,000 km^2 and consists of 23 local government areas and 244 political wards. The population is predominantly rural, Muslim and consists almost entirely of Hausa/Fulani ethnic groups.

Elemental and data analysis

Herbal snuffs are widely seen in Sokoto city. They are powdered materials (usually of plant origin) stocked in small containers that are snuffed by users to get some feelings of therapy on various issues affecting them. The name of each herbal powdered snuff is denoted mostly by name of its company or manufacturer which is boldly written on the containers. Since the snuffs are from different companies/ manufacturers they may differ in effect and compositions, likewise their price and consumer preferences. The six different herbal snuffs namely, Hajiya Aisha, Hajiya safiya, Dr Lambo and others (some of them were shown in Figures 2-4) were purchased from Sokoto Market, Sokoto City, Sokoto State, Nigeria. The determination of heavy metals (lead, chromium, and cadmium) was performed by the methods of Association of Analytical Chemists (AOAC) described in Tukur et al., (2023).

Estimation of Human Health Risk Assessment

Human Health risk was calculated using three different equations shown in this section. **CDI**=CP×IR×EF×ED/Bw×AT (mg/kg/day). Where, CDI= Chronic Daily Intake, CP= concentration of

metal in herbal snuff, IR=Ingestion Rate=1, EF= Frequency of Exposure=90 days, ED=Exposure Duration=30 days, Bw=weight=70 kg, AT= 2700 days.

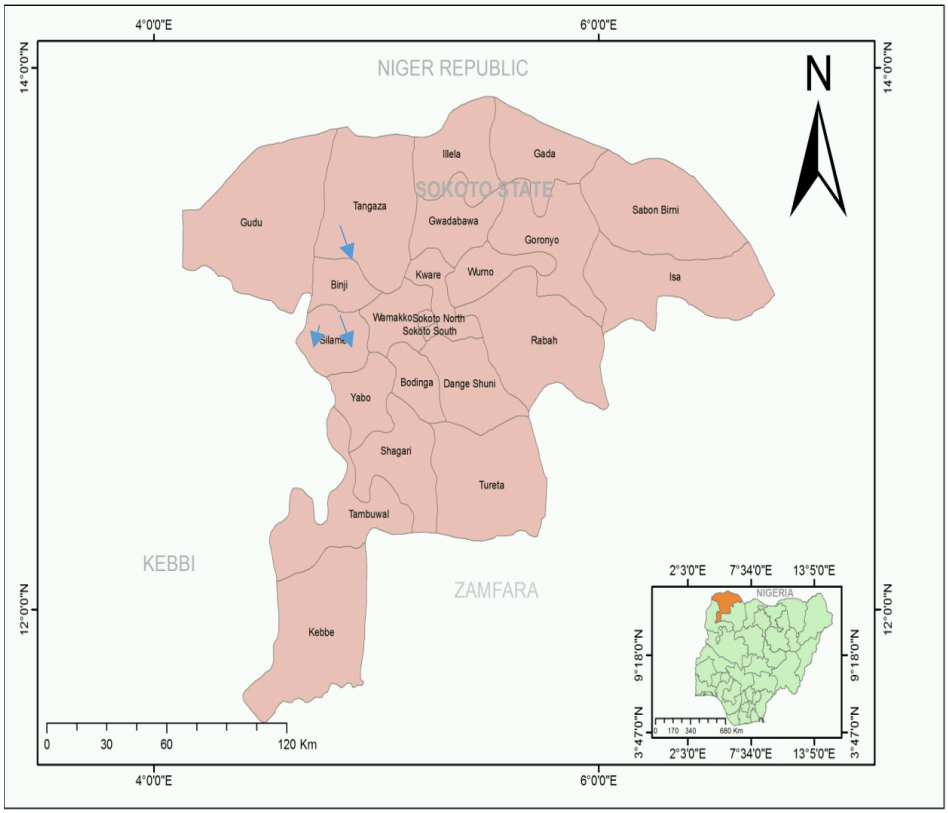

Figure 1. Map of Sokoto State, Nigeria, (Hamza et al. 2023).

Figure 2. Dr Lambo Herbal Medicine

Figure 3. Hajiya Aisha Herbal Snuff

Figure 4. Hajiya Safiya Herbal Snuff

Hazard Quotient= CDI/RfD
Where, RfD= Chronic Oral Reference Dose, lead=3.5, chromium=3.0, cadmium=5.0. (Olagunju et al., 2020; Tschinkel et al., 2020).
Hazard Index (HI)= Summation of hazard quotient of Pb, Cd, and Cr= $HQ_{cd} + HQ_{Cr} + HQ_{Pb}$
EDI= C×QMC/bw
EDI= Estimated daily intake, C= concentration of metal, QMC= 0.00788 g, quantity of snuff taken every day approximately from a review, bw= weight, it is 70 kg for adult.

Statistical analysis

The descriptive statistics and one-way analysis of variance (ANOVA) were carried out at (p<0.05) significance level using Microsoft excel version 7.

Results and Discussion

The results for this study were shown in Tables 1- 5.

Table 1. Showing concentrations of lead, cadmium, and chromium metals assessed in some herbal snuffs collected from Sokoto, Nigeria

Type of herbal snuff	**Lead (ppm)**	**Cadmium (ppm)**	**Chromium (ppm)**
1=Snuff herbal powder	0.03± 0.001	0.08± 0.0002	0.08± 0.001
2= Hajiya Ayisha snuff AK 47	0.03± 0.001	0.07± 0.001	0.06± 0.003
3= Dr Lambo Special Sundu	0.03± 0.001	0.07± 0.001	0.06± 0.003
4= Hajiya Ayisha snuff AK47 Blue Cover	0.09± 0.004	0.11± 0.001	0.10± 0.001
5= Dr Lambo Herbal Powder	0.11± 0.005	0.12± 0.005	0.04± 0.001
6= AK 47	0.06± 0.0001	0.13± 0.005	0.13± 0.006

Keys: Values are expressed as mean ± standard deviation

Table 2. CDI pertaining concentrations of lead, cadmium, and chromium metals assessed in some herbal snuffs collected from Sokoto, Nigeria

Snuff type	**Cadmium**	**Chromium**	**Lead**
1=Snuff herbal powder	0.001143	0.001143	0.00042857
2= Hajiya Ayisha snuff AK 47	0.001	0.0008571	0.00042857
3= Dr Lambo Special Sundu	0.001	0.0008571	0.00042857
4= Hajiya Ayisha snuff AK47 Blue Cover	0.001571	0.0014286	0.00128571
5= Dr Lambo Herbal Powder	0.0017143	0.0005714	0.001571
6= AK 47	0.0018571	0.0018571	0.0008571

Table 3. HQ pertaining concentrations of lead, cadmium, and chromium metals assessed in some herbal snuffs collected from Sokoto, Nigeria

Snuff type	Cadmium	Chromium	Lead
1=Snuff herbal powder	0.0002286	0.0004767	0.00012245
2= Hajiya Ayisha snuff AK 47	0.0002000	0.000381	0.00012245
3= Dr Lambo Special Sundu	0.0002000	0.000381	0.00012245
4= Hajiya Ayisha snuff AK47 Blue Cover	0.00031420	0.0004762	0.00036735
5= Dr Lambo Herbal Powder	0.00034286	0.000190467	0.00036735
6= AK 47	0.00185710	0.00190467	0.00024489

Table 4. Showing Hazard Index (HI) of concentrations of lead, cadmium, and chromium metals assessed in some herbal snuffs collected from Sokoto, Nigeria

Type of herbal snuff	Hazard Index (HI)
1	0.00511805
2	0.00070345
3	0.0052345
4	0.0020149
5	0.004206827
6	0.00621067

Table 5. Revealing the EDI pertaining concentrations of lead, cadmium, and chromium metals assessed in some herbal snuffs collected from Sokoto, Nigeria

Type of snuff	Cd	Pb
1	2.10133333333E-5	0.00000078
2	1.83866666666E-5	0.00000078
3	6.98693333333E-6	0.00000078
4	6.98693333333E-6	0.000234
5	2.88933333333E-5	2.8893333333333E-5

6	0.000312	0.00001576

Table 1 shows the assessed concentrations of herbal snuff Cd, Cr, and Pb in some common herbal snuff consumed in Sokoto, Nigeria. The ranges of Cd, Cr, and Pb respectively are as follows: 0.07± 0.001 to 0.13 ± 0.005 ppm, 0.06± 0.001to 0.13± 0.006 ppm, and 0.03± 0.001 to 0.11 ± 0.005 ppm respectively. Nowadays, there is an increasing trend of utilization of herbal/ traditional therapy across the various parts of the world, let alone in developing countries like Nigeria (Muhammad et al., 2021; Salifu et al., 2023). This trend could be attributed to the increase in burden of diseases, poor healthcare systems, poverty, and antibiotic resistance among others. Thus, it is imperative to perform assessment of quality of herbal stuffs; therewith, the need to assess heavy metals such as Cd, Cr, and Pb because they are capable of leading to toxicity in humans at any slight concentration (Quds et al., 2021; Al-Thani et al., 2023. And the widespread pollution to anthropogenic activities that easily spoil food or other products (Olagunju et al., 2020; Labbo et al., 2021). Nevertheless, the non-essential heavy metals Cd, Cr, and Pb assessed in herbal stuff in Sokoto (as shown in Table 1) in 72.2% of the samples are within safe levels reported elsewhere. Parable, Pb determined in snuff (Table 1) is less than limit set by WHO (<10mg/kg), 250ug/day limit set by the Joint FAO/ WHO Expert Committee (JECFA), and 20ug/day limit set by American National Standards Institute (ANSI) (Mathew et al., 2021). This was in consonant with a survey of herbal stuffs in Pakistan that shows lead within permissible limit (Quds et al., 2021).

Cd concentrations (0.07±0.001 to 0.13 ± 00.005 ppm) and Cr (0.06± 0.001 to 0.13 ± 0.006ppm) shown in Table 1 depicting levels of non-essential heavy metals in snuff consumed in Sokoto are evident. The WHO permissible limit for Cd 0.3ppm conflicted with what was found in herbal varieties examined in this work. This contradicts a survey of Cd stuffs in Pakistan that shows Cd below the WHO limits (Quds et al., 2021). The presence of Cd in excess is either due to plants being cultivated in polluted soils, contamination during production, and leaching chemicals through from the containers (Balali-mood et al., 2021; Mathew et al., 2021; Quds et al., 2021; Umar et al., 2023). Cd metal have the potential to affect respiratory system and spur cardiac and kidney disorders (Quds et al., 2021; Al-Thani et al., 2023). Therefore, there is need to routinely assess this metal in herbal medicines to safeguard public health. However, another Recommended Daily Limit (RDL) for cadmium reported in Saeed et al., (2011) of 70 ug was higher than the cadmium found in this study (Table 1). Additionally, another potentially toxic metal is chromium. Chromium concentrations when compared to the WHO permissible limit (30-35 ppm for adults and 11-25 ppm for children) shows a lower trend and was in conflict with results from Pakistani branded herbal medicines that contain higher Cr in 96% of the stuff studied (Saeed et al., 2011).

Moreover, since heavy metal consumption in foods and other sources are issues of concern, further assessment of the values obtained in Table 1 is imperative. The subjection of the results (in Table 1) to health risk assessment (HRA) was ensured. Table 2 shows the CDI for Cd, Cr, and Pb for snuff consumed in Sokoto, Nigeria; and fortunately, all the values are below 1. Thus, the population exposed to the snuff may not be at risk due to the metals in question with the assumption that consumers take in 1g/day (Mafuyai et al., 2020), further consumption above 1g could put the consumers at risk (Njoga et al., 2021. according to Table 3, HQ of Cd, Cr, and Pb in snuff was unveiled and all the values are below 1; therefore, it might not cause non-carcinogenic adverse effects on consumers using the observed concentrations (Table 1) (Njoga et al., 2021).

Similarly, Hazard Index (HI) for Cr, Pb, and Cd shows all values are below 1 for all the stuffs (Table 4). Thus, all the mixture of Cd, Pb, and Cr may not pose harm to the consumers at observed concentrations or may only lead to little harm (if there is any to the users) (Njoga et al., 2021). EDI, Estimated Daily Intake (Table 5) shows the amount that can be taken daily without expecting much risk and therewith all the values are below 1(Njoga et al., 2021). It is indeed imperative to assess non-cancer at these concentrations. Thus, the risk estimated for Cd, Pb using the observed concentrations (in Table 1) was shown in Table 5 and was fortunately lower than 1 and therefore there may be minor chance for the observed concentrations (Table 1) to elicit non-cancer risks (Njoga et al., 2021). Still people need to take care of when dealing with foods, and herbal stuffs because of possibility of pollution and agencies and scholars need to observe these herbal stuffs routinely before allowing public exposure.

Conclusion

Herbal stuffs are getting popular world over, but there is concern about possible pollution, for instance with heavy metals. Thus, quality is routinely checked regarding heavy metals and other pollutants in herbal stuffs. This study reveals that health risk assessment of lead, cadmium and chromium concentrations divulge values that are below 1 and hence can only pose little or naught non-cancer/cancer risk to the consumers. However, people need to take caveat in consumption of herbal stuffs and agencies need to routinely check for quality of these stuffs to safeguard public health.

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