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EVALUATION OF HEAVY METAL CONTAMINANTS IN SOME PLANTS USED IN PHYTOTHERAPY IN ISIN AND MORO LOCAL GOVERNMENT AREAS OF KWARA STATE, NIGERIA

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ABSTRACT

Phytotherapy had been considered to be less expensive and readily available in the world today because it involves the direct use of certain readily available herbs which possess specific phytochemical agents capable of combating varying degrees of infections and ailments. Some heavy metals are useful to human body but at high concentrations they can be destructive. This research work evaluated the concentration of arsenic, cadmium, copper, lead and nickel in seven different plants used for herbal medicine within Kwara state. They are *vernonia amygdalina*, *Moringa oleifera*, *Occimum gratissimum*, *Anacardium occidentale*,

Introduction:

Phytotherapy has gained wide acceptance globally in recent times as an alternative to western medicine. Phytotherapy (or herbal medical treatment) is the use of plants or herbs to manage certain health conditions. This type of therapy also refers to making use of substances that come from plants or herbs to treat certain ailments. Medicinal plants and herbs are seeing as a form of complementary medicine that one can receive alongside traditional Western

Cassia alata, *Garcinia kola* and *Hibiscus sabdariffa* collected from four different locations within Isanlu-Isin and Bode-Saadu in Isin and Moro LGAs of Kwara state respectively. Arsenic concentration: highest- 6.31ppm, which is higher than the FAO/WHO standard of 5.00ppm, lowest - 0.001ppm. Cadmium concentration: Highest- 14.08ppm which is also far higher than the 0.30ppm standard, lowest- 0.001ppm. Copper concentration: Highest- 131.0ppm, lowest- 2.30ppm which was below the standard of 150ppm. Lead concentration: Highest- 68.23ppm which is far beyond the 10ppm standard, lowest- 0.003ppm. Nickel concentration: Highest- 91.10ppm was observed which was also higher than the recommended maximum tolerable amount, lowest- 0.002ppm. The trend of this results implicated Bode-saadu, which is a commercial hub compared to Isanlu-Isin, as the location with arsenic, cadmium, lead and nickel toxicities and this is directly linked to environmental pollution via anthropogenic activities.

Keywords: Heavy metal toxicity, Phytotherapy, Health risks, Kwara State.

medicine (Onyiapat, Okoronkwo and Ogbonnaya, 2011).
In the world today, several plants have been employed in alternative traditional medicine (ATM), i.e. herbal medicine. In fact, alternative traditional medicine have been extensively and widely employed in the treatment of various types of diseases such as fevers, septicemia, dyspepsia, hypertension, hyperglycemia (diabetes), convulsion, migraine, thrush, pneumonia, flatulence, impotence, dysentery, diarrhea, headache, dental issues and many more (Kofi, Rita, Isaac and Isaac, 2013). World Health Organization (2005) estimated the population of those that rely on herbal medicine globally as their primary healthcare service to about 65-80%. This is not

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unconnected to the various health benefits derived from it and also due to the fact that it is less expensive (WHO, 2005).

Traditionally in times past, certain pattern of belief by some people of old which attached the treatment of certain ailments to specific plants was the basis for the traditional medicine. This belief system is known as the "Doctrine of Signature" (DoS) which held that, "organs of plants or a whole plant (herb) resembling various parts of the body can be used by herbalists to treat ailments of those body parts." Though accurate in some trials, DoS caused a lot of mortality and several illnesses in decades past, therefore referred to as pseudoscience (Simon, 2014). For instance, a plant called birthwort (socalled because of its resemblance to the uterus), once used widely for pregnancies, is carcinogenic and very damaging to the kidneys, owing to its aristolochic acid content (Robertson, 2022).

Recently, herbal medicine particularly in Nigeria and some other African countries had come under a great criticism and scientific scrutiny. Firstly, because of the uncertainties trailing the prescription, secondly, the linkage between the geographical location and sources from which the used medicinal plants are harvested, with their chemical and mineral contents (Adepoju, 2012).

There are two possible locations where these medicinal plants may be harvested; they may be harvested from the wild zones or grown for herbal medicinal purpose. If grown, the environmental and growth factors can be controlled, thereby reducing the possibility of hypertoxocity. Of greater concern to scientists and even the learned consumers of traditional herbal medicine are the toxicological effects of the heavy metal contents in plants harvested wild on the body system. While harvesting these plants, the herbal drug formulators hardly consider the environment from which they are plucking the plant.

Own to their sessility, plants cannot escape any unpleasant variation in the environmental condition. A good example of such environmental changes is exposure to heavy metals which is capable of triggering a wide range of physiological and biochemical alterations, leaving the plants with no option than to either develop or adopt a series of strategies that allow them to cope with the negative consequences of heavy metal toxicity e.g. avoidance mechanism and tolerance mechanism, while in some cases, plants with no ability to adapt will die off in the process (Kavamura and Esposito 2010).

Plants respond to external stimuli including heavy metal toxicity via several mechanisms.

According to Tamás, Mistrík, Huttová, Halusková, Valentovicová and Zelinová (2010), response of some plants to hypertoxicity of heavy metal results to varying degree of visible changes in certain organs of the plant. For instance, Tamás *et al.,* (2010) reported that early signs of metal toxicity in barley were similar to water deficiency signs, and thus, overexpression of genes related to dehydration stress in barley was found after exposure to Cadmium (Cd) and Mercury (Hg).

Another study by Indriolo, Na, Ellis, Salt and Banks (2010), demonstrated that seed germination and seedling growth of wheat was found to be inhibited due to high concentration of Arsenic (As).

In similar vein, Imran, Khan, Ali and Mahmood (2013) reported reduction in plumule and radicle length of *Helainthus annuus* L. seedlings when exposed to Arsenic (As).

Yuan, Xu, Liu and Lu (2013) have reported that excess Copper (Cu) affects both elongation and meristem zones by altering the distribution of auxin through PINFORMED1 (PIN1) protein, and that Copper-mediated auxin redistribution is responsible for Copper-mediated inhibition of primary root elongation.

In several medicinal plants, the concentration of heavy metals is not high enough to cause a visible change in the organs. This is because the concentration is below the toxic level (That is, it is within the maximum tolerable concentration) meanwhile, same concentration might be toxic to human consumer of such plants when exploited for its medicinal values (Maiga, Diallo, Bye and Paulsen, 2005).

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Although, some heavy metals are essential as nutrients for humans in small quantities.

For example, copper, iron, cobalt and zinc but are toxic in higher quantities. But few metals, such as lead, cadmium, chromium, arsenic and, mercury are poisonous even in small quantities. This makes heavy metals have two major categories; Essential Heavy metals are less toxic at low concentrations and they act as coenzyme in biological process (e.g. copper, iron, cobalt and, zinc). For example Hemoglobin and Myoglobin consist of Iron, Vitamin B12 consists of cobalt. The non-essential heavy metals are highly toxic even at very low concentrations, they are non -biodegradable and cause severe toxic effects to living organisms. Both essential and non-essential heavy metals (lead, cadmium, chromium, arsenic and, mercury) at high concentration cause varying degrees of disorders to the system of the consumers (Maiga *et al.,* 2005). See figures 1 and 2 below:

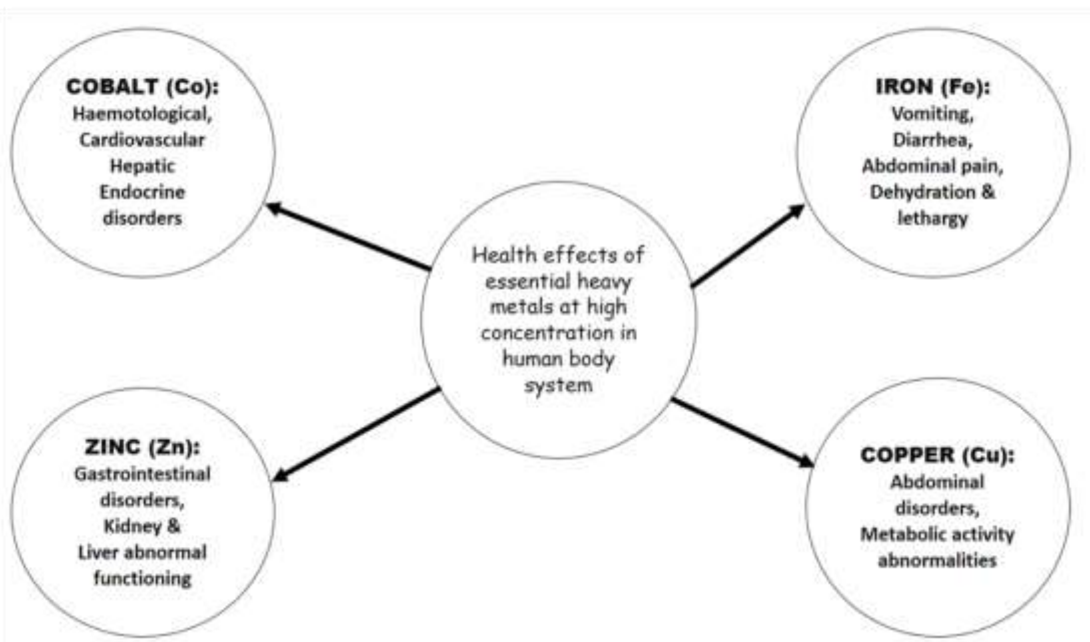

Figure 1: Health effects of high concentration of essential heavy metals in human body system

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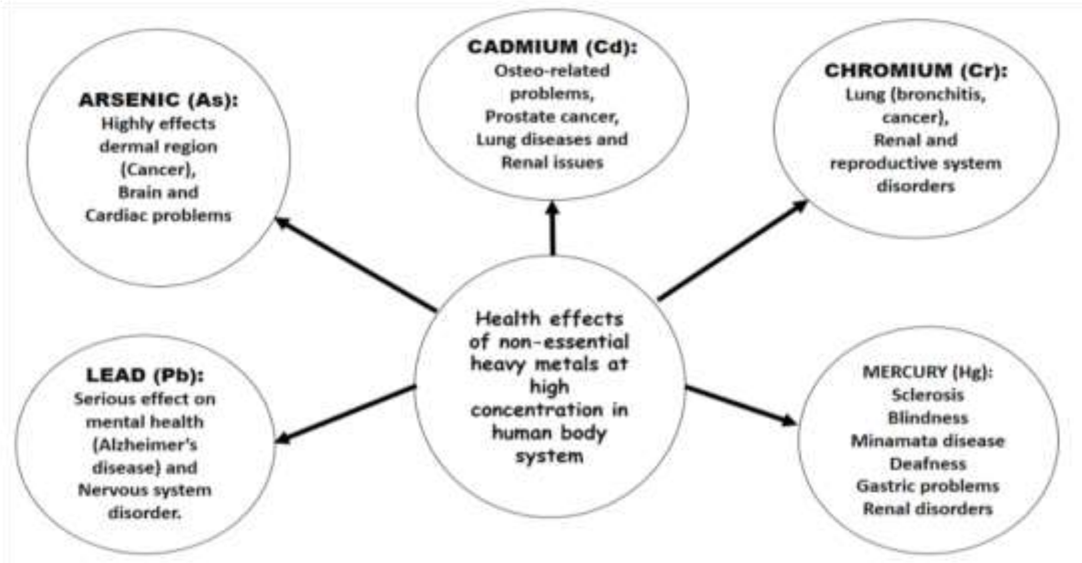

Figure 2: Health effects of high concentration of non-essential heavy metals in human body system

The toxicity of heavy metals depends on i) concentration in the environment ii) period of exposure and iii) route of exposure.

Many heavy metals occur naturally in the earth's crust at various levels, the problem arises when they are released in excess into the environment due to anthropogenic activities (Kim, Kim, Kumar, 2019).

During the last few decades, increased anthropogenic activities (e.g. Release of sewages from homes, wastes disposal, municipal effluents etc.), rapid industrialization (e.g. Release of heavy metal from smelting industries and metalliferous mines) and modern agricultural practices (e.g. Large areas of land have been contaminated with heavy metals due to the use of pesticides, fertilizers, municipal and compost wastes), have resulted in increased heavy metal contamination in the environment, which causes toxicity to the living organisms (Eapen and D'souza, 2005; Kavamura and Esposito, 2010; Miransari, 2011). Pharmacological information of the plant species under study are given below;

Plant species	Family name	Common names	Some illnesses treated	Formulations
Vernonia amygdalina	Asteraceae	Bitter leaf	Diabetes, fever, gastroenteritis	Shoot decoction
Moringa oleifera	Moringaceae	Moringa	Hypertension, Diabetes, Gastritis	Shoot decoction

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Garcinia kola	Guttiferae/Clusiaceae	Bitter kola	Liver and throat disorders, Diabetes	Infusion
Anacardium occidentale	Anacardiaceae	Cashew plant	Colic, Diarrhea, Diabetes, Sore throat	Shoot decoction
Occimum gratissimum	Lamiaceae	Scent leaf plant	Cancer, Fungal and Bacterial infections	Infusion
Cassia alata	Caesalpinaceae	Cassia plant	Ringworm, Typhoid, Eczema, Asthma	Shoot decoction/ Direct application
Hibiscus sabdariffa	Malvaceae	Zobo plant	Fungal and Bacterial-infections, Cancers (Kofi *et al.,* 2013)	Decoction

Statement of problem

In recent times, reports from several parts of Nigeria where local phytotherapy (herbal medicine) are used in preference to western medicine in the treatment of illnesses have it that, complications of diverse sorts are trailing the usage. There has been several reports around Ilorin, Kwara state and other areas in Nigeria that several herbal medicines used for certain ailments such as infertility, fever, impotence, etc., has been resulting in other health conditions that affect ectopic organs like kidney, liver and gastrointestinal tract which sometimes lead to severe health conditions or even death. This development gave birth to the quest for this research work, to ascertain the level of heavy chemical concentration in widely used herbs in alternative traditional medicine in relation to their sites of harvest (plucking), since some locations can induce hike in the concentration which can result in diverse health challenges and at times death.

Aim and Objectives

The aim of this research is to analyse the adverse effects of the high level of toxicity of selected heavy metals induced by the location of growth in herbal medicinal plants on the body system of the consumer.

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This aim will be achieved through the following specific objectives:

i. Collecting samples of the parts of the named seven medicinal plants from four major locations (Refuse dumping site, forest area, within the town and gardens) in the pre-determined sampling areas
ii. Determining the presence of five common heavy metals (Arsenic-As, Cadmium-Cd, Copper-Cu), Lead- Pb and Nickel- Ni in the plants.
iii. Determining the extent of their concentrations and relate this to the location of sampling.
iv. Comparing the level of these heavy metal concentrations with the WHO/FAO standard/permissible range.

Scope of the study

Nigeria is a tropical region, which makes the distribution of vegetation specific. Seven commonly used medicinal plants in phytotherapy are analysed in this research work for the presence and prevalence of selected heavy metals. Each of these plants was plucked from four different locations around Isin metropolis of Kwara state, Nigeria, knowing fully well that they all require same growth conditions in any location.

Significance of the study

In Nigeria, it has been observed that many studies have been concentrated on the phytochemicals and bioactivities of medicinal plants. Prevalently has been the antimicrobial, anti-inflammatory, antibiotic as well as anthelminthic properties of these medicinal herbs, not much emphasis had been laid on the presence and prevalence of heavy chemical in relation to their location of growth. This research study beams light on this and also suggests better and safe practices in sourcing for all these plants of medicinal importance and to avoid heavy metal phytotoxicity.

Methodology

Study Area

The study area for this research was the metropolis of Isin local government area of Kwara state, located in the North central part of Nigeria.

Sampling of plant materials

A total of seven (7) medicinal plants used for the purpose of this research were collected randomly, from four (4) different natural habitats (Refuse dumping site - RDS, forest area - FA, within the town - WTT and gardens – G, from Isanlu-Isin and Bode-Saadu in Isin and Moro local governments respectively). These plant samples are leaves of bitter leaf, *Moringa*, cashew plant, scent leaf plant, *Cassia* plant, seeds of bitter kola and calyces of zobo plant. Each sample was wrapped in a clean aluminum foil and labelled appropriately to avoid any form of mix up.

Authentication of the Plant species

These plants species were authenticated at the Plant biology department, faculty of Life sciences in the University of Ilorin, Kwara state, Nigeria. Basic information about the plant species have been previously given.

Preparation and Acid digestion of the plant sample

The collected samples were air-dried inside the laboratory for 6 days, ensuring that the environment was as dust-free as possible. After the air-drying, each sample was pulverized using a cleaned porcelain mortar and pestle. From this, 1g was weighed out using a digital weighing balance into a 100ml beaker. This was followed by the addition of acid mixture of 10ml of 65% nitric acid (HNO3) and 30ml of 37% Hydrochloric acid (HCl) in ratio 1:3. Then, the mixture was boiled gently over a water bath at 950C until the sample had completely dissolved and clear solution was obtained (Ang and Lee 2005).

The mixture is then filtered using Whatman 42 filter paper with 2.5-µm particle retention into a 50ml volumetric flask. The collected filtrate was then topped up to the mark with 0.1% Nitric acid. In order to confirm the precision of the result, each plant sample was digested and analyzed in duplicate. These digested samples were then transferred into plastic bottles and then stored in the refrigerator at 40C for analysis. A mixture of 30 ml HCl and 10ml HNO3 was made to prepare the blank solution. This was treated similarly as that of the sample. Standard solutions with different concentrations of 1, 2, 3, 4, 6 mg/l were prepared from 50mg/l stock solutions for each metal (Charun and John 2006).

Aliquots of the mixture was later used to determine the concentrations of arsenic-As,

Cadmium-Cd, Copper-Cu, Lead- Pb and Nickel-Ni by iCE 3000 SERIES AASpectrometer (AAS) with statistical significance ($p<0.05$). The Atomic Absorption spectrometer (AAS) was switched on. For Pb, Cd and Cu, the required Acetylene gas turned on; while for As and Ni, Acetylene and nitrous gas was employed. Metal-specific lamp was inserted and the machine was stabilized for 15 Minutes. Standards were analyzed to prepare calibration curves followed with blank and samples analysis in AAS. Each sample undergoing analysis thrice and the results recorded as mean $\pm$ SD with the unit part-per-million (ppm).

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Results

Table 1: Heavy metal contents (PPM) of *Vernonia amygdalina* from different locations in Isanlu-Isin and Bodesaadu.

Isanlu-Isin						*Bode-Saadu*					
Heavy metal content (PPM)						Heavy metal content (PPM)					
Site	As	Cd	Cu	Pb	Ni	Site	As	Cd	Cu	Pb	Ni
RDS	-	0.15	12.45	0.65	-	RDS	0.001	0.360	21.5	10.75	-
FA	-	0.05	28.50	0.26	0.25	FA	0.85	0.13	12.23	0.54	-
WTT	0.03	2.05	15.50	0.44	-	WTT	0.002	0.43	10.32	68.23	2.91
G	-	1.85	32.30	0.03	-	G	5.20	0.86	49.72	6.46	0.03

Table 2: Heavy metal contents (PPM) of *Moringa oleifera* from different locations in Isanlu-Isin and Bode-saadu.

Isanlu-Isin						*Bode-Saadu*					
Heavy metal content (PPM)						Heavy metal content (PPM)					
Site	As	Cd	Cu	Pb	Ni	Site	As	Cd	Cu	Pb	Ni
RDS	0.015	0.73	8.75	0.55	0.014	RDS	4.12	0.62	32.0	4.84	-
FA	0.003	0.22	54.10	0.43	-	FA	0.013	0.29	2.37	3.40	3.35
WTT	0.020	0.63	71.21	3.42	0.002	WTT	6.31	0.58	13.70	8.21	8.43
G	0.001	0.001	13.90	3.92	-	G	0.002	0.001	89.50	1.00	0.020

Table 3: Heavy metal contents (PPM) of *Garcinia kola* from different locations in Isanlu-Isin and Bode-saadu.

	Isanlu-Isin Heavy metal content (PPM)					*Bode-Saadu* Heavy metal content (PPM)				
Site	As	Cd	Cu	Pb	Ni	Site	As	Cd	Cu	Pb	Ni
RDS	na	na	na	na	na	RDS	na	na	na	na	na
FA	3.20	0.03	38.12	8.23	24.80	FA	na	na	na	na	na
WTT	na	na	na	na	na	WTT	2.87	0.18	36.52	0.45	91.10
G	na	na	na	na	na	G	4.29	0.04	17.86	1.28	72.38

Table 4: Heavy metal contents (PPM) of *Anacardium occidentale* from different locations in Isanlu-Isin and Bodesaadu.

	Isanlu-Isin Heavy metal content (PPM)					*Bode-Saadu* Heavy metal content (PPM)				
Site	As	Cd	Cu	Pb	Ni	Site	As	Cd	Cu	Pb	Ni
RDS	0.005	0.02	45.20	2.05	0.75	RDS	-	0.38	13.2	2.83	21.50
FA	-	0.002	37.90	0.005	-	FA	-	0.15	2.30	1.52	5.22
WTT	0.001	-	96.59	0.007	28.23	WTT	0.07	1.78	12.05	5.25	7.20
G	-	0.30	4.20	-	-	G	-	-	34.20	0.25	0.02

Table 5: Heavy metal contents (PPM) of *Occimum gratissimum* from different locations in Isanlu-Isin and Bodesaadu.

	Isanlu-Isin Heavy metal content (PPM)					*Bode-Saadu* Heavy metal content (PPM)				
Site	As	Cd	Cu	Pb	Ni	Site	As	Cd	Cu	Pb	Ni
RDS	0.005	0.42	19.00	4.70	22.4	RDS	4.38	1.62	87.00	5.10	0.07
FA	-	-	18.30	0.03	-	FA	0.54	0.002	17.43	3.23	0.03
WTT	-	0.28	57.90	0.003	10.50	WTT	3.22	0.12	63.20	0.02	16.62
G	-	14.08	6.25	5.44	0.89	G	0.11	-	16.10	6.42	-

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Table 6: Heavy metal contents (PPM) of *Cassia alata* from different locations in Isanlu-Isin and Bode-saadu.

Isanlu-Isin						*Bode-Saadu*					
Heavy metal content (PPM)						**Heavy metal content (PPM)**					
Site	As	Cd	Cu	Pb	Ni	**Site**	**As**	**Cd**	**Cu**	**Pb**	**Ni**
RDS	**-**	**-**	**15.8**	**4.40**	**14.1**	RDS	0.21	-	58.2	16.4	16.35
FA	**-**	**0.27**	**9.83**	**7.00**	**1.42**	FA	-	-	35.50	6.77	14.00
WTT	-	0.04	8.01	9.20	16.76	WTT	0.006	0.09	13.00	8.40	72.8
G	0.02	0.29	28.76	6.50	0.012	G	-	0.03	5.03	4.84	3.86

Table 7: Heavy metal contents (PPM) of *Hibiscus sabdariffa* from different locations in Isanlu-Isin and Bode-saadu.

Isanlu-Isin						*Bode-Saadu*					
Heavy metal content (PPM)						**Heavy metal content (PPM)**					
Site	As	Cd	Cu	Pb	Ni	**Site**	**As**	**Cd**	**Cu**	**Pb**	**Ni**
RDS	**0.094**	**0.008**	**51.20**	**-**	**13.5**	RDS	0.02	0.18	28.00	0.32	-
FA	**-**	**-**	**11.52**	**-**	**-**	FA	0.26	0.01	16.10	-	0.002
WTT	**0.17**	**0.25**	**22.60**	**0.007**	**-**	WTT	3.48	0.28	11.23	0.98	-
G	**0.45**	**-**	**43.00**	**-**	**0.005**	G	-	-	131.0	0.09	0.02

Key: RDS- Refuse dumping site, **FA-** forest area, **WTT-** within the town and **G-** garden **As-** Arsenic, **Cd-** Cadmium, **Cu-** Copper, **Pb-** Lead, **Ni-** Nickel while **(-)** means "Not Detected", **na-** "Not Applicable" (Because no sample was collected in those areas due to unavailability).

Discussion

Concentration of arsenic was observed to be highest in *M. oleifera* collected within the town of Bode-Saadu with the value of 6.31ppm (Table 2) and the lowest concentration of this metal (0.001ppm) was found in *M. oleifera* and *A. occidentale* (Tables 2 and 4) collected on a garden and within the town of Isanlu-Isin for this experimental analysis. This contradicts the findings of Kofi *et al.,* (2013) in which the highest arsenic concentration observed in the ten medicinal plants analysed was 0.002ppm observed in *Cassia alata* harvested by the roadside and *Taraxacum officinale* fetched from a refuse dump site. 6.31ppm concentration is higher than the FAO/WHO recommended standard of 5.0ppm for arsenic concentration. In line with the work of Nriagu (1994), the high concentration of arsenic is traceable to the feed additives discarded incessantly on the soil by chikun feeds depot beside the site of sampling of *M. oleifera* within the town or continuous application of pesticides to combat infestation of pests. Short exposure to high dose of arsenic can be deadly while long exposure may result in skin, lungs and kidney cancers (ATSDR, 2005). Therefore care must be taken while fetching medicinal herbs within the town to avoid arsenic poisoning in the herbal drug consumers.

The highest concentration of cadmium (14.08ppm) was discovered in *Occimum gratissimum* collected from a garden in Isanlu-Isin (Table 5) and the lowest concentration of 0.001ppm was observed in *M. oleifera* in gardens from both Isanlu-Isin and Bode-Saadu (Table 2). In the work of Kofi *et al*., (2013), the findings showed a similar concentration of 14.05ppm in *Taraxacum officinale*, making both observations be in tandem with each other. The high concentration value of 14.08ppm is far beyond the FAO/WHO standard of 0.30ppm in medicinal plants. This high concentration is no unconnected to the phosphate fertilizers applied to the soil of the garden which usually contains cadmium impurity (ATSDR, 2005). Primarily, cadmium poisoning affects kidney and lungs while the secondary effects include impaired skeletal system, and has been experimentally proven to be carcinogenic (Waisberg, Joseph. Hale and Beyersmann, 2003).

The concentration of copper observed was 131.0ppm and it was detected in *Hibiscus sabdariffa* collected from a garden in Bode-Saadu (Table 7) while the least concentration of 2.30ppm was observed in *Anacardium occidentale* which was collected from a forest area of the same town (Table 4). This concentration is below the FAO/WHO standard concentration value of 150ppm. The findings of Annan, Asante, Asare, Asare-Nkansah and Bayor (2010) shares similarities with this range. Abundance of copper in the soil is directly linked to the application of farm manure, municipal or industrial wastes, agrochemicals, application of copper-containing compounds to control phytodiseases, and so many other sources. In human diet, copper has been found to be relatively essential in preventing bone diseases such as osteoporosis, cardiac diseases such as cardiovascular diseases, maintenance of healthy nerves and so on but at recommended quantity, because copper poisoning has been implicated in hepatomegaly, liver impairment, jaundice, and gastrointestinal disorder (Kunutsor, 2021).

In this research work, the highest concentration of lead (68.23ppm) was detected in *V. amygdalina* collected within the town of Bode-Saadu (Table 1) while the lowest concentration was 0.003ppm in *Occimum gratissimum* collected also within the town of Isanlu-Isin (Table 5). This display a high level of contradiction in values to the work of Samsudeen, Musbau and Ibrahim (2019). In the work, highest level of lead concentration was 23.93ppm in *Newboulda laevis* while the lowest (7.10ppm) was observed in *Mangifera indica* but in terms of locationinduced increment in lead concentration, the works show a high level of agreement. Meaning that abundance of lead in the environment is directly proportional to commercial activities in such environment. In the part of Bode-Saadu where the highest concentration of lead was detected, vehicular movement, battery repair workshops and several other anthropogenic activities are the order of the day. The concentration of 68.23ppm also far exceeds the FAO/WHO standard of 10ppm in medicinal plants. As stated by Jabeen, Shah, Khan, and Hayat (2010), lead poisoning either acute or chronic poses greater health problems on consumer's ectopic organs such as kidney and liver. More so, lead poisoning can impair the immune system of human's body (Maiga *et al.,* 2005).

Furthermore, nickel has its highest concentration in *G. kola* collected within the town of BodeSaadu with a value of 91.10ppm (Table 3) while the lowest value detected was 0.002ppm both in *M. oleifera* also collected within the town of Isanlu-Isin (Table 2) and *H. sabdariffa* (Table 7) collected in a forest area in Bode-Saadu. This deviated from the findings of Leonid and Najat (2017) in which the values of nickel detected from the leaf of *M. oleifera* and calyces of *H. sabdariffa* used in Tanzania for phytotherapy were 2.25ppm and 1.98ppm respectively. This variation may not be unconnected to the variations in the extent of environmental pollutions in the locations where samples were collected. Exactly like the lead, nickel becomes abundant with an abundance in the anthropogenic activities such as smelting, application of sewage sludge, enrichment of the soil with the compost made from sewage sludge, fuel combustion, fuel oil etc. This justifies the high nickel concentration in *G. kola* fetched from within the town where heavy commercial activities was the order of the day. This anthropogenicity-based result corroborates the experiment performed by Monica and Malgorzata (2020) where higher concentration of nickel was observed in soil within the areas characterized by high human activities but reverse was the case for soils with limited or no human activities. It can therefore be suggested that high nickel concentration in *G. kola* plucked within the town of Bode-Saadu is largely due to the overwhelming activities of humans such as blacksmithing and sewage disposition frequently around the collection site.

It worth noting that *G. kola* was only found in the forest area of Isanlu-Isin, none in any refuse dumping site, within the town or garden while in Bode-Saadu, it was found within the town and a garden but no anyway in sight in either the forest area or the refuse dumping sites. This is the reason for representing the corresponding values of heavy metal concentrations there by “na” (not applicable).

Conclusion

Heavy metal poisoning observed in this finding was more in Bode-Saadu where anthropogenic activities (human and commercial activities) are in abundance. Arsenic toxicity in the *M.* oleifera, lead toxicity in *V. amygdalina* and nickel toxicity in *G. kola* all collected within the town of Bode-Saadu. Only cadmium toxicity was detected in *O. gratissimum* collected in a garden of Isanlu-Isin, which might the impurity in phosphate fertilizer applied on to the garden soil. BodeSaadu is a commercially active town compared to Isanlu-Isin which is a village. Meanwhile, these plants are been used frequently in phytotherapy as an alternative to chemotherapy in medicine due to certain phytoactive ingredients they contain. As advantageous as this seems to be, it may become dangerous because some of these medicinal plants possess phytoextraction potential, making them easily trap the heavy metals sometimes in excess and become phytotoxic. If consumed, they can pose a greater danger to health. It is therefore of paramount importance, to carefully collect these herbs in an environment free of pollution or an environment not prone to the release of substances that can lead to heavy metal pollution. Without this measure, solving one kind of medical condition using herbs with a high concentration of heavy metals may give rise to other health challenges.

Recommendations

Based on this research findings, the scope of the knowledge about the need to prevent heavy metal poisoning among the herbal medicine consumers and the conditions that can lead to their toxicity in the plants have been established. The following recommendations will therefore be of a greater help:

i. Trado-medical personnel should desist from collecting medicinal herbs from polluted soils and environments, especially within the town in an urban settings with high commercial activities.
ii. Since the concentration of heavy metals is relatively low in plants cultivated in the garden, the practitioners should cultivate the habit of planting essential medicinal plants in gardens.
iii. Before usage for phytotherapy, herbs should be subjected to heavy metal contents and concentration analysis to ascertain their presence and extent.
iv. After the phytomedicines have been manufactured, heavy metal analysis and other toxicological tests should be carried out on the finished products before distribution for sales to the consumers.

If all these are not undertaken, phytotherapic treatments of mild diseases might be giving rise to an entirely chronic and more serious health issues due to heavy metal poisoning.

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