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Evaluation of Some Heavy Metal Contamination in Agricultural Soils at Malleri, Kwami L.G.A. Gombe State, Nigeria

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ABSTRACT

The study evaluates the presence of heavy metals contamination in agricultural soils in Malleri, Kwami Local Government Area, Gombe State, Nigeria. Thirty two (32) soil samples were taken randomly from six distinct farms using a soil auger and labeled at depths ranging from 0 to 25 cm. The results for Arsenic (As), Lead (Pb), Cadmium (Cd), Chromium (Cr), Iron (Fe), Copper (Cu), and Cobalt (Co) in the agricultural soils of Malleri, Kwami Local Government Area of Gombe State, Nigeria, showed a significant difference ($p<0.05$). The following is the decreasing order of heavy metals: Ni > Fe > Cu > Cr > As > Cd > Pb. The reason for this difference may be ascribed to the low agricultural practices such as fertilizer application, intense use of manure and the sandy nature of the soil. These factors can have potentials to cause metals to seep into lower ground layers. The study's conclusions led to the following recommendations being made: farmers should use organic manures and biofertilizers in place of chemical pesticides and fertilizers. By using natural techniques of pest control instead of pesticides, soil contamination can be reduced and food safety can be increased. Food crops should be properly cleaned to remove as much soil as possible from soils with elevated heavy metal concentrations in order to decrease health concerns.

Keywords: Contamination, Heavy metals, Concentration, Soil.

INTRODUCTION

The term "heavy metals" refers to metals (As, Cd, Pb, Cr, and Ni) that have comparatively high densities, atomic weights, or atomic numbers and a specific density of more than 5 g/cm3 As per Jyothi, (2020). When these metals are ingested by plants, they become hazardous to individuals, as well as having the capacity to build into the body over the years (Balali-Mood *et al.*, 2021). Different contaminated metals have different contaminated effects, For instance, in the skeletal system, cadmium replaces calcium and results in osteodystrophy (Angelova *et al.*, 2010). It is necessary that soil be the most significant component of the environment, but it is also the most underappreciated, exploited, and misused resource on Earth. Monitoring of their sources and dispersion in the environment is necessary to decrease soil contamination (Sulaiman *et al.,* 2019). The environmental problem of heavy metal poisoning of soil is grave and has substantial consequences for the health of humans and animals (Moore *et al.*, 2009). Several studies have documented the transport of these heavy metals from soil to plants (Mahmood and Malik, 2014; Sulaiman *et al.,* 2019; Ibrahim and Salem, 2017). The ratio of an element's concentration in plants to that in the surrounding soil, or the heavy metal's concentration, is called the transfer factor (TF). The primary source of heavy metal contamination in soil is human-caused processes, including mining, smelting, applying pesticides, herbicides, fertilizer, and using contaminated water for irrigation. Consequently, human activity contributes more to the mobilization of heavy metals, a worldwide issue (Sun *et al*., 2014). The growing use of livestock can be the cause of an increase in heavy metals in the soil, plants, and artificial fertilizers, even though heavy metals are naturally present in a wide range of environmental materials, such as poultry manure. According to Goitom *et al*. (2020), irrigation wastewater causes heavy metals to build over time in soils and plants, where upon absorbed minerals settle in the edible tissue of the crops. These metals are non-biodegradable and accumulate as they pass through the food chain and reach people (Uddin *et al.,* 2021. The toxicity of heavy metals in plants, or phytotoxicity, affects plant growth and development, causes oxidative stress, and has cytotoxic and genotoxic effects on plants (Saud *et al*., 2022).According to FAO (2020), prolonged exposure to heavy metals in the food chain can interfere with a variety of biological and biochemical processes in the human body. The health of humans and a balanced diet both depend heavily on vegetables rich in many different nutrients all of which are critical for immune system stimulation and bodily growth (Iqbal *et al.,* 2021; Sulaiman *et al*., 2021). Vegetables are rich in antioxidants, vital nutrients, and secondary metabolites that are beneficial to human health, including organic acids, vitamins C and E, lycopene, beta-carotene, chlorophyll, and flavonoids (Di Gioia *et al*., 2020). Still, a number of studies showed that fruits and greens vegetables are susceptible to soil, water, and air contamination by heavy metals (Sulaiman, 2019). Many elements, including clay minerals, soil pH, oxides, carbonates, and organic matter affects the availability of metals in plants (Angelova *et al*., 20I0; Chibuike and Obiora, 2014). Reports have shown that approximately half of the average ingestion of cadmium, mercury, and lead is linked to the eating of fruits, vegetables, and grains. Vegetables absorb metals through their roots through absorption from contaminated soil and also through the exposed portions of the vegetable in an environment with contaminated air (Islam *et al*., 2007; Zwolak *et al.,* 2019). It is imperative that these heavy metals' sources and dispersion in the environment be continuously and effectively monitored (Sulaiman *et al*., 2019). The main way that humans are exposed to heavy metals is by eating fruits and vegetables (FAO,2020). Given that vegetables are a staple of the human diet, it is imperative to assess the amount of heavy metal buildup in crops, such as vegetables, from agricultural soil (Ibrahim and Salem, 2017). Plants in affected areas absorb these metals from soil through roots or atmospheric contaminants through leaves. This accumulation can pose a potential risk to humans and animals. To ensure compliance with international requirements, some heavy metal concentrations needs to be assessed. The study aims to evaluate the levels of concentrations of some heavy metals resulting from contamination in some agricultural soils at Malleri, Kwami LG.A Gombe State, Nigeria.

MATERIALS AND METHODS

Geographical Description of Area of the Study

Malleri is a village in Kwami Local Government Area, and Kwami LGA is one of the eleven local governments of Gombe State, located about 6 kilometers in the north-eastern part of Gombe town. Kwami lies at latitude 102935"N and longitude 11°12'36"E. The area falls within the northern Guinea savanna zone of Kwami Local Government Area of Gombe State. Kwami has a total area of 1,787 km

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(690 sq mi). It has a population of 95,298 (2006 Census). The area receives an annual rainfall averaging approximately 800 mm, enough for a single farming season. Kwami local government area shares its boundaries with Funakaye local government area from the north, Yamaltu-Deba LGA from the east, Dukku and Shongom LGA from the west, and Gombe LGA from the south. The annual rainfall pattern is erratic at the beginning of the rainy season, starting in April, intensifying as the season advances rising from 600 mm to 1000 mm. The maximum temperature could rise as 4°C and the minimum as low as 16°C, with the temperatures usually being high, averaging 34°C. Malleri of Kwami L.G.A. is in the interior savannah woodland, which can sustain large-scale livestock farming as well as the cultivation of agricultural products like onions, spinach, rice, groundnuts, maize.

Samples and Sampling techniques

Soil samples were collected from nine different farms; four samples were randomly selected and collected from each farm to make a composite sample. About 50 g of composite soil samples were collected around the roots of the plants from each sampling site where the plants were uprooted using a soil auger with a diameter of 2.5 cm. vertically at different depths of from 0-20 cm. The composite sample was placed in a labeled Ziploc bag, transported to the laboratory, and stored at room temperature until analysis. A total of 24 soil samples were collected for the study.

Dilution Procedure

The dilution procedure was recommended by AOAC as described by Omojola, (1993) with slight modifications. The air-dried soil samples were crushed in a mortar with a pestle and sieved through a 2 mm mesh standard sieve. 2.5 g were digested in 10 mL freshly prepared aqua regia (3: I HCI: HNO_3) and placed on a hot plate at 95 °C for 1 h. The sample will then be diluted to 50 mL of distilled water was left to settle overnight. The total concentrations of Cr, Pb, Fe, As, Cd, Cu and Ni were then determined, using Atomic Absorption Spectrophotometer.

Quality Control Analysis

Quality control measures were based on the soil management framework (SMAF) as reported by Andrews *et al*.,(2008). were taken to ensure the reliability of the study results. Standards were prepared for each heavy metal from their stock solution to calibrate the instrument.

Data Analysis

The data obtained are expressed as mean±SEM of triplicate measurements and were statistically analyzed using SPSS software version 25, and one way ANOVA was used to compare the mean values obtained from different sampling sites at $p < 0.05$. Pearson's correlation was used to assess the significant difference among heavy metals in soil samples.

RESULTS AND DISCUSSION

The mean amounts of heavy metals (mg/kg) in soil samples are shown in Tables 1. The findings of the chemical study of the agricultural soils in Malleri, revealed the average concentrations of heavy metals in the top soil in the range of 0 to 15 cm: Pb (0.015–0.083 mg/kg), Cd (0.074–0.275 mg/kg), Cr (0.016–0.69 mg/kg), Ni (9.365–49.338 mg/kg), Fe (0.754–15.224 mg/kg), Co (0.053–0.726 mg/kg), and Cu (0.274–2.346 mg/kg) are among the substances as mentioned above. Dirts thickness between 0 and 15 cm. Pb (0.015–0.083 mg/kg), Cd (0.074–0.275 mg/kg), Cr (0.016–0.69 mg/kg), Ni (9.365–49.338 mg/kg), Fe (0.754–15.224 mg/kg) and

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Cu (0.274–2.346 mg/kg) are among the substances as mentioned above.

Table 1: Mean concentrations (mg/kg) of heavy metals in soil samples

FARM 1	**As**(mg/kg)	**Pb**(mg/kg)	**Cd**(mg/kg)	**Cr**(mg/kg)	**Ni**(mg/kg)	**Fe**(mg/kg)	**Cu**(mg/kg)
Position A	0.4941 ± 0.0018	0.0645 ± 0.0004	0.1040 ± 0.0006	0.4147 ± 0.0009	23.4676 ± 0.0000	2.4955 ± 0.1109	0.3630 ± 0.0007
Position B	0.1585 ± 0.0005	0.0244 ± 0.0018	0.0735 ± 0.0002	0.2827 ± 0.0005	11.4346± 0.0704	0.7535 ± 0.0754	0.5459 ± 0.0011
Position C	0.6234 ± 0.0006	0.0546 ± 0.0007	0.1881 ± 0.0007	0.6945 ± 0.0005	35.7242± 0.0006	8.2465 ± 0.0003	2.3102 ± 0.0005
Position D	0.6231 ± 0.0008	0.0532 ± 0.0006	0.1867 ± 0.0007	0.6932 ± 0.0008	35.4592± 0.1082	8.3787 ± 0.0655	2.3460 ± 0.0174
FARM 2	**As**(mg/kg)	**Pb**(mg/kg)	**Cd**(mg/kg)	**Cr**(mg/kg)	**Ni**(mg/kg)	**Fe**(mg/kg)	**Cu**(mg/kg)
Position A	0.4931 ± 0.0017	0.0644 ± 0.0003	0.1039 ± 0.0005	0.4145 ± 0.0008	23.4675 ± 0.0000	2.4954 ± 0.1108	0.3629 ± 0.0006
Position B	0.1585 ± 0.0005	0.0243 ± 0.0018	0.0734 ± 0.0002	0.2826 ± 0.0005	11.4345 ± 0.0704	0.7534 ± 0.0754	0.5457 ± 0.0010
Position C	0.6232 ± 0.0005	0.0545 ± 0.0006	0.1880 ± 0.0005	0.6944 ± 0.0004	35.7241± 0.0005	8.2464 ± 0.0002	2.3101 ± 0.0003
Position D	0.6229 ± 0.0006	0.0531 ± 0.0004	0.1865 ± 0.0005	0.6931 ± 0.0006	35.4590 ± 0.1080	8.3785 ± 0.0654	2.3455 ± 0.0172
FARM 3	**As**(mg/kg)	**Pb**(mg/kg)	**Cd**(mg/kg)	**Cr**(mg/kg)	**Ni**(mg/kg)	**Fe**(mg/kg)	**Cu**(mg/kg)
Position A	0.4929 ± 0.0016	0.0642 ± 0.0002	0.1038 ± 0.0004	0.4144 ± 0.0005	23.4674 ± 0.0001	2.4953 ± 0.1106	0.3626 ± 0.0004
Position B	0.1582 ± 0.0004	0.0242 ± 0.0014	0.0734 ± 0.0001	0.2826 ± 0.0006	11.4345 ± 0.0702	0.6534 ± 0.0744	0.5458 ± 0.0009
Position C	0.4234 ± 0.0004	0.0546 ± 0.0004	0.1781 ± 0.0006	0.6745 ± 0.0003	35.5242± 0.0002	8.2452 ± 0.0003	2.3101 ± 0.0003
Position D	0.6221 ± 0.0005	0.0332 ± 0.0006	0.1857 ± 0.0007	0.4932 ± 0.0006	35.3592 ± 0.1081	8.3777 ± 0.0654	2.3450 ± 0.0164
FARM 4	**As**(mg/kg)	**Pb**(mg/kg)	**Cd**(mg/kg)	**Cr**(mg/kg)	**Ni**(mg/kg)	**Fe**(mg/kg)	**Cu**(mg/kg)
Position A	0.3941 ± 0.0014	0.0545 ± 0.0004	0.1040 ± 0.0006	0.2147 ± 0.0004	23.4476 ± 0.0000	2.4755 ± 0.1009	0.3530 ± 0.0004
Position B	0.1485 ± 0.0004	0.0234 ± 0.0017	0.0725 ± 0.0001	0.2727 ± 0.0005	11.4336 ± 0.0604	0.7435 ± 0.0734	0.5259 ± 0.0009
Position C	0.6234 ±	0.0546 ±	0.1281 ±	0.6745 ±	35.6524 ±	8.2465 ±	2.3101 ±

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	0.0004	0.0005	0.0006	0.0005	0.0006	0.0003	0.0005
Position D	0.6241 ± 0.0007	0.0522 ± 0.0004	0.1827 ± 0.0002	0.6432 ± 0.0006	35.4492 ± 0.1072	8.3627 ± 0.0645	2.3260 ± 0.0144
FARM 5	**As**(mg/kg)	**Pb**(mg/kg)	**Cd**(mg/kg)	**Cr**(mg/kg)	**Ni**(mg/kg)	**Fe**(mg/kg)	**Cu**(mg/kg)
Position A	0.4841 ± 0.0018	0.0625 ± 0.0004	0.1040 ± 0.0006	0.3147 ± 0.0009	23.4676 ± 0.0000	2.4955 ± 0.1109	0.3630 ± 0.0007
Position B	0.1585 ± 0.0005	0.0244 ± 0.0018	0.0735 ± 0.0002	0.2627 ± 0.0005	11.4346 ± 0.0704	0.7535 ± 0.0754	0.5359 ± 0.0011
Position C	0.5234 ± 0.0004	0.0446 ± 0.0007	0.1681 ± 0.0007	0.6945 ± 0.0005	35.7242 ± 0.0006	8.1465 ± 0.0003	2.3102 ± 0.0005
Position D	0.5231 ± 0.0006	0.0432 ± 0.0005	0.1867 ± 0.0007	0.6932 ± 0.0008	35.4592 ± 0.1082	8.3767 ± 0.0655	2.3460 ± 0.0154
FARM 6	**As**(mg/kg)	**Pb**(mg/kg)	**Cd**(mg/kg)	**Cr**(mg/kg)	**Ni**(mg/kg)	**Fe**(mg/kg)	**Cu**(mg/kg)
Position A	0.4841 ± 0.0017	0.0615 ± 0.0004	0.1040 ± 0.0006	0.3147 ± 0.0009	23.4676 ± 0.0000	2.4955 ± 0.1109	0.3630 ± 0.0007
Position B	0.1585 ± 0.0005	0.0243 ± 0.0016	0.0635 ± 0.0002	0.2627 ± 0.0005	11.4346 ± 0.0704	0.7535 ± 0.0754	0.5359 ± 0.0011
Position C	0.5234 ± 0.0004	0.0446 ± 0.0007	0.1681 ± 0.0007	0.6935 ± 0.0005	35.7242 ± 0.0006	8.1465 ± 0.0003	2.3102 ± 0.0005
Position D	0.5131 ± 0.0004	0.0432 ± 0.0002	0.1467 ± 0.0007	0.6932 ± 0.0008	35.3592 ± 0.1052	8.3767 ± 0.0655	2.3460 ± 0.0154
FARM 7	**As**(mg/kg)	**Pb**(mg/kg)	**Cd**(mg/kg)	**Cr**(mg/kg)	**Ni**(mg/kg)	**Fe**(mg/kg)	**Cu**(mg/kg)
Position A	0.4641 ± 0.0017	0.0615 ± 0.0004	0.1038 ± 0.0006	0.3147 ± 0.0009	23.4652 ± 0.0000	2.4840 ± 0.1109	0.3430 ± 0.0006
Position B	0.1575 ± 0.0005	0.0243 ± 0.0016	0.0635 ± 0.0002	0.2627 ± 0.0005	11.4346 ± 0.0704	0.7535 ± 0.0754	0.5359 ± 0.0009
Position C	0.5134 ± 0.0002	0.0446 ± 0.0007	0.1681 ± 0.0007	0.6935 ± 0.0005	35.7242 ± 0.0005	8.1465 ± 0.0003	2.3101 ± 0.0005
Position D	0.5121 ± 0.0001	0.0432 ± 0.0001	0.1467 ± 0.0006	0.6932 ± 0.0007	35.3592 ± 0.1052	8.3766 ± 0.0654	2.3450 ± 0.0154
FARM 8	**As**(mg/kg)	**Pb**(mg/kg)	**Cd**(mg/kg)	**Cr**(mg/kg)	**Ni**(mg/kg)	**Fe**(mg/kg)	**Cu**(mg/kg)
Position A	0.4841 ± 0.0017	0.0615 ± 0.0004	0.1040 ± 0.0006	0.3146 ± 0.0007	23.4676 ± 0.0002	2.4952 ± 0.1106	0.3631 ± 0.0005
Position B	0.1595 ± 0.0002	0.0243 ± 0.0014	0.0235 ± 0.0002	0.2627 ± 0.0004	11.4346 ± 0.0702	0.7535 ± 0.0754	0.4359 ± 0.0011
Position C	0.5234	0.0446	0.1681	0.6915	35.7242	8.1465	2.2102

	± 0.0004	± 0.0007	± 0.0007	± 0.0003	± 0.0005	± 0.0003	± 0.0005
Position D	0.5129 ± 0.0003	0.0422 ± 0.0002	0.1457 ± 0.0007	0.6722 ± 0.0008	35.3592 ± 0.1052	8.3767 ± 0.0655	2.3360 ± 0.0144
FARM 9	**As**(mg/kg)	**Pb**(mg/kg)	**Cd**(mg/kg)	**Cr**(mg/kg)	**Ni**(mg/kg)	**Fe**(mg/kg)	**Cu**(mg/kg)
Position A	0.4840 ± 0.0014	0.0612 ± 0.0004	0.1030 ± 0.0005	0.3047 ± 0.0009	23.4676 ± 0.0000	2.4955 ± 0.1109	0.3430 ± 0.0007
Position B	0.1595 ± 0.0004	0.0233 ± 0.0016	0.0535 ± 0.0001	0.2527 ± 0.0005	11.4346 ± 0.0704	0.7535 ± 0.0754	0.5359 ± 0.0010
Position C	0.5232 ± 0.0001	0.0246 ± 0.0007	0.1621 ± 0.0007	0.6735 ± 0.0005	35.7232 ± 0.0005	8.1465 ± 0.0003	2.2102 ± 0.0005
Position D	0.5130 ± 0.0002	0.0422 ± 0.0002	0.1447 ± 0.0005	0.6832 ± 0.0008	35.3582 ± 0.1051	8.3767 ± 0.0655	2.3260 ± 0.0154

Arsenic (As)**:** The result revealed that arsenic had the highest value mean 0.623 mg/kg in farm (1) and the least was obtained in farm (5) with 0.1585 mg/kg. The variation depends on weather conditions and, above all, rainfall and soil moisture. At the same venue, there are significant differences in the concentration of mobile forms of heavy metals in a year. Such a strong variation in the contents of mobile forms of heavy metals is due to the activities of soil organisms, rhythmic changes in chemical elements acquisitions by plants and other factors. To use mobile forms of heavy metals for soil contamination assessment, it is important to standardize the procedure for the selection of a soil sample. ATSDR, (2007) reported that it is necessary to agree, on in what period of the year soil sampling should be done and that it is best to select a soil sample in the rainy season when soil moisture is maximal and slightly varies from year to year, rather than in the dry season when humidity varies strongly and during the season and from year to year.

Lead (Pb)**:** The mean total concentration of lead in the soil samples is 0.0645 mg/kg as the highest value in farm (1) and 0.0243 mg/kg as the lowest value in farm (6) and (8) the agricultural soils of Malleri, Kwami L.G.A. In all the collected soil samples, the concentration of lead was recorded below the permissible limit set by FAO (2020) (50.00 mg/kg^{-1}). Similar range of values for lead has been reported (Nazir *et al.* 2015). However the lead levels observed in this study are significantly higher than those reported by Lu (2009), and lower than those of other similar studies (Okunola *et al.*, 2007). The concentration of lead in the soil is likely to have derived from vehicle exhaust fumes containing some lead-rich aerosols (Babatunde *et al.,* 2014). Studies have shown that the use of tetraethyl lead as an antiknocking agent in gasoline gives rise to its release during emissions from automobiles and fossil fuel combustion. Major sources of lead pollution are exhaust gases of petrol engines, which account for nearly 80% of the total lead in the air. In addition, lead levels on the roadside can also be attributed to the wearing down of vehicle brake linings and tyres (Zhang *et al.* 2012). Elevated levels of lead constitute a serious health risk. FAO (2020) reported several deaths in a village in Zamfara State, Nigeria as a result of lead poisoning. There have been a lot of attention paid to lead levels in soil because it is well-known to cause adverse health effects, and is relatively widespread as a result of its historical use in many commercial products, from gasoline to paint. It accumulates with age in the bones aorta, and kidney, liver and spleen. It can enter the human body through the uptake of food (65%), water (20%) and air (15%) (Taber,2009). Adekola *et al.* (2010) reported a higher amount of Pb as sorbed by organic matter than the amount found in exchangeable form. In the Olkusz district of Poland, concentration Pb up to 404 mg/kg is reported in some arable soils close to industrial areas.

Cadmium (Cd)**:** The mean total concentration of cadmium in the soil samples is 0.1867 mg/kg as the highest value in farm (5) and 0.1030 mg/kg as the lowest value in farm (2) from agricultural soils of Malleri, Kwami L.G.A. In all the collected soil samples concentration of cadmium was recorded below the maximum permissible limit set by FAO (2020) (3.00 mg kg^{-1}). High Cd values may have resulted from repeated use of fertilizers which are sources of Cd in the soil. Cd is a highly mobile ion (Suleiman *et al*., 2019) but here it showed relatively low mobility to the exchange complex in comparison to the total amount in the soil across all the sites.

The maximum level of Cd was 1.12 mg/kg in the sample obtained at Atikankan abattoir and the minimum level of Cd (0.74 mg/kg) was observed in the sample obtained from Iworoko Road Abattoir and Ikere - Ekiti Abattoir was observed to be 1.03 mg/L, the values of Cd obtained in all the sites are below the permissible limit of FAO (2020). Cd is considered one of the most ecotoxic heavy metal and is reported to exhibit an adverse effect on soil health, plant metabolism, biological activity and the health of animals and human beings (Sun *et al.,* 2016). According to EFSA (2012), the European population has an average daily Cd intake of 35% of the recommended maximum, which intake can be up to 135-208% in some groups of the population.

Chromium (Cr)**:** The mean total concentration of chromium in the soil samples ranges from 0.6945 - 0.2147 mg/kg being the lowest concentration from farm (4) agricultural soils of Malleri, Kwami L.G.A. In all the collected soil samples concentration of chromium was recorded below the permissible limit set by FAO (2020) (100 $mgkg^{-1}$). In a small amount, chromium stimulates the growth of crops; an excess of it however promotes various diseases. A wide distribution of Cr in the environment is unfavorable for humans and animals. Chromium toxicity depends on its oxidation status. Cr occurs in two states in soils. The oxyanion chromate CrO_4^{2-}, is highly mobile and more toxic in soils and groundwater. On the contrary, the reduced ion Cr (III) forms either a weakly soluble hydroxide or stable complexes with soil minerals (ATSDR,2007). The mean value presented in the present study was lower than those reported by FAO,(2020); but lower than the values reported by Nazir *et al.,* (2015). The findings in the present study disagreed with the findings of Balali-Mood *et al.* (2021) who found that 47.76-89.23 mg/kg of Cr was reported in cultivated soils that were exposed to chemical fertilizers for a long time.

Nickel (Ni)**:** The mean total concentration of nickel in the soil samples ranges between 9.365 - 49.338 mg/kg from agricultural soils of Malleri, Kwami L.G.A. The mean value obtained in the present result was lower than the one obtained by Nazir *et al.* (2015) who found 4.54, 2.04, 0.24, and 4.50 mg kg^{-1} soil in Achialum, Meupi, Nepele and Ala'amiti sites respectively. The concentration of Ni in all soil samples were lower than the maximum permissible limit set by FAO (2020) of 50.00 mg/kg. Nickel has been considered to be an essential trace element for human and animal health. The existence of Ni in the soil samples could be attributed to impurities in the chemical fertilizers and the sandy nature of the soil (Angelova *et al*.,2010**).** Ni occurs in a very low amount in nature and is essential in small doses, but it can be toxic when the maximum tolerable concentration is exceeded (Saud *et al*., 2022). Also, the Ni concentrations of 21.16-41.18 mg/kg were also reported for agricultural soil as a result of long-term agricultural activities (Sun *et al,*.2016). The concentration of Ni from four different locations of soil samples collected from Punjab (India) was found to be in the range of 9.67 - 24.32 mg/kg (Mahmood and Malik*.,* 2014). The mean value of nickel obtained in this study is consistent with the values reported by Suleiman *et al.* (2021). The mean level of nickel obtained in this study is however higher than that reported by Pam *et al.,* (2013). Anthropogenic input of nickel in the study areas could also be from the diesel used in automobiles (Babatude *et al*.,2021). The result here deviates from the findings of Abdu (Okonula *et al.,*2007) for similar soils due particularly to the higher clay contents of his soil.

Iron (Fe)**:** The mean total concentration of iron in the soil samples ranges from 0.7535 – 8.3787 mg/kg found from agricultural soils of Malleri, Kwami L.G.A. The concentration of Fe in all the soil samples were below the maximum permissible limit set by FAO (2020) as 5000.00 mg/kg. Very high concentrations of total and available Fe could be from the soil parent materials (basalt, trachytes and rhyolite) which are natural sources of Fe in the soil. Strong Fe concretions were also very visible in all the soil profiles. Also, since the soils were very acidic, Fe solubility was highly favored leading to high available concentrations. Excess amount of iron (more than 10 mg/kg) causes a rapid increase in pulse rate and coagulation of blood in blood vessels, hypertension and drowsiness (Ibrahim and Salem, 2017). The mean value of iron obtained in this study is lower than those reported by , but higher than the values reported by Suleiman, (2021).

Copper (Cu)**:** The mean total concentration of copper in the soil samples ranges between 0.274 - 2.346 mg/kg from agricultural soils of Malleri, Kwami L.G.A. The concentration of copper in all the soil samples was below the maximum permissible limit set by FAO (2020) of 100.00 mg/kg. Copper accumulates in the liver and brain and its toxicity is a fundamental cause of Wilson's disease. Copper particulates are released into the atmosphere by windblown dust; volcanic eruptions; and anthropogenic sources, primarily copper smelters and ore processing facilities (). Contamination with Cu was attributed to anthropogenic activities such as the application of excessive and low quality chemical fertilizers and irrigation water (Balali-Mood *et al.,*2021). Accumulation of copper in soils is mainly due to anthropogenic origin, such as mining or industrial activities, Agricultural use of products containing copper is also common, especially in pesticides applied in vineyards and orchards (Iqbal *et al*, 2021).

CONCLUSION

Heavy metals contaminants in agricultural soils in Malleri, Kwami Local Government Area of Gombe State, Nigeria was indicated. The results indicated the variation of heavy metals in the study area. The concentrations of all studied heavy metals were below the maximum permissible limits for agricultural soils set by WHO/FAO 2020. The result of heavy metals decreases in the following order: Ni > Fe > Cu > Cr > As > Cd > Pb. This variation is attributed to intensive agriculture practices and to the nature of the soil texture, which was considered to be loamy thus favors crop production. Both factors can cause the leaching of metals into lower ground layers. Farmers should reduce the use of chemical fertilizers and pesticides by applying bio-fertilizers and manures as substitutes. Furthermore, natural methods of pest control should be used instead of pesticides, thereby minimizing soil pollution and increasing food safety.

In other to reduce health risks in soils with elevated heavy metal content, food crops should be thoroughly washed to remove as much soil as possible. Lastly, government through extension agents, should train farmers on the possible methods of remediating soil contamination.

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