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Heavy Metal Analysis of *Telfairia occidentalis* and its Soils In Ilushin Farm Settlement, Ogun State Southwest, Nigeria

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Abstract
Telfairia occidentalis is mainly cultivated in southern Nigeria and it is used primarily in soups and herbal medicines. This study investigates the level of pollution in terms of heavy metals (Pb, Ni, Mn, Cu, and Zn) in fluted pumpkin *(Telfairia occidentalis)* vegetable samples and its soils. *Telfairia occidentalis* and its soils collected from ilushin farm settlement in Ogun waterside, Ogun state, Nigeria were prepared and digested with acid mixture of HNO_3 and H_2SO_4 in the ratio 3:1 and analysed using Atomic Absorption Spectroscopy (AAS) to determine the concentration of heavy metals. Physico-chemical properties of the collected soil samples were determined using standard analytical methods. The pH of soil samples (5.82±0.53, slightly acidic), percentage (%) organic carbon (0.70±0.33), and the CEC (4.75±0.12) were determined. Concentrations of the heavy metals (Pb, Ni, Mn, Cu, and Zn) analysed for *Telfairia occidentalis* samples were determined with Pb not detected in the samples. Soil samples were analysed with the mean values determined to be 16.97±22.69 (Pb), 14.31±14.42 (Ni), 116.51±52.67 (Mn), 3.57±2.54 (Cu), 13.61±4.76 (Zn) respectively in mg/kg. The results were compared with permissible levels as recommended by the USEPA standards. The mean values were found to be below permissible limit in the samples except for Mn; the concentration of Mn (405.54mg/kg) in the fluted pumpkin vegetable samples exceeded the permissible limit (155mg/kg) recommended by USEPA, and this calls for the need to continually monitor these heavy metals in order to prevent their toxicity and transfer to human beings through food consumption.

Keywords: Heavy metals, Soil, *Telfairia occidentalis*, Fluted pumpkin, AAS.

Introduction
In recent times, with the advancement of the global economy, the content of heavy metals in the soil and water caused by human activities have gradually increased, resulting in the disruption of the environment (Prajapati, 2014; Sayadi, 2014). Due to their effects and interactions, accumulation of heavy metals in soil affects regional environmental safety and poses a threat to relevant flora, fauna and other forms of life. Accumulated heavy metals in vegetal tissues has been shown to transfer to the human and even animal system on consumption, such heavy metals become increasingly detrimental when they are not metabolized by the body and accumulates in the soft tissues. Also, heavy metals can enter human bodies through the food chain, leading to severe health conditions such as brain damage, deformity and cancer (Zojaji, 2014).

Fluted pumpkin (*Telfairia occidentalis)* is a tropical vine grown in West Africa as a leaf vegetable and for its edible seeds. Common names for this vegetable include fluted gourd, fluted pumpkin, ugu (Igbo language in Nigeria), and ikong-ubong (Efik and Ibibio languages in Nigeria). *Telfaira occidentalis* is a member of the family Cucurbitaceae and it is indigenous to the people of southern Nigeria (Akoroda, 1990). The fluted gourd grows in many nations of West Africa, but mainly cultivated in southern Nigeria and it is used primarily in cooking and herbal medicines (Nwanna, 2008). Although the fruit is inedible, the seeds produced by the gourd are high in protein and fat, and can, therefore, contribute to

a well-balanced diet. The plant is a drought-tolerant, dioecious perennial that is usually grown trellised. Typically, humans absorb heavy metals through drinking water, food, and air. Increased exposure to high concentrations of these metals could gradually lead to muscular, physical and neurological degenerating disease conditions (Walter, 2016; Osobamiro, 2019). Studies have shown that fruit and vegetable consumption is the primary pathway of human exposure to heavy metals (Adamsa, 2011). Heavy metals enter the vegetable tissues mainly through the roots and foliage, of which root uptake was the prevailing pathway. This paper investigates the concentration of heavy metals in *Telfairia occidentalis* and its soils in ilushin farm settlement in Ogun state, Nigeria.

Materials and Methods

Sampling Area

Ilushin is a farm settlement located in Ijebu-Waterside in Ogun State. Ijebu waterside is a Local Government Area in Ogun State. Its geographical coordinates are 6°29' 0" N, 4° 2' 0" E. The major occupations are farming and fishing. The soil is rich in organic matter, well drained and deep which makes it support various crop cultivation. The major agricultural products are cassava flakes (garri), rubber, rice and maize. Major natural resources are timber, wild oil palm trees and vast manila forest.

Sample collection of Fluted Pumpkin

Five samples each of fluted pumpkin vegetable *(Telfairia occidentalis)* were systematically collected from three (3) different agricultural plots making a total of about fifteen (15) vegetable samples. The estimation of each plot was about 2 acres located in Ijebu water side, Ibiade ilushin called 'Rubber estate plantation'. Five feet were measured before taking the next fluted pumpkin vegetable samples. After the measurement of the Five feet, the fluted pumpkin vegetables were plucked using the knife so as to avoid contamination and carefully labeled for easy recognition. This was done in all the three different plots until a total of 15 vegetable samples were gathered. After that, they were placed in polythene nylon. Then, the samples were oven dried for about 10-15 minutes, and then transferred for sample digestion.

Fig 1: Fluted pumpkin (*Telfairia occidentalis*)

Sample collection of Soil

Five samples were collected systematically with each samples from three different plots making a total of fifteen (15) soil samples. Five feet were measured before the subsequent sample was taken. After the measurement of the five feet, the soil beside the vegetable sample were dug of about 0-20m depth and then the soils were poured into a polythene bag with the use of the hand trowel to avoid contamination and labeled for easy identification during sample dryness. In drying, the 15 soil samples polythene bags were widely opened and sun dried for 4-5 days. After drying, samples were transferred for sample digestion.

Sample Digestion

To 1g of the measured samples, 10ml of HNO_3 and H_2SO_4 mixed in the ratio 3:1 were added into a boiling tube containing the soil sample and mixed together. The samples were taken into the fume cupboard and heated for about 30-40 minutes. After cooling, 50ml of deionized water was added, and the samples filtered using whatmann filter paper. The resulting solution (filtrate) was then taken to the laboratory inside a clean and well labeled (S1-S5) sample bottle for analysis using Atomic Absorption Spectrophotometer (AAS).

Sample Analysis

Heavy metal analysis of the samples (Fluted pumpkin and soil) was performed with the use of an Atomic Absorption Spectrometer (AAS).

Physicochemical Properties of Soil

10g of the soil sample was mixed with 100ml distilled water in a standard flask. It was then stirred vigorously using a glass rod. After that, the mixture was heated using the heater to a temperature of about 80℃ and allowed to cool at room temperature. After the cooling of the mixture, the pH meter was calibrated using buffer solution of pH 4.0, and the tip of the electrode was placed into the mixture with continuous stirring until the reading stabilizes, and pH value recorded. Other physicochemical properties (soil organic matter, cationic exchange capacity, and soil texture) of the soil other than the pH were also determined using standard analytical methods.

Quality Control

Samples were analysed to validate the instrument and method used. The standard calibration curves for all parameters were gotten using a series of varying concentrations. All calibration curves were linear with correlation coefficients close to 1 (Idris, 2020).

Results

Heavy Metal Analysis of Telfairia occidentalis and Soil

Heavy metals including Pb, Ni, Mn, Cu and Zn were analysed by Atomic Absorption Spectroscopy in *Telfairia occidentalis* and soil samples collected from Ilushin Farm Settlement, Ijebu water side, Ogun State. The tables below shows the five heavy metals contained in these samples with their varying concentrations.

Table 1: Mean concentration of heavy metals in soil samples from ilushin farm settlement.

S/N	Pb	Ni	Mn	Cu	Zn
S1	20.65	7.60	96.25	2.55	10.75
S2	ND	2.60	96.20	2.10	8.70
S3	54.60	37.15	111.20	2.50	20.50
S4	9.60	19.80	207.25	8.10	16.35
S5	ND	4.40	71.65	2.60	11.75
Mean± S.D	16.97±2 2.69	14.31±1 4.42	116.51±5 2.67	3.57±2 .54	13.61± 4.76

*ND: Not Detected, SD: Standard Deviation

This result shows the concentration of heavy metals (Pb, Ni, Mn, Cu, and Zn) with their mean values 16.97±22.69, 14.31±14.42, 116.51±52.67, 3.57±2.54, 13.61±4.76. Pb was not detected in samples S2 and S5. It was found that Mn has the highest mean value of (116.51±52.67), in the soil samples followed by Pb (16.97±22.69), Ni (14.31±14.42), Zn (13.61±4.76) and Cu (3.57±2.54) in the soil sample, indicating the trend of the result: Mn > Pb > Ni > Zn > Cu.

PML- Permissible Maximum Limits from USEPA standard

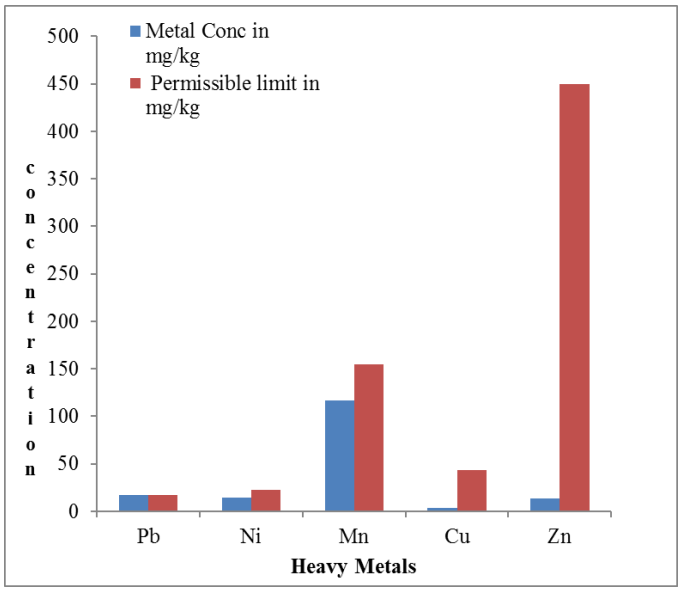

Fig 2: A bar chart showing the levels of metals in soil samples and their Permissible limits using USEPA standards.

Table 2: Mean concentration of heavy metals in *Telfairia occidentalis* samples from ilushin farm settlement.

S/N	Pb	Ni	Mn	Cu	Zn
S1	ND	12.80	388.45	7.60	39.65
S2	ND	14.60	363.30	10.15	54.10
S3	ND	11.85	307.90	10.05	53.65
S4	ND	10.65	448.90	8.25	43.90
S5	ND	13.90	519.15	8.60	38.25
Mean±S.D	ND	12.76±1.58	405.54±81.20	8.93±1.13	45.91±7.74

*ND: Not Detected, SD: Standard Deviation

This result shows the concentration of heavy metals (Pb, Ni, Mn, Cu, and Zn) with their mean values which are ND, 12.76±1.58, 405.54±81.2, 8.93±1.13, and 45.91±7.74 respectively. Pb was not determined in the samples. The analysis indicated that Mn has the highest mean value of (405.54±81.2), followed by Zn (45.91±7.74), Ni (12.76±1.58), Cu (8.93±1.130) and Pb (0±0), and the trend of the result is as follows: Mn > Zn > Ni > Cu > Pb.

PML- Permissible Maximum Limit from USEPA standard

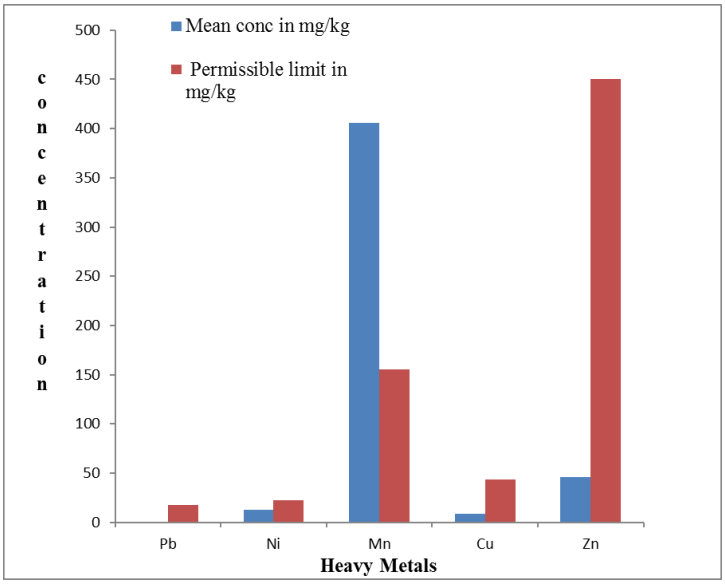

Fig 3: A bar chart showing the levels of metals in *Telfairia occidentalis* samples and their Permissible limits using USEPA standards.

Physicochemical Properties of Soil

Table 3: Mean values of the physical properties of soil in ilushin farm settlement.

SAMPLE	% CLAY	% SILT	% SAND
SAMPLE A	12.8	11.4	78.8
SAMPLE B	16.8	11.4	78.8
SAMPLE C	16.8	11.4	71.8
MEAN±S.D	15.5±2.31	11.4 ± ND	76.5±4.04

The soil of the area is characterized as sandy soil due to the high proportion of sand fraction exceeding 60%. The coarse nature of the soils is attributed to high precipitation in the area resulting in the weathering of parent materials (Attoe and Amalu, 2005).

Table 4: Mean values of the chemical properties of soil in ilushin farm settlement.

CHEMICAL PROPERTIES	SAMPLE A	SAMPLE B	SAMPLE C	MEAN±S.D
pH	5.93	5.24	6.28	5.82±0.53
% Org C	0.39	0.65	1.05	0.70±0.33
% N	0.04	0.07	0.12	0.08±0.04
Avail P mg/kg	9.01	9.55	6.08	8.21±1.87
Exch Acidity cmol/kg	0.6	0.6	0.6	0.6±ND
CEC cmol/kg	4.84	4.79	4.62	4.75±0.12
Na cmol/kg	0.34	0.27	0.45	0.35±0.09
Mn mg/kg	57.4	51.9	37.1	48.8±10.5
Fe	189	194	145	176±27.0
Cu	0.57	0.59	0.38	0.50±0.10
Zn	1.07	0.9	0.78	0.92±0.15

The pH of the soil samples were acidic in the range (5.82±0.53) which is below the permissible limit according to the WHO standard (6.5-8.5). The organic carbon (Org C) levels in the farmland soils were lower than the 2.5% which is considered adequate for arable land crop production in South Western Nigeria. The % N (0.08±0.04) is below the permissible limit of 0.20% (EPA standard), while the Available Phosphorus (8.21±1.87) of the range is also below the permissible limit of 20mg/kg (EPA standard). The exchange acidity (0.6±ND) of the range is below the permissible limit of 4.1cmol/kg (EPA standard).

The cation exchange capacity (CEC) plays an important role in soil fertility, and it depends especially on the pH, clay and on the soil organic matter content. Result of this study revealed that soils from Ilushin has lower values of CEC of the range (4.75±0.12) cmol/kg as compared to the Food and Agricultural Organization (FAO) standard of 20cmol/kg which is regarded as being suitable for crop production.

The low proportions of the physical properties may be ascribed to biomass contamination by industrial pollutants thereby disrupting the rate of litter decay. It may also be attributed to the little rate of nutrients returned to the soil through the fall and subsequent decomposition of litters, and plant materials (Offiong and Iwara, 2011).

Discussion

In Table 1, it was observed that Mn has the highest mean value of (116.51±52.67), followed by Pb (16.97±22.69), Ni (14.31±14.42), Zn (13.61±4.76) and Cu (3.57±2.54) in the soil sample, indicating the trend of the result: Mn > Pb > Ni > Zn > Cu.

In Table 2, it was observed that Mn has the highest mean value of (405.54±81.2), followed by Zn (45.91±7.74), Ni (12.76±1.58), Cu (8.93±1.130) and Pb (0±0), and the trend of the result is as follows: Mn > Zn > Ni > Cu > Pb. The high concentration of Manganese (Mn) may be attributed to the richness of the soil in manganese. The trend in the values of the result above can be attributed to many factors like metals natural content within the soil but others as a result of increase in man's activity like smelting of iron, pollution from nearby industries, application of fertilizer and the use of pesticides on farmlands.

Lead (Pb)

The permissible maximum limit for lead is 17.5mg/kg (USEPA). The mean value of Pb in soil and fluted pumpkin vegetable samples from Ilushin are 16.97mg/kg and ND (Table 1 and 2) respectively. It can be deduced that the amount of Pb in the soil is within the permissible level while Pb was not detected in the fluted pumpkin vegetable sample.

Nickel (Ni)

Ni has a permissible maximum limit of 22.5mg/kg (USEPA). The mean values of Ni obtained for Ilushin soil and fluted pumpkin vegetable samples are 14.31 and 12.76mg/kg (Table 1 and 2) respectively, which falls below the permissible level but lower than the one reported by Hassan and Mohammed (2013).

Manganese (Mn)

Mn has natural permissible limit of 155mg/kg (USEPA), the mean values of the analysis carried out in soil and fluted pumpkin vegetable samples from Ilushin are116.51 and 405.54mg/kg (Table 1 and 2) respectively. It can be deduced that the amount of Mn in the soil is within the permissible level while that of the fluted pumpkin vegetable sample is above the permissible limit.

Copper (Cu)

The permissible level for copper is between 43.5mg/kg (USEPA) but the values of Cu gotten from the analysis of Ilushin soil and fluted pumpkin vegetable samples are 3.57 and 8.93mg/kg (Table 1 and 2) respectively. These values are below the ones reported by Hassan & Mohammed (2013) but still within the permissible limit.

Zinc (Zn)

The permissible limit in the environment is 450mg/kg (USEPA) and the mean values of Ilushin soil and *Telfairia occidentalis* samples are 13.6 and 45.91mg/kg (Table 1 and

2) respectively. These values were higher than those gotten by Richa and Saxena (2015) but still within the permissible limit.

In this study, the highest mean concentration for the soil sample is Manganese (Mn) while the lowest is Copper (Cu). In the same vein, the highest mean concentration for the fluted pumpkin vegetable sample is Mn while the lowest mean concentration is Lead (Pb). However, there is an observation in the concentration of Pb in the soil samples of the area. Pb (16.97mg/kg) in the soil is close to the permissible level (17.5mg/kg) according to USEPA standard. This translates to mean that heavy metal assessment of the area must be conducted frequently to ensure the concentration of Pb in ilushin farm settlement is within the permissible limit.

Conclusion and Recommendation

This study investigates the level of pollution in terms of heavy metals (Pb, Ni, Mn, Cu and Zn) in soil and *Telfairia occidentalis* samples and the level of their toxicity. From the result, it can be deduced that concentrations of heavy metals are within the permissible levels except for Manganese (Mn) in the *Telfairia occidentalis* samples. The study results show a gradual accumulation of Mn in arable farmlands, while the concentration levels of the other heavy metals in the evaluated farmland soils do not pose serious concern. The sources of the metals in farmlands are suspected to be either from the use of nutrient replenishing materials (such as fertilizer) and aerial deposition.

Manganese is a trace mineral vital to the human body but it is required in small amounts. At high concentrations, Manganese toxicity can result in a permanent neurological disorder. The high concentration of Manganese (Mn) in the area of study may be as a result of richness in soil samples in Manganese, anthropogenic sources, and agrochemicals i.e., application of fertilizers, releasing of lead fumes to the atmosphere. Additionally, the research shows that there is a gradual accumulation in the concentration of Lead (Pb) in the soil, and the levels may rise to exceed the permissible limit in time to come.

The authors recommends the need to continually monitor the heavy metals pollution in the area from time and check the excessive use of fertilizers and the use of waste water for agricultural purposes. Farmers should be educated on the negative effects of fertilizer and other related farming activities. Owing to the fact that most local farmers in the area of study inherited their farming methods from their parents, thereby having little or no knowledge on the effect of certain activities like burning, use of fertilizer and waste water for farming activities, and other causes of pollution and how it affects the crop yield. Also, the anthropogenic activities in the area must be assessed by the relevant regulatory bodies to reduce pollution of the environment in order to ensure sound health and safety of lives in ilushin and extensively, Nigeria.

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