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Research paper

Determination of some heavy metals in some vegetable samples grown around gwaigwaye dam

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Abstract

Consumption of vegetables contaminated with heavy metals poses a serious health risk such as cancer and kidney failure, this highlights the need for monitoring of these metals in vegetables. This study aimed at determining the concentrations of Cadmium, Nickel, Copper, Cobalt, Lead and Zinc in Cabbage, Lettuce and Moringa oleifera leaves grown around Gwaigwaye dams. These vegetables were collected, prepared, digested and analyzed using microwave plasma atomic emission spectroscopy. The results obtained were in the following ranges, 0.018±0.03 to 0.021±0.01 mg/kg for Cd, 0.00±0.00 to 0.19±0.01 mg/kg for Co, 0.00±0.00 to 0.086±0.00 mg/kg for Pb, 0.03±0.00 to0.9±0.00 mg/kg for Ni, 0.21±0.01 to 1.92±0.00 mg/kg for for Cu and 0.00±0.00 to 0.23±0.03 mg/kg for Zinc in cabbage, lettuce and moringa oleifera leaves obtained farmlands around gwaigwaye dam. Fortunately, the levels of these metals fell within the acceptable limits of FAO/WHO. The Analyzed vegetables are free from toxic metals and therefore suitable for human consumption. P- Values obtained from the statistical analysis were greater than 0.05, the differences in the concentrations of the metals observed were therefore not statistically significant.

Keywords: *Cabbage; Dam; Heavy Metals; Lettuce; Moringa Oleifera.*

1. Introduction

Heavy metals are metallic elements with high density and potential toxicity, posing harm at elevated concentrations[1]
Industrial growth has led to surge in the level of heavy metal in the environment, increasing pollution and ecological risk. The use of different fertilizers and pesticides in agricultural practices has also contributed to rise in the levels of heavy metals in the environment [1] Industrial waste in water pollutes soil, Agricultural lands and rivers thereby creating multiple pollution sources and higher environmental impact. Heavy metals contaminates soil and are absorbed by plants, transported and stored in both edible and non-edible parts threatening the food chain with potentially harmful consequence[2] Fruits and vegetables are rich in essential nutrients making them a vital component of healthy diet, supporting disease prevention and treatment[3] Vegetables play significant role in human nutrition offering a rich source of essential nutrients and antioxidants for maintaining good health[4] Despite the contribution of vegetables to human health, vegetables absorbs and store heavy metals in their leaves, roots and stems resulting in concentration of harmful metals in these tissues[5] Heavy metals tend to accumulate at higher levels in leafy and tuberous vegetables compared to grains and fruits. The vegetables (Cabbage, Lettuce and Moringa Oleifera) were selected for this research because they are the most popularly consumed in the area of the study. The choice of the study area was as a result of the closeness of the dam to Funtua textile factory whose untreated effluents are coming into the dam's water, which is then used for irrigation purposes. The aim of this study is to assess the levels of Cd, Co, Cu, Ni, Pb and Zn in Cabbage, Lettuce and Moringa Oleifera and to find out whether the consumers of these vegetables are at the risk of any ill health or not, as these information s were partially discussed in the previous literatures.

2. Materials and methods

The study used analytical grade chemicals of high purity, with solutions prepared using distilled water. Analytical grade reagents and de-ionized water were used consistently throughout the study. All the glass wares and plastic containers used were washed cleaned and dried in an oven at 105°C to ensure complete dryness. An Analytical balance was used for all weight measurement[6]

2.1. Description of the study area

Gwaigwaye Dam was constructed in the year 2003 by the former president Chief Olusegun Obasanjo in Funtua Katsina state, with the aim of providing water for irrigation to the surrounding communities and drinking water for the local government areas namely Funtua Faskari

and Bakori Local Government. The reservoir is formed by an embankment over Gwaigwaye River on Latitude (11º 58'N) and longitude (7º 20' E) Funtua, Katsina state. The size of the reservoir is above 450 m while the depth is about 130m. It has a storage capacity of 130 million cubic meters. The climate of the area is typical savannah type with wet season (May- October) and dry season (November-April [7].

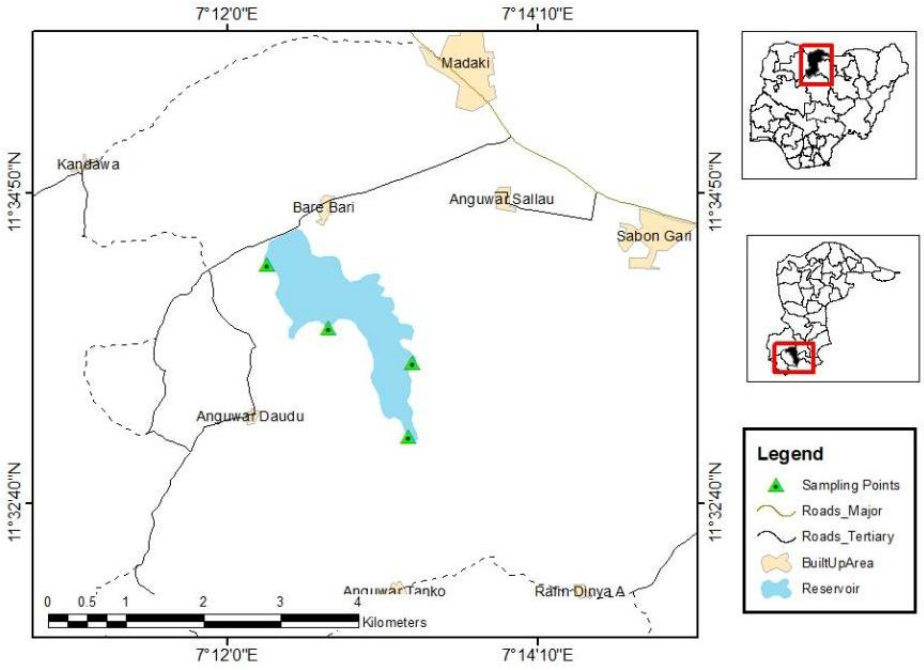

Fig. 2.1: Map of Gwaigwaye Dam.

2.2. Samples collections and preparations

The representative samples of cabbage, lettuce and moringa oleifera leaves were collected from farmlands surrounding Gwaigwaye reservoir in Funtua local Government from Multiple locations each separated by 30m and 50m from Roadsite in January 2024. Vegetables were washed with tap water and rinsed with de-ionized water to remove surface sand and dust. The samples were cut into smaller pieces and air dried for 24 hours to reduce moisture . Each sample was dried in an oven at 80^{0c} for 3hours until constant weight was achieved . The samples were ground into powder using mortar and pestle, sieved through 2.0mm mesh size and preserved until ready for analysis[8]

2.3. Sample digestion

0.5g of dried vegetable sample was digested using tri -acid mixture of (HNO_3 H_2SO_4 and $HCLO_4$) In the ratio of 5:1:1 until transparent fumes were observed. The samples were filtered and made up to the final volume of 50ml with distilled water.

2.4. Instrumentation

The digested samples of cabbage, lettuce and moringa oleifera leaves were put into sample cups. The sample cups were then firmly placed in the microwave plasma atomic emission spectrometer and were securely sealed. The instrument was switched on and left to stabilize for a short time allowing it to reach its optimal performance temperature. The sample was introduced into the plasma torch, where it was atomized and excited through contact with microwave energy. The excited atoms released distinctive wavelengths of light, which were subsequently detected and quantified by microwave plasma atomic emission spectrometer. The microwave plasma atomic spectrometer analyzed the wavelength and determined the corresponding concentrations of Cd, Co, Cu, Ni,Pb and Zn present in the samples. The results were displayed on the computer screen[9]

2.5. Statistical analysis

The result of statistical Analysis indicated no significant difference between the concentrations of Cd, Co, Cu, Ni, Pb and Zn in Cabbage, Lettuce and Moringa oleifera leaves.

Table 1: Result of Statistical Analysis

SUMMARY						
Groups	Count	Sum	Average	Variance		
Cabbage	6	0.483	0.0805	0.007282		
Lettuce	6	2.674	0.445667	0.263501		
Moringa	6	2.75	0.458333	0.571817		
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.55253	2	0.276265	0.983616	0.396828	3.68232
Within Groups	4.213002	15	0.280867			
Total	4.765533	17				

3. Results and discussion

Table 2: Concentrations of Some Heavy Metals in (Mg/Kg) of Some Vegetables Collected Around Gwaigwaye Dam, Katsina State, Nigeria

	Cd	Co	Cu	Ni	Pb	Zn
Cabbage	0.021±0.01	0.036±0.03	0.2±0.01	0.03±0.00	0.016±0.00	0.18±0.00
Lettuce	0.018±0.03	0.19±0.01	1.3±0.01	0.85±0.00	0.086±0.00	0.23±0.00
Moringa	0.19±0.01	ND	1.92±0.00	0.63±0.00	ND	0.01±0.03

From table2 above, the concentrations of Cd in all the vegetables studied were within the permissible limits of 0.2 mg/kg by FAO and WHO. This shows that all the vegetables sampled from gwaigwaye reservoir in this research are safe for consumption[10] obtained 0.67±0.024 mg/kg for Cd in cabbage from district kasur, Pakistan. This was slightly higher than the result of the present study. Likewise, 0.97-1.52 mg/kg of Cd reported in lettuce from Romania by [1] was above the result of the current research. However, 0.075±0.012 mg/kg of Cd in moringa oleifera leaves sampled from Nakhon pathom, Thailand reported by [11] was lower than the result of this research.

The Concentrations of cobalt in all the vegetable samples clearly shown in table 2 above were obtained as follows, 0.036±0.03 mg/kg in cabbage, 0.19±0.01 mg/kg in lettuce and very luckily, it was not found in moringa oleifera. The levels of cobalt in all vegetable samples analyzed were below 0.1-0.2 mg/kg by FAO and WHO. This suggests that these vegetables are safe consumption[12] reported higher value of 2.04 mg/kg for Coin lettuce from Kubanni stream, Zaria, Kaduna state, Nigeria, in another study by [13], 0.3661 mg/kg of Co was found in cabbage from Quetta city. This result also disagreed with present study. The result of cobalt in moringa leaves (0.16 mg/kg) from java by[14] is not in agreement with the finding of this study.

Copper concentration level as indicated in table2 was found to be highest in moringa oleifera with 1.92±0.00 mgkg, followed by lettuce with a concentration of 1.3±0.01 mg/kg and the least concentration of copper (0.23±0.03 mg/kg) was observed in cabbage. The concentrations of copper in all vegetables samples assessed were lower than the acceptable limits of 73.3 mg /kg by FAO/WHO. This signified the absence of any health hazard in relation to their consumption. In a similar research by [15] a copper concentration ranged from 0.89-7.20 mg/kg was found in cabbage sampled from yankaba market, Kano state, Nigeria. This result also disagreed with recent research. The result of [16], that reported 1.016±0.08 mg/kg of copper in moringa leava from onicha area of ebonyi state, Nigeria was lower than the result of current research[17] obtained copper in lettuce in the range of 0.00-9.70 mg/kg from Kaduna state, Nigeria which is in agreement with recent study.

Nickel concentrations in the vegetable samples analyzed were extremely lower than 5.0 mg/kg recommended by FAO and WHO, as 0.03±0.00 mg/kg was obtained in cabbage, 0.85±0.00 mg/kg in lettuce and 0.63±0.00 mg/kg in Moringa Oleifera as contained in table2. There is no any health risk associated with consumption of these vegetables. This result was compared with some previously reported works in the literatures as follow, [18] reported a Nickel concentration in the range of 1.3-3.9 mg /kg higher than the finding of this research but below the permissible limit of 5.0 mg/kg from Gurage zone, Ethiopia. Similarly, 13.0-17.75 mg/kg range of Ni in moringa leaves from Pakistan reported by [19] was found to have by far exceeded the permissible limit FAO/WHO and the result of the present study. However, 0.7 mg/kg of Ni obtained in lettuce from urban garden of mexico city by [20] closely agreed with the current Research.

Lead concentrations in cabbage, lettuce and moringa leaves as shown in table 2 above, varied from 0.00±0.00 to 0.086±0.00 mg/kg. These concentrations were below 0.3 mg/kg permissible limits of FAO/WHO, hence safe for consumption. The report of [21] in which 0.012±0.01 mg/kg of lead was obtained in lettuce from Dorayi Babba, Kano state, Nigeria agreed with the present study .[22] reported 0.479±0.0273 mg/kg for pb in moringa oleifera leaves from Kashere metropolis, Gombe state, Nigeria which disagreed with the result of the present study. The result of [10] in which 3.21±0.031 mg/kg was obtained in cabbage from district kausar, pakistan also contrasted the finding of this study.

Significantly lower concentrations of zinc in cabbage, lettuce and Moringa leaves were obtained in this research as revealed by table2. Interestingly, 0.18±0.00 mg/kg was obtained in cabbage, 0.23±0.00 mg/kg in lettuce and 0.01±0.03 mg/kg was obtained in moringa oleifera leaves, all these were far below 99.4 mg/kg safety limits of FAO/WHO, indicating that consuming these vegetables is harmless to human health .[18] reported a concentration of zinc in lettuce from Kaduna in the range of 0.01-0.16 mg/kg which agreed with the present study. According another study by[23] 21.3 mg/kg of zinc was found in moringa oleifera leaves from india which is not in agreement with present study. Likewise, [13]obtained 6.0±2.25 mg/kg of Zinc in white cabbage from south Poland which disagreed with present study. The uptake of heavy metals by plants is influenced by various factors, including plant species, soil composition and plant's ability to absorb these metals which vary significantly[8].

3.1. Conclusion

Heavy metals analysis in leafy greens plays an important role in safeguarding the public health by preventing foodborne toxicity, reducing bioaccumulation risk thereby protecting the consumer's health.

The Concentrations of cadmium, cobalt, copper, Nickel, lead and zinc were assessed in cabbage, lettuce and moringa oleifera leaves grown within the farmlands around Gwaigwaye Reservoir. After comparison with standard organization's acceptable limits, all the metals falls within their safe limits, hence the analyzed vegetables are safe for human consumption. Despite the current safety levels, monitoring of these toxic metals is very vital due to the use of gwaigwaye dam's water for irrigation. To guarantee that their concentrations remains within the safe threshold,. Other toxic metals that are not considered in this research should also be investigated in the subsequent research.

3.2. Acknowledgement

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3.3. Conflict of interest

The Authors have declared that no conflict of interest exist.

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