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Assessment of Trace Metals Concentration in Vegetables from Gombe Markets, Gombe State, Nigeria

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ABSTRACT: This study determined the concentration of trace metals in vegetables (lettuce, tomato and cabbage) from Gombe markets, Gombe State, Nigeria. A total of 60 samples of vegetables were analyzed for trace metals (Cd, Pb, Mn, Cr, Zn, Ni and Cu) using Atomic Absorption Spectrophotometer (AAS). The mean concentration of Cd in lettuce, tomato and cabbage samples ranged from (0.05 - 0.06 mg/kg), (0.03 - 0.07 mg/kg) and (0.08 - 0.90 mg/kg), Pb ranged from (BDL - 0.02 mg/kg), (BDL - 0.03 mg/kg) and (0.01 - 0.02 mg/kg), Mn ranged from (0.27 - 1.02 mg/kg), (0.09 - 0.12 mg/kg) and (0.25 - 0.31 mg/kg), Cr ranged from (0.05 - 0.65 mg/kg), (0.04 - 0.05 mg/kg) and (0.03 - 0.05 mg/kg), Zn ranged from (2.67 - 3.32 mg/kg), (1.93 - 2.87 mg/kg) and (2.45 - 3.26 mg/kg), Ni ranged from (0.68 - 0.77 mg/kg), (0.23 - 0.26 mg/kg) and (0.73 - 0.86 mg/kg), and Cu ranged from (0.95 - 0.97 mg/kg), (0.76 - 0.83 mg/kg) and (0.94 - 1.00 mg/kg) respectively. The abundance of trace metals was found in decreasing order: Zn > Cu > Ni > Mn > Cr > Cd > Pb in lettuce, tomato and cabbage samples. The concentration of trace metals in the different vegetables were below the World Health Organization/Food and Agriculture Organization (WHO/ FAO) standard, except Cd in all studied samples. Therefore, monitoring and strict regulation is recommended to control the safety of vegetables sold in these markets.

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Vegetable is one of the most important parts of the human diet providing dietary requirements of nutrients (Ovaskainen *et al.*, 2008; Bolor *et al.*, 2018). It is an understandable fact that the demand and consumption of vegetable are significantly increasing all around the world as it constitutes an important part of the human diet (Gebeyehu and Bayissa, 2020). They are generally used for culinary purposes (Ononamadu *et al.*, 2019). Vegetables are essential sources of vitamins, minerals salt and fiber that are rudiments for body development and enhancing the immune system (Sulaiman *et al.*, 2021a). However, vegetables and fruits sold in the market can be sources of trace metals that destroy consumers' health. Several studies revealed that vegetables and fruits are susceptible to trace metals contamination (eg. carrot, green pepper, onion, tomato, cabbage, lettuce, etc) (Ametepey *et al.*, 2018; Sulaiman *et al.*, 2019a; Gebeyehu and Bayissa, 2020). The consumption of vegetables contaminated with trace metals is one of the contributing factors to human exposure to trace metals (Sulaiman *et al.*, 2021a). Trace metals have been given considerable concern worldwide due to their toxicity and accumulative behavior (Alinnor, 2008; Sulaiman *et al.*, 2019b). Trace metal contamination of soil is a rising environmental problem that may enter the food chain as a result of their uptake by edible plants, affecting food quality and human health (Chibuike and Obiora,

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2014; Zwolak *et al.*, 2019; Hazrat *et al.*, 2019). On the other hand; Pb is relatively highly toxic to higher animals. It is absorbed and translocated to plant tissues, from which it affects animals and humans when consumed with plants (Sulaiman *et al.*, 2021b). It is obvious that prolonged vegetable consumption with unsafe concentrations of trace metals could lead to chronic accumulation in the liver and kidney of human beings and causes different disorders in various biochemical processes which leads to kidney bone, nervous and cardiovascular diseases (Jarup 2003; Ametepey *et al.*, 2018). In the current study, we aim to determine the concentration of trace metal in vegetables (lettuce, tomato and cabbage) from Gombe Markets.

MATERIALS AND METHODS

Study Area: The area of study is Gombe metropolis, Gombe State capital located between latitude 10°19′12"N to 10°14′12"N and longitude 11°10′7.12"E to 11°10′15.12"E. with an area 2 coverage of about 52 km. Figure 1 shows the map of Gombe town and the sampling sites. The study area is tropical climates with two distinct dry (November-April) and wet (May-October) seasons. Other weather conditions are: temperature range 23 to 36, 903 mm mean precipitation and relative humidity ranges from 15 to 20% in December and 70 to 80% in August (Maigari *et al.*, 2021).

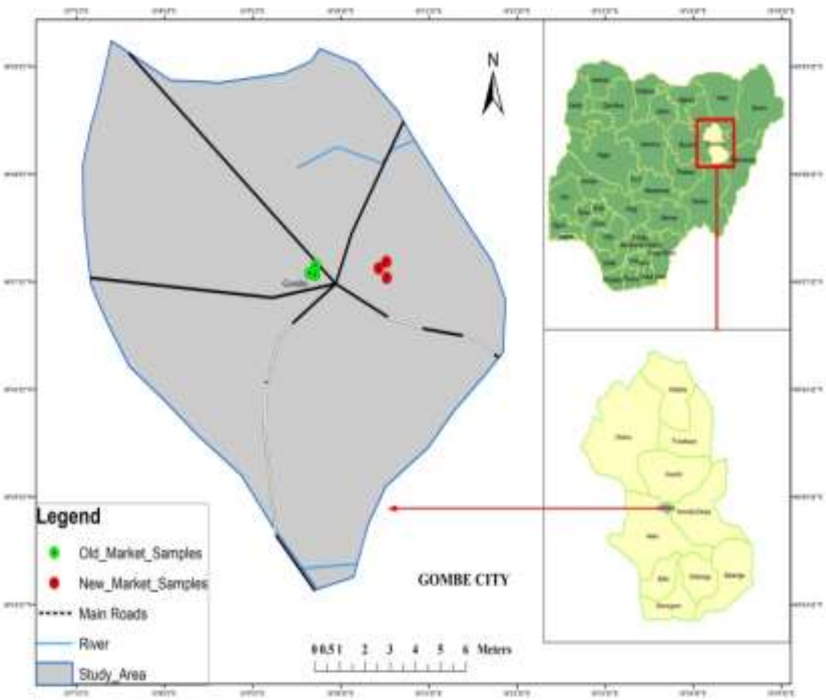

Figure 1: A map Gombe town and the sampling sites

Sample collection: A total of 60 samples (lettuce, tomato and cabbage; 20 each) were purchased from markets (old and new) for the analysis of trace metals. The purchased vegetable samples were placed in poly bags and were taken to the o laboratory and stored in a refrigerator at 4 ºC until the analysis.

Samples preparation and analysis: Each sample was put in a different crucible and ash in a furnace at 650 ºC for two hours. (0.4 g) of ash from each vegetable sample was weighed separately into a beaker. To each, 1 ml of concentrated HNO_3 and 3 ml of concentrated HCl were added, and heated on a hot plate for 10 minutes at 100 ºC to obliterate any carbonates, and filtered with Whatman's No. 42 filter paper and <0.45 µm Millipore filter paper. The concentrate was then transferred quantitatively to a 50 ml volumetric flask topped up to the mark with deionized water. The filtrate was analyzed for the presence of trace metals using Atomic Absorption Spectrophotometer (unicam 919 AAS).

Quality Control Analysis: Quality assurance protocols were taken to ensure the reliability of the results. Standard solution was prepared for each trace metal from their stock solution to calibrate the instrument. The percent recovery ranged from 92.0 - 96% in the vegetables. The samples analysis was replicated three times.

Statistical Analysis: Means, standard deviations of the concentrations of the trace metals for the various samples were calculated using SPSS software version 25 for Windows.

RESULTS AND DISCUSSION

Concentration of trace metals in vegetable samples: The results of lettuce, tomato and cabbage samples are presented in Table 1. The results of the investigation have shown that the mean concentration of Cd in lettuce, tomato and cabbage samples ranged from 0.05 to 0.06 mg/kg, 0.03 to 0.07 mg/kg and 0.08 to 0.90 mg/kg. The study revealed that Cd concentration in the three vegetables was above (0.02 mg/kg) WHO/FAO stipulate limit (WHO/FAO, 2007). In Nigeria, a study conducted by Sulaiman *et al.* (2019a) reported Cd values above the detection limit in vegetables grown in irrigated urban farming sites in Gombe. A similar study conducted by Odai *et al.* (2008) on vegetables grown on waste dumping sites in Kumasi, reported high cadmium levels that ranged from 0.68 to 1.78 mg/kg. It is obvious that Cd is becoming an increase in agricultural produce and its associated health issues such as; damage of kidneys, bones and its probable carcinogenic nature (Suruchi and Pankaj, 2011). Pb ranged from BDL to 0.02 mg/kg, BDL to 0.03 mg/kg and 0.01 to 0.02 mg/kg, in lettuce, tomato and cabbage samples respectively. The concentration of Pb in the vegetables was below the WHO/FAO permissible limit of 0.30 mg/kg (WHO / FAO 2007).Mn ranged from 0.27 to 1.02 mg/kg, 0.09 to 0.12 mg/kg and 0.25 to 0.31 mg/kg in lettuce, tomato and cabbage samples respectively. The concentration of Mn in the vegetables was below the WHO/FAO permissible limit of 500 mg/kg (WHO/FAO, 2007).

Chromium is essential for insulin activity and deoxyribonucleic acid transcription in living organisms' particularly human beings. However, an intake of less than 0.02 mg per day could lessen cellular responses to insulin (Kohlmeier, 2003). Cr ranged from 0.05 to 0.65 mg/kg, 0.04 to 0.05 mg/kg and 0.03 to 0.05 mg/kg in lettuce, tomato and cabbage samples respectively. The concentration of Cr in the vegetables was below the WHO/FAO permissible limit of 5.0 mg/kg (WHO/FAO, 2007). A study conducted by Sulaiman *et al.* (2019a) reported Cr values ranged from 0.13 to 0.22 mg/kg below the values obtained in this study. Zinc is an essential element in the human diet as it requires for maintaining the functioning of the immune system and its deficiency in the diet may be highly detrimental to human health (Kudirat and Funmilayo *et al.*, 2011). Zn ranged from 2.67 to 3.32 mg/kg, 1.93 to 2.87 mg/kg and 2.45 to 3.26 mg/kg in lettuce, tomato and cabbage samples respectively. The concentration of Zn in the vegetables was below the WHO/FAO permissible limit of 60 mg/kg (WHO/FAO, 2007). Similar studies from Lagos, Nigeria reported a Zn concentration below the permissible limit (Kudirat and Funmilay, 2011).

Tables 1: Mean concentration (mg/kg) of trace metals in the vegetables samples from Gombe Market

Samples	**Markets**	**Cd**	**Pb**	**Mn**	**Cr**	**Zn**	**Ni**	**Cu**
Lettuce	Old	0.05 ± 0.014	BDL	0.27 ± 0.06	0.05 ± 0.01	2.67 ± 0.93	0.77 ± 0.12	0.97 ± 0.06
	New	0.06 ± 0.012	0.02 ± 0.01	1.02 ± 0.01	0.65 ± 0.02	3.32 ± 0.41	0.68 ± 0.14	0.95 ± 0.24
Tomato	Old	0.03 ± 0.001	BDL	0.09 ± 0.03	0.04 ± 0.01	1.93 ± 0.14	0.23 ± 0.13	0.83 ± 0.09
	New	0.07 ± 0.002	0.03	0.12 ± 0.05	0.05 ± 0.04	2.87 ± 0.31	0.26 ± 0.97	0.76 ± 0.21
Cabbage	Old	0.19 ± 0.016	0.01 ± 0.00	0.25 ± 0.02	0.05 ± 0.01	3.26 ± 0.36	0.73± 0.98	0.94 ± 0.38
	New	0.08 ± 0.005	0.02 ± 0.01	0.31 ± 0.04	0.08 ± 0.03	2.45 ± 0.34	0.86 ± 0.88	1.00 ± 0.11
WHO/FAO (2007)	-	0.02	0.30	500.00	5.00	60.00	50.00	40.00

Ni ranged from 0.68 to 0.77 mg/kg, 0.23 to 0.26 mg/kg and 0.73 to 0.86 mg/kg, in lettuce, tomato and cabbage samples respectively. The concentration of Ni in the vegetables was below the WHO/FAO permissible limit of 50 mg/kg (WHO/FAO, 2007). Cu ranged from 0.95 to 0.97 mg/kg, 0.76 to 0.83 mg/kg and 0.94 to 1.00 mg/kg, in lettuce, tomato and cabbage samples respectively. The concentration of Cr in the vegetables was below the WHO/FAO permissible limit of 40 mg/kg. Similar study by Lugwisha and Othman, (2016) recorded the concentration of Cu below the permissible limit in vegetables. Generally, the abundance of trace metals was found in decreasing order: Zn > Cu > Ni > Mn > Cr > Cd > Pb. A higher concentration of Zn was obtained in lettuce from the new market followed by cabbage from the old market and tomato from the old market. It observed that is that leafy vegetables (lettuce and cabbage) happened to accumulated more trace metals than the fruity vegetables (tomato). Similar research findings also reported that the leafy vegetables generally accumulate metals to a greater extent compared with non-leafy vegetables (Gebeyehu and Bayissa, 2020; Chang *et al.*, 2012; Luo *et al..*, 2011). The concentrations of Pb, Mn, Cr, Zn, Ni and Cu in vegetables were below the permissible limits in vegetables by FAO/WHO, while the concentration of Cd was above the permissible limits in vegetables by FAO/WHO.

Conclusion: Vegetables from the market in Gombe, Gombe State, Nigeria were determined for Cd, Pb, Mn, Cr, Zn, Ni and Cu. The results of the metals show that the abundance of trace metals was in declining order: Zn > Cu > Ni > Mn > Cr > Cd > Pb in both samples. The result generally revealed that the concentration of Pb, Mn, Cr, Zn, Ni and Cu in vegetables were below the permissible limits in vegetables by FAO/WHO, except Cd was above the permissible limits in vegetables by FAO/WHO. Based on the findings of this study; it is recommended that further research work should be carried out to study the health risk implication of trace metals in vegetables and other vegetables in Gombe Market to improve measures to reduce their concentration in vegetables and prevent these health implications.

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