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POLLUTION LOAD OF HEAVY METALS ON PLANTS AND AQUATIC ANIMALS AT GALENA MINE OF NAHUTA, ALKALERI LOCAL GOVERNMENT AREA BAUCHI STATE

[1]Usman Y. M., [2]Maitera O. N., [3]Modibbo U.U, [4]Maina H. M.

[1]Department of Chemistry, Gombe State University P.M.B. 127 Gombe, Gombe State

[2,3,4] Department of Chemistry, ModibboAdama University of Technology Yola, P.M.B. 2076 Yola, Adamawa State, Nigeria

Abstract: **Heavy metals are extreme in raining season crops of Beans, Maize, Rice, Okro and Tomatoes with concentrations ranging from 6.58 ppm to 5.70 ppm. Analysis proved Fe, Zn, As, Pb and Cr heavy metals concentrations in both irrigated and raining season edible crops ranges between 0.01 ppm to 0.65 ppm within the vicinity of Nahuta Galena mine area. Aquatic animals at the mine lake contains 162.2 ppm of Pb, 14.7 ppm of Fe, while Cu and Mn concentrations of fish was 0.9 ppm each. Other metals such as Cd, Ni, Co, As and Cr concentrations are too high and toxic.**

Keywords: **Heavy metals, plants, Aquatic animals, toxic.**

1. INTRODUCTION

Mineral deposits exposed at the earth's surface, released at sufficient amounts which are considered pollutants such as arsenic released from the weathering of arsenical pyrite. When such deposits are mined, their released was typically enhanced because of the crushing of ore and gangue (waste) materials and the resulting increase in surface area of material exposed to weathering processes. Thus, pollution can become a serious problem, especially if the oxidations of sulfide minerals, which are often present in heavy metal ore deposits, causes acid mine drainage, which can enhance the mobility of heavy metal cations (Gordon *et al*., 1999).

2. MATERIALS AND METHODS

Plants Sampling

Sample plants collected are; Maize (*Zea mays*), Rice(*Oryza glaberimo*),Beans(*Phaseohus vulgaris*),Tomato (*lycopericon esculentum*), Okro (*Hibiscus esculentum*).Five samples at interval of 5m apart of the above mention plants was collected at two locations of Nahuta upstream and Nahuta downstream along mining site during dry and raining seasons. The sampling method adopted was ensured in relation to proper identifications of species and constituents present in the samples. Samples collected was kept in polythene bags to avoid evaporation of important constituents and later dried and preserved for analysis at the laboratory as adopted by (Titus *et al*., 2012).

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Fish Sampling

Five commonly occurring species of fresh catch of fish was purchased at the mine lake bank at Nahuta from the fishermen as stated by (Titus et al., 2012). Fish samples was preserved in coolers in contact with ice blocks and taken to the laboratory for analysis. The species analyzed were; Tilapia (*Oreochromis niloticus),*

Table 1: Sample and Sample Locations

Samples	Location	Sample Type
Plants	Upper & lower land Maize	Maize
	Upper & lower land Rice	Rice
	Upper & lower land Beans	Beans
	Upper & lower land Tomatoes	Tomato
	Upper & lower land Okro	Okro
Fish	Nahuta mine Lake	Tilapia
	Nahuta mine Lake	Tilapia
	Nahuta mine Lake	Tilapia
	Nahuta mine Lake	Tilapia
	Nahuta mine Lake	Tilapia

Sample preparations by digestion methods for MP-AES

10 cm^3 of 1:1 HNO_3 was added to 1.00 g of sample in a 25 x 150 mm glass digestion tube. The samples were then heated to 95 ± 10 °C for about 15 minutes. When cool, 5 cm^3 of HNO_3 was added and heat was applied for another 30 minutes. The digests were again allowed to cool, before 2 cm^3 of distilled water and 3 cm^3 of 30% H_2O_2 was added and heated to 95 ± 5 °C. After the digests were cooled again, another 1 cm^3 of 30% H_2O_2 was added. Heating continued until the sample volumes reduced to approximately 5 cm^3. The digests were then allowed to cool again before being diluted to 50 cm^3 with distilled water. Prior to analysis, the sample digests were further diluted tenfold. The 2% moisture content given in the certificate of analysis of the sample was incorporated into the calculation on specific intensities that would analyzes metals contents present. Then sample solution were then injected into MP-AES machine for analysis of heavy metals present. (Oliveria *et al*., 2004)**.**

3. RESULTS AND DISCUSSIONS

Concentrations of Heavy Metals in Irrigated Beans at Nahuta

Heavy metals of irrigated beans at Nahuta galena mine area, were examined. Only Arsenic metal shows highest average concentration of 1.5 ppm in all the samples, which was more prominent in B3 sample while Cobalt forms the second highest metal content in sample B3 with average of 0.13 ppm. Cd and Ni exhibits the least heavy metal content of less than 0.34 ppm and 037 ppm in all the beans sample. On the other hand Fe projected with 25.5 ppm exhibits an average of 6.5 ppm in all the sample, but Zn, Pb, Mn and Cr shows an average of 0.34ppm, 0.1ppm, 0.15ppm and 0.01ppm respectively, thus concentrations of heavy metals content was less than the maximum accepted by WHO. However, Irrigated beans at Nahuta vicinity was not polluted by heavy metals as indicated on figure 55a and 55b.

Concentrations of Heavy Metals in Raining Season Beans at Nahuta

Heavy metal content of raining season beans at Nahuta explained that Fe was more prominent with 36.2ppm in sample B3 beans formed an average of 13.2 ppm in all samples but the content of other heavy metals such as Zn, Pb, Mn and Cr was so negligible ranging from 0.35 ppm, 0.1 ppm, 0.25 ppm to 0.02 ppm. Other heavy metals such as Cd, Cu, Ni, As and Co possessed average compositions 0.01ppm, 0.05ppm, 0.06ppm, 0.6ppm and 0.008ppm accordingly in the raining season cultivated beans at Nahuta as shown on figure 55c and 55d. The result indicated that raining season beans cultivated within the vicinity of Nahuta galena mine area was not polluted with toxic heavy metals as compared to WHO maximum accepted concentrations.

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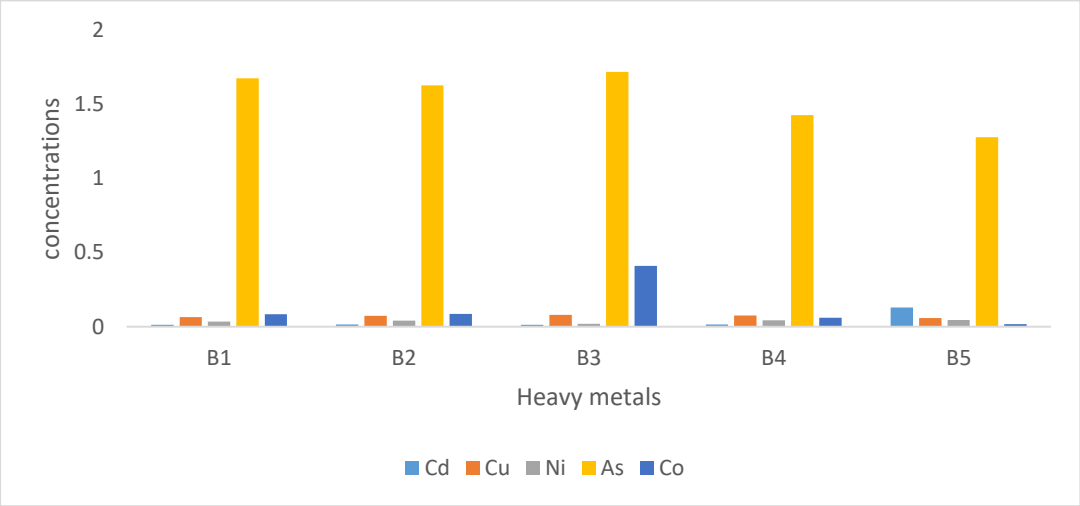

Figure 1a: Concentration of Heavy Metals in Irrigated Beans at Nahuta

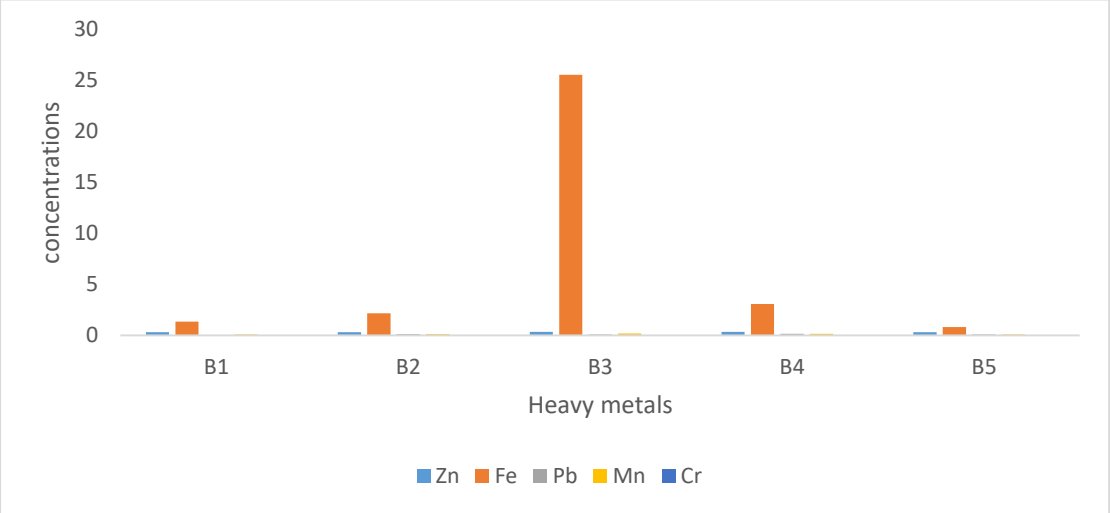

Figure 1b: Concentration of Heavy Metals in Irrigated Beans at Nahuta

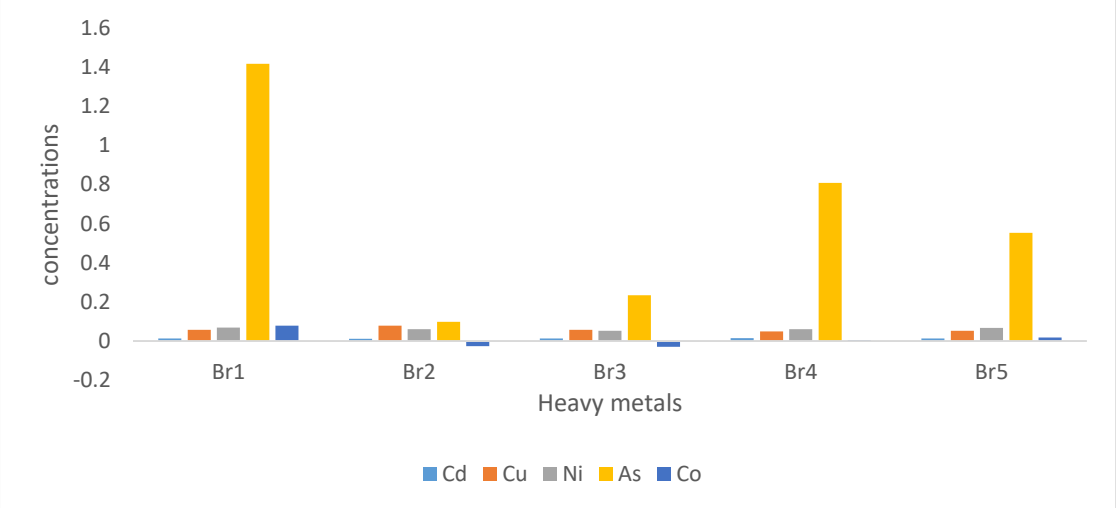

Figure 1c: Concentration of Heavy Metals in Raining Season Beans at Nahuta

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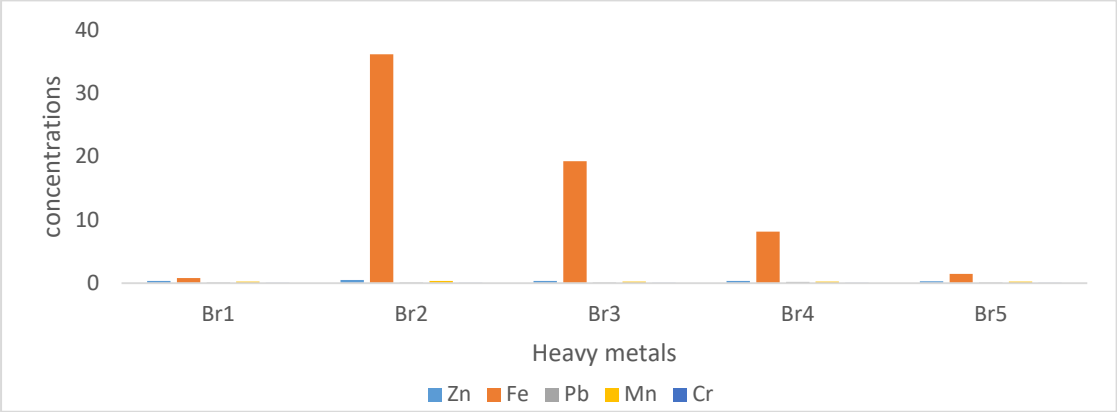

Figure 1d: Concentration of Heavy Metals in Raining Season Beans at Nahuta

Concentration of Heavy Metals in Fishes at Nahuta

Copper metal forms the most prominent metal in F1 and F3 fish samples followed by Arsenic both have An average content of 0.90 ppm and 0.55 ppm, but Cd Ni and Co exhibits an average composition of 0.019 ppm, 0.01 ppm and 0.008 ppm. In the same fish samples content heavy metals of Zn, Fe, Pb, Mn and Cr with an average compositions of 1.48 ppm, 14.66ppm, 162.2 ppm. 0.87 ppm and 0.024 ppm respectively, where Pb content was more pronounce in F3sample. These shows that fishes from Nahuta galena mine lake area content high toxic heavy metals which was polluted by environmental degradations was far above maximum recommended human consumption level as shown on figure 2a and 2b.

Concentration of Heavy Metals in Irrigated Maize at Nahuta

Concentrations on figure 3b revealed that Fe contains 12.13 ppm the as highest bar with an average of 2.89 ppm while Zn, Pb, Mn and Cr exhibits average concentrations of 0.32 ppm, 0.18 ppm, 0.23 ppm and 0.015 ppm. On related figure 3a shows excess concentrations of Cu and As on sample F3 and F5 with an average of 0.03 ppm and 0.29 ppm respectively. Other remaining metals such as Cd, Ni, and Co contain average compositions of 0.013 ppm, 0.0118 ppm and – 0.029 ppm. Thus concentration of heavy metals on irrigated maize was slightly above recommended human consumption and can be toxic if frequently adopted as a means food supplements.

Concentration of Heavy Metals in Raining Season Maize at Nahuta

Arsenic was more prominent on figure 3c in all maize samples revealed an average concentration 2.90 ppm, while Cd, Cu, Ni and Co possessed an average of 0.15 ppm, 0.044 ppm, 0.16 ppm and 0.033 ppm. Other related figure 3d shows high concentration of Fe on Mr4 sample forms average of 3.10 ppm, other heavy metals such as Zn, Pb, Mn and Cr revealed proportions of 0.39 ppm, 0.15 ppm, 0.070 ppm and 0.015 ppm. Thus concentration of heavy metals on raining season cultivated maize was slightly above WHO recommended human consumption and can be toxic if frequently adopted as a means food supplements.

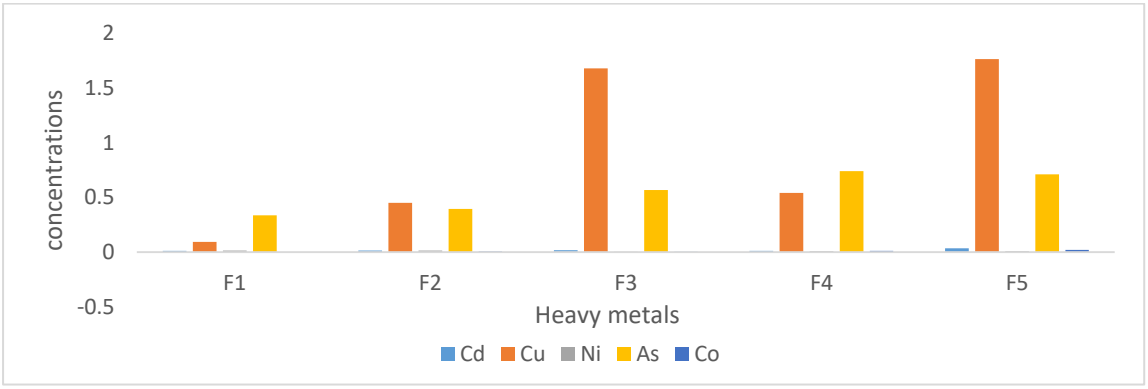

Figure 2a: Concentration of Heavy Metals in Fishes at Nahuta

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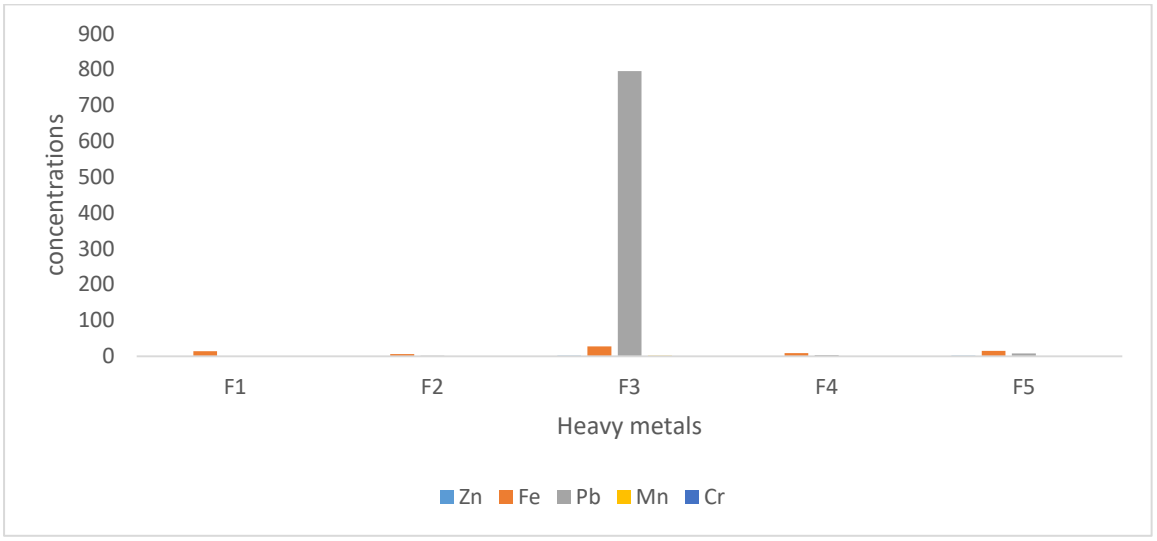

Figure 2b: Concentration of Heavy Metals in Fishes at Nahuta

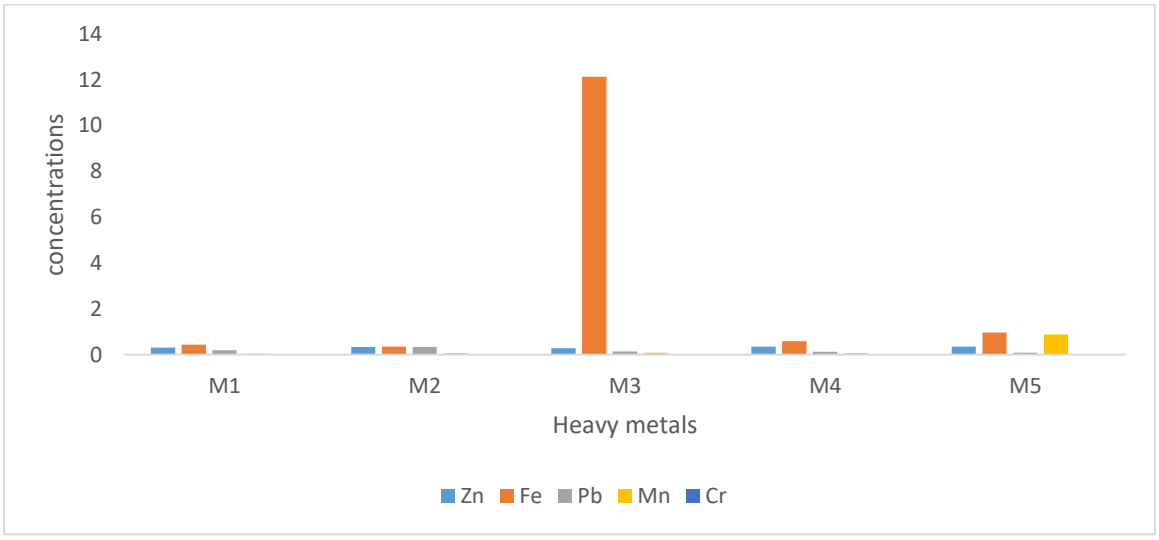

Figure 3a: Concentration of Heavy Metals in Irrigated Maize at Nahuta

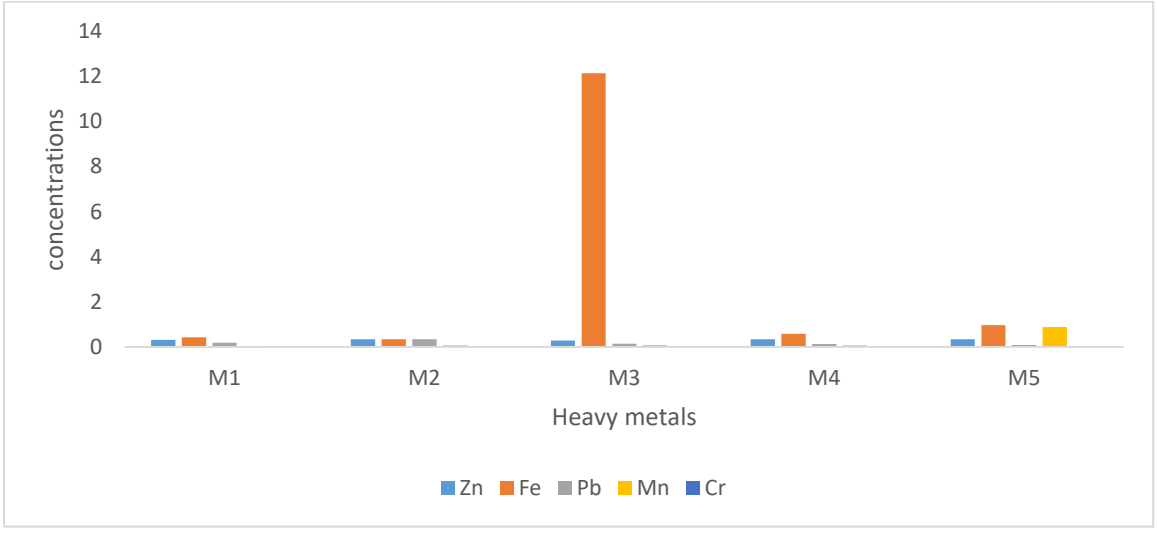

Figure 3b: Concentration of Heavy Metals in Irrigated Maize at Nahuta

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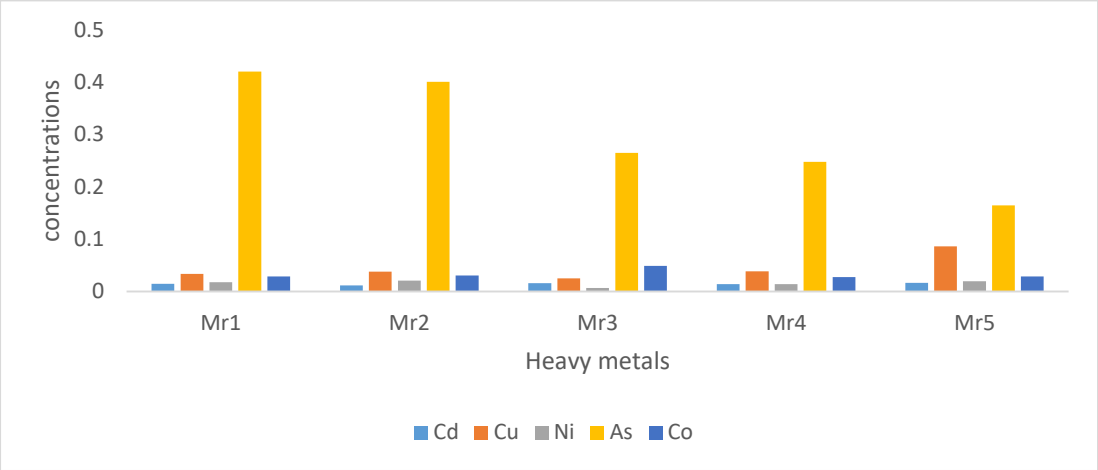

Figure 3c: Concentration of Heavy Metals in Raining Season Maize at Nahuta

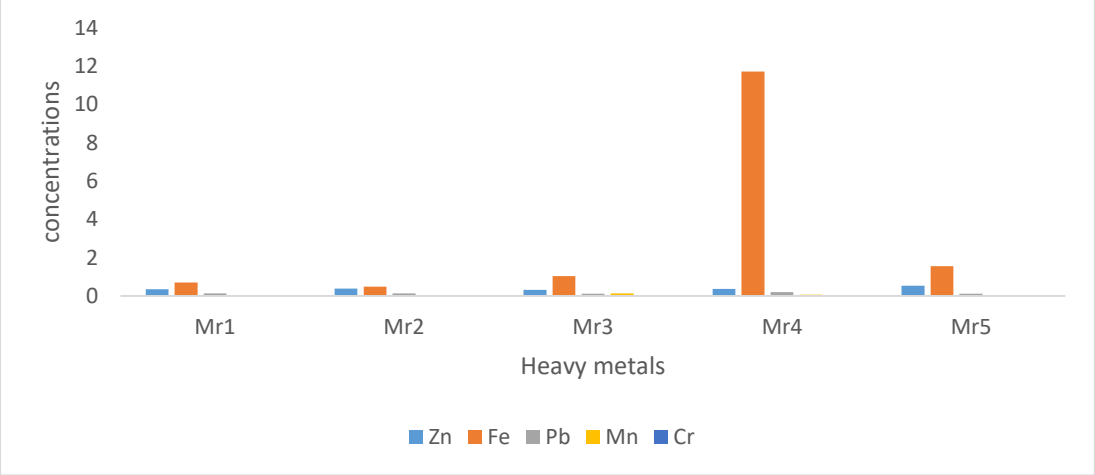

Figure 3d: Concentration of Heavy Metals in Raining Season Maize at Nahuta

Concentration of Heavy Metals in Irrigated Okro at Nahuta

Concentrations of Arsenic metal in irrigated Okro increases with variation in samples as shown on figure 4a while the average concentrations remain 0.68 ppm, Cd, Cu, Ni and Co metals formed an average concentration of 0.009 ppm, 0.013 ppm, 0.035 ppm, 0.044 ppm accordingly. The same irrigated Okro revealed vivid bar charts of heavy metals of Zn, Fe, Pb Mn and Cr with average concentrations of 0.044 ppm, 1.02 ppm 0.24 ppm, 0.60 ppm and 0.18 ppm as shown in figure 4b. Most toxic heavy metals such as Pd, Cd As on irrigated Okro was slightly above WHO recommended human consumption and can be toxic if frequently adopted as a means food supplements.

Concentration of Heavy Metals in Raining Season Okro at Nahuta

Arsenic metal was more prominent on Or1 and Or2 and shown figure 4c revealed an average concentration 0.46 ppm, while Cd, Cu, Ni and Co possessed an average of 0.024 ppm, 0.065 ppm, 0.010 ppm and -0.013 ppm. Other related figure 4d shows high concentration of Pb on Or1 sample forms average of 1.41 ppm, other heavy metals such as Zn, Fe, Mn and Cr revealed proportions of 0.45 ppm, 1.85 ppm, 0.18 ppm and 0.013 ppm. Concentration of heavy metals on raining season cultivated Okro was slightly above WHO recommended human consumption and can be toxic if frequently adopted as a means food supplements.

Concentration of Heavy Metals in Irrigated Rice at Nahuta

Concentrations on figure 5a revealed that Arsenic metal forms the moderately highest bar on R3 and R5 with an average of 0.10 ppm while Cd, Cu, Ni and Co exhibits average concentrations of 0.0088ppm, 0.054 ppm, 0.024 ppm and 0.010

ppm. On related figure 5b shows excess concentrations of Cu and Fe on sample R4 with an average of 5.00 ppm. Other remaining metals such as Zn, Pb, Mn and Cr contain average compositions of 0.18 ppm, 0.066 ppm, 1.00 ppm and 0.019 ppm .Thus concentration of heavy metals on irrigated Rice was slightly above WHO recommended human consumption and can be toxic if frequently adopted as a means food supplements.

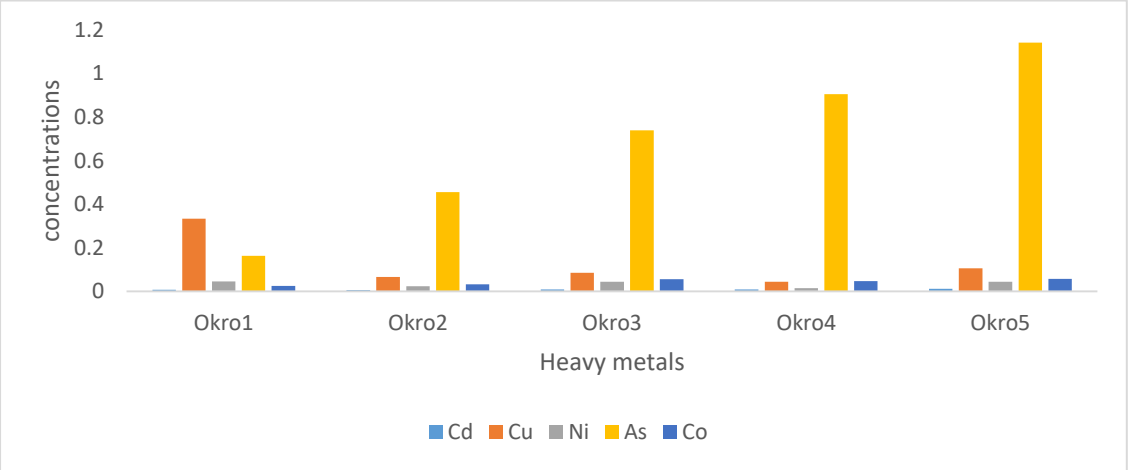

Figure 4a: Concentration of Heavy Metals in Irrigated Okro at Nahuta

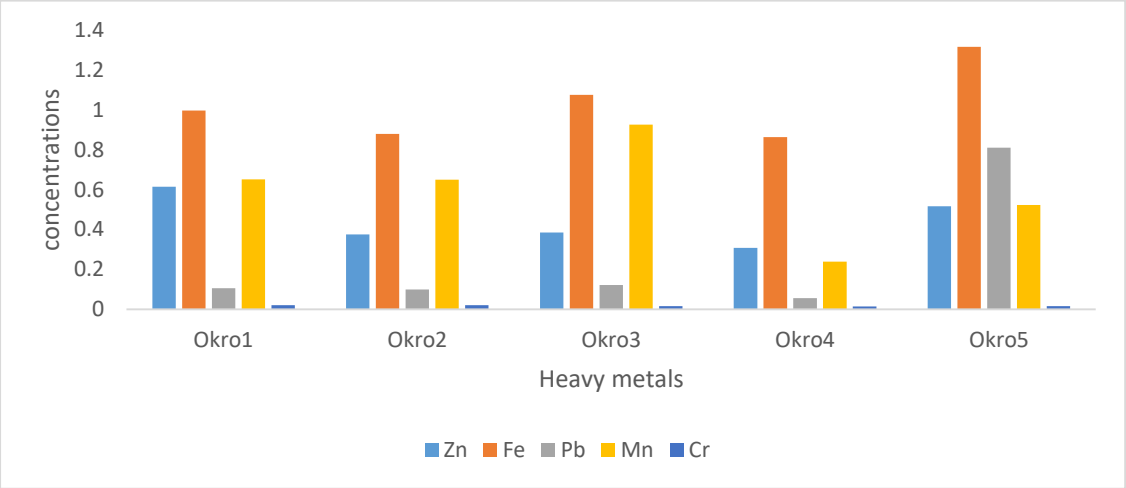

Figure 4b: Concentration of Heavy Metals in Irrigated Okro at Nahuta

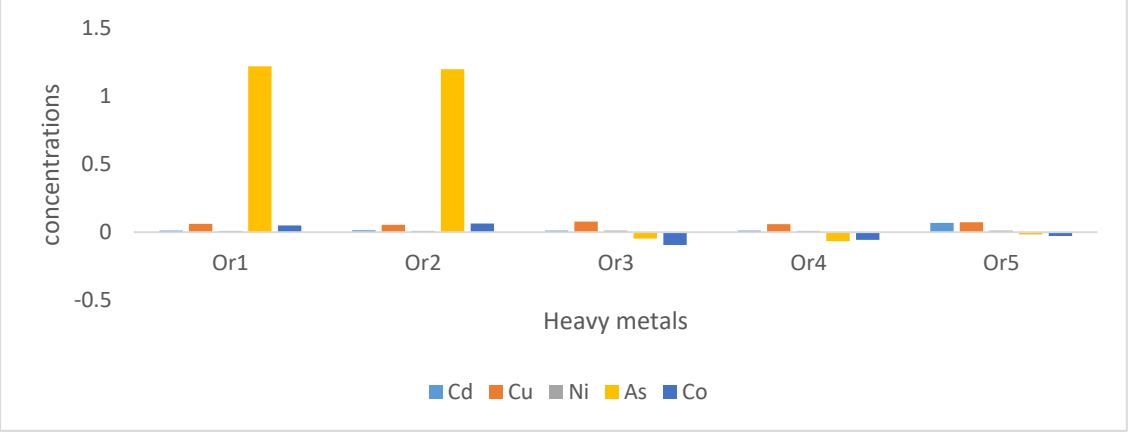

Figure 4c: Concentration of Heavy Metals in Raining Season Okro at Nahuta

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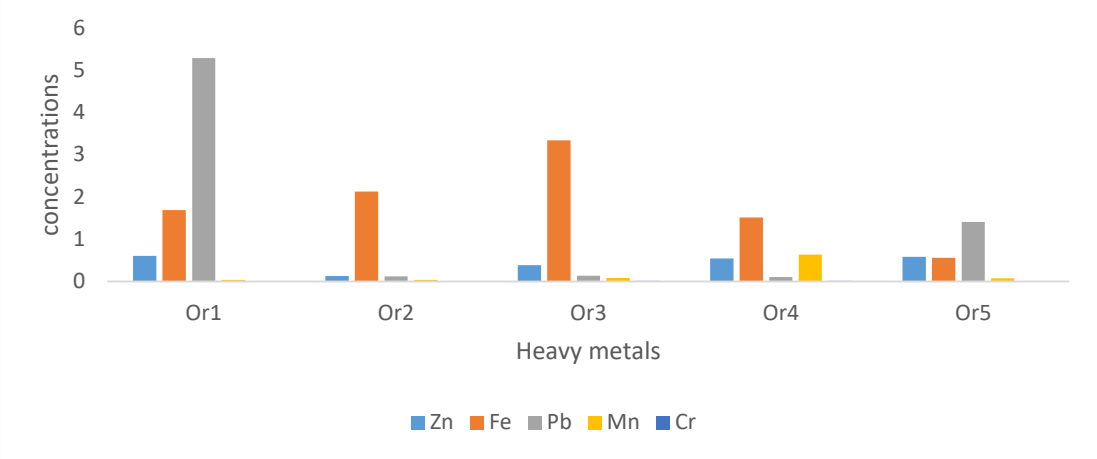

Figure 4d: Concentration of Heavy Metals in Raining Season Okro at Nahuta

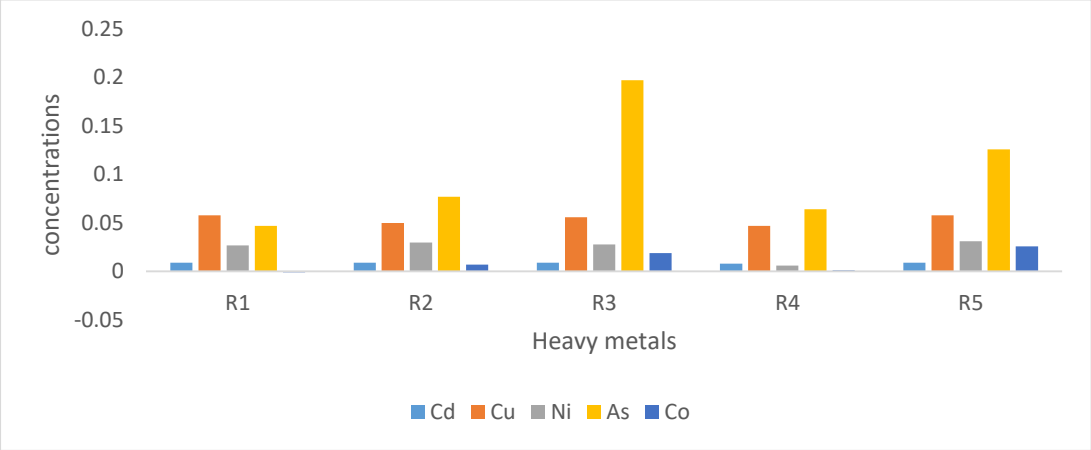

Figure 5a: Concentration of Heavy Metals in Irrigated Rice at Nahuta

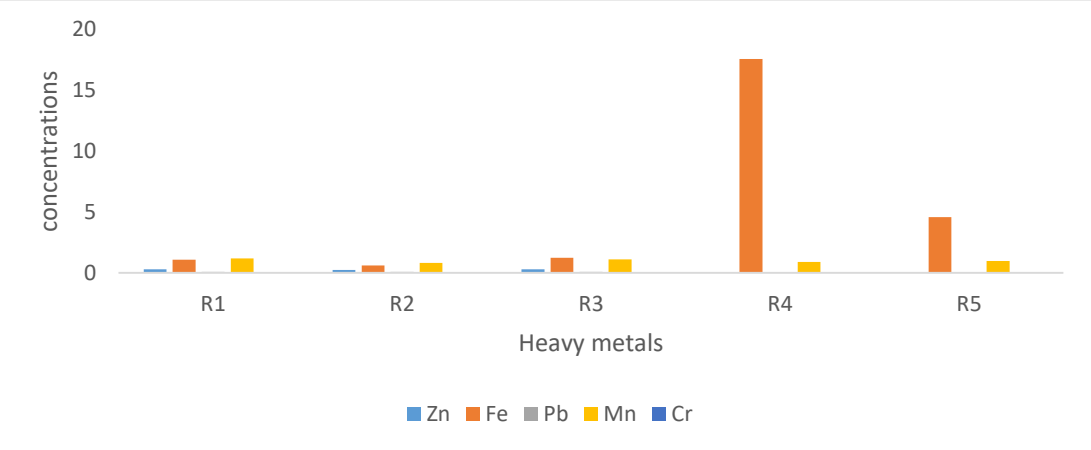

Figure 5b: Concentration of Heavy Metals in Irrigated Rice at Nahuta

Concentration of Heavy Metals in Raining Season Rice at Nahuta

Information on figure 5c shows that As metal was more pronounce on sample R4 and R5 whose average concentration was 0.39 ppm while Cd, Cu, Ni and Co possessed average composition of 0.018 ppm, 0.046 ppm, 0.019 ppm and 0.059 ppm. The same rice shows highest concentration on figure 5d hold at Rr5 with average of 2.82 ppm, remaining heavy metals such as Zn, Pb, Mn and Cr forms average of 0.23 ppm, 0.577 ppm, 0.37 ppm and 0.14ppm respectively. Finally,

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concentration of heavy metals on Raining Season Rice was slightly above WHO recommended human consumption and can be toxic if frequently adopted as a means food supplements.

Concentration of Heavy Metals in Irrigated Tomatoes at Nahuta

Concentration of Arsenic metal was more prominent in all the samples, while copper metal projected only of T3 sample as shown on figure 6a these metals possessed average concentrations of 0.92 ppm, and 0.023 ppm. Remaining metals of Cd, Ni, and Co held average of 0.0096 ppm, 0.041 ppm and 0.048 ppm. The same tomatoes obsessed metals of Zn, Fe, Pb, Mn and Cr owned average concentrations of 1.78 ppm, 2.54 ppm, 0.67 ppm, 0.88 ppm and 0.16 ppm as indicated on figures 6a and 6b, which explained that heavy metals of irrigated tomatoes were moderately above WHO accepted human consumption levels.

Concentration of Heavy Metals in Raining Season Tomatoes at Nahuta

Protruded bars on figure 6b shows that Arsenic metal was more pronounce on all the sample except Tr2 which was the lowest, whose average concentrations was 1.23 ppm while Cd, Cu, Ni and Co retained average composition of 0.030 ppm, 0.084 ppm, -0.004 ppm and 0.055 ppm. The same tomatoes on Figures 6c and 6d kept highest concentration of Fe at Tr3 and Tr4 with average of 5.70 ppm, remaining heavy metals such as Zn, Pb, Mn and Cr forms average of 0.29 ppm, 0.056 ppm, 0.074 ppm and 0.15ppm respectively. Concentration of heavy metals on Raining Season Rice was slightly above WHO recommended human consumption and can be toxic if frequently adopted as a means food supplements.

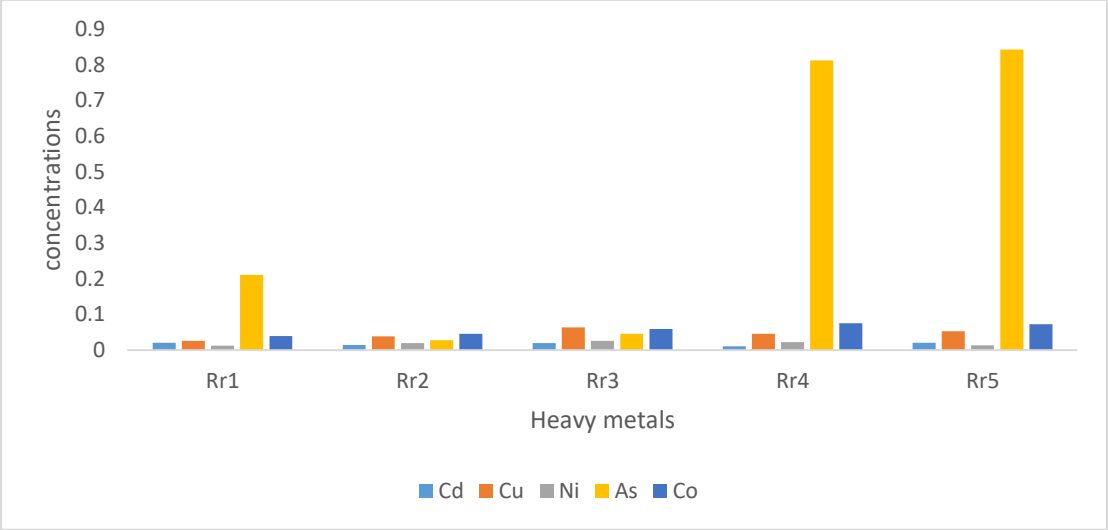

Figure 5c: Concentration of Heavy Metals in Raining Season Rice at Nahuta

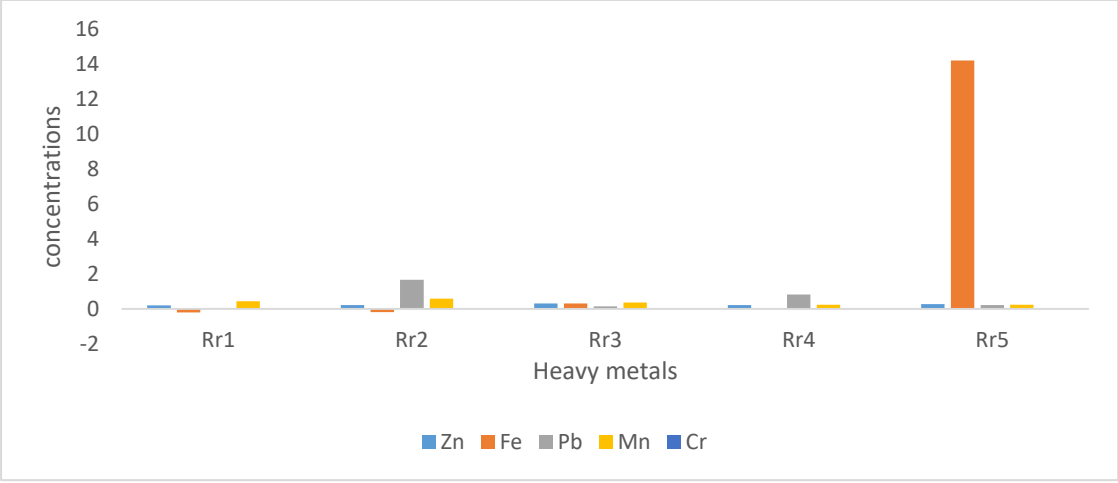

Figure 5d: Concentration of Heavy Metals in Raining Season Rice at Nahuta

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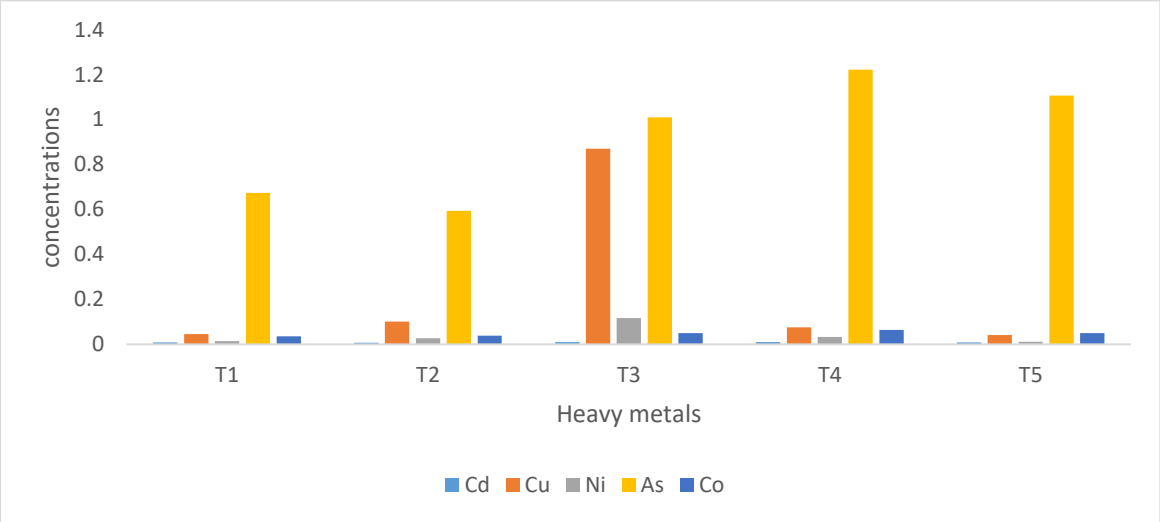

Figure 6a: Concentration of Heavy Metals in Irrigated Tomatoes at Nahuta

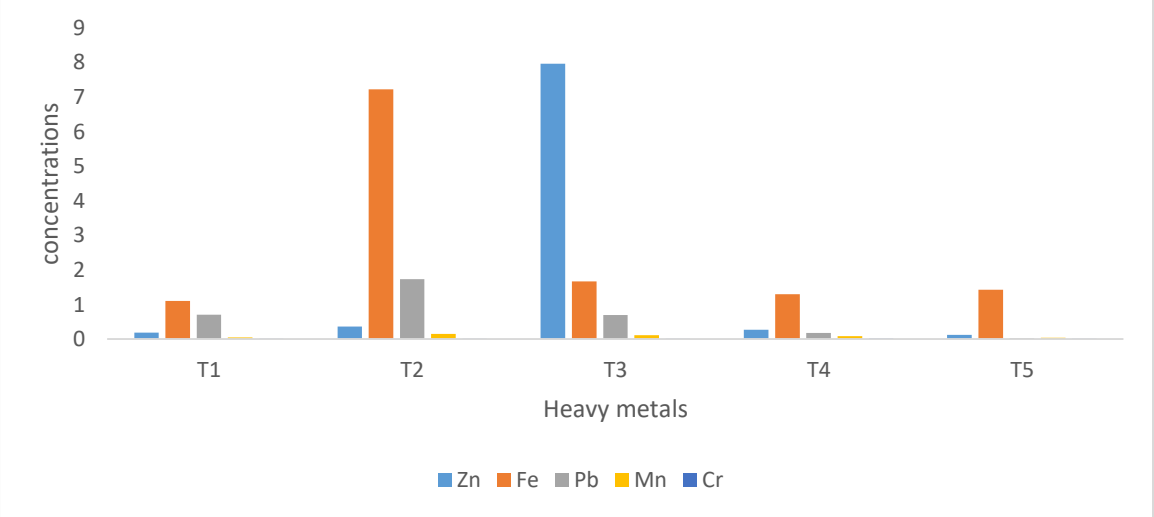

Figure 6b: Concentration of Heavy Metals in Irrigated Tomatoes at Nahuta

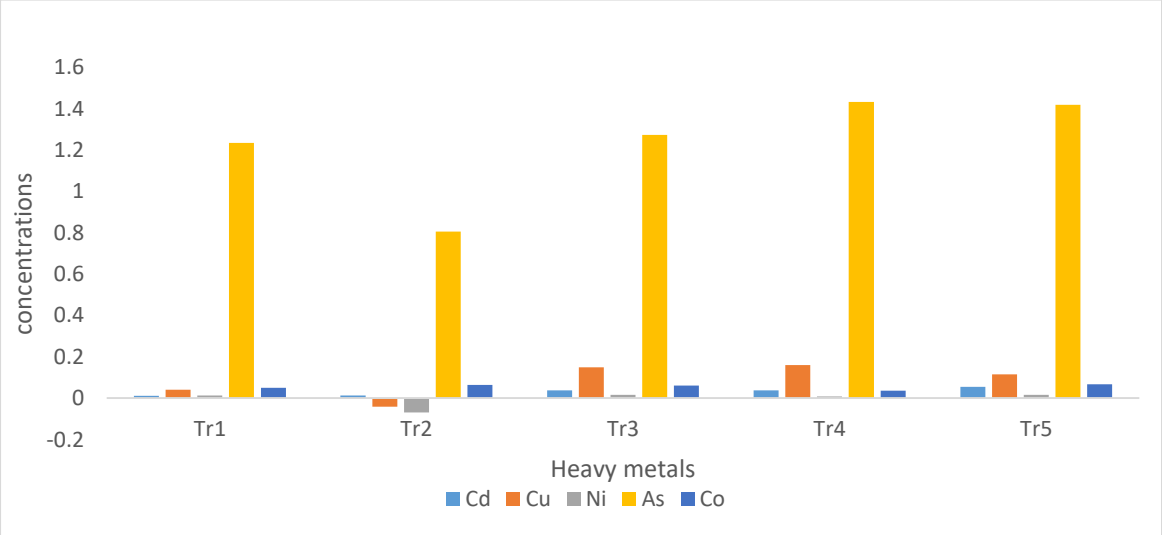

Figure 6c: Concentration of Heavy Metals in Raining Season Tomatoes at Nahuta

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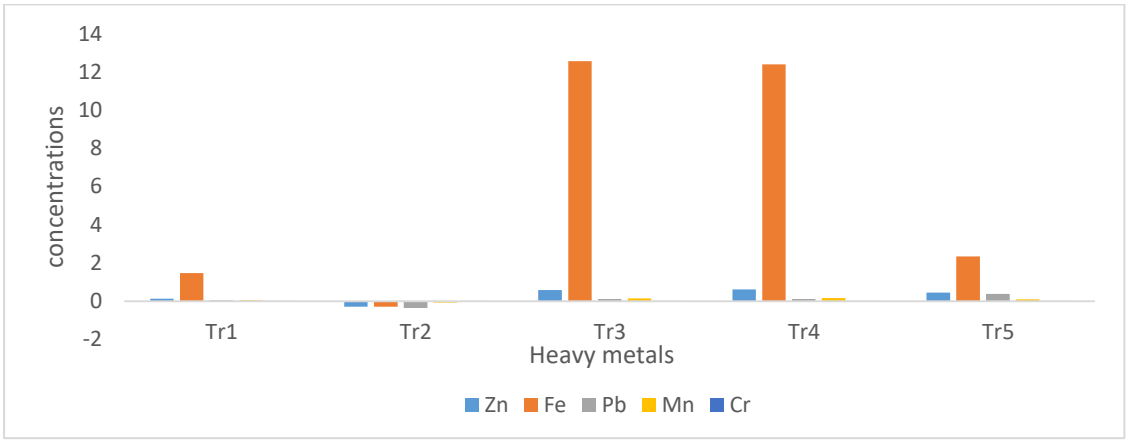

Figure 6 d: Concentration of Heavy Metals in Raining Season Tomatoes at Nahuta

Concentration of Heavy Metals in Fishes at Nahuta

Copper metal forms the most prominent metal in F1 and F3 fish samples followed by Arsenic both have An average content of 0.90 ppm and 0.55 ppm, but Cd Ni and Co exhibits an average composition of 0.019 ppm, 0.01 ppm and 0.008 ppm. In the same fish samples content heavy metals of Zn, Fe, Pb, Mn and Cr with an average compositions of 1.48 ppm, 14.66ppm, 162.2 ppm. 0.87 ppm and 0.024 ppm respectively, where Pb content was more pronounce in F3sample. These shows that fishes from Nahuta galena mine lake area content high toxic heavy metals which was polluted by environmental factors was far above WHO maximum recommended human consumption level as shown on figure 7a and 7b.

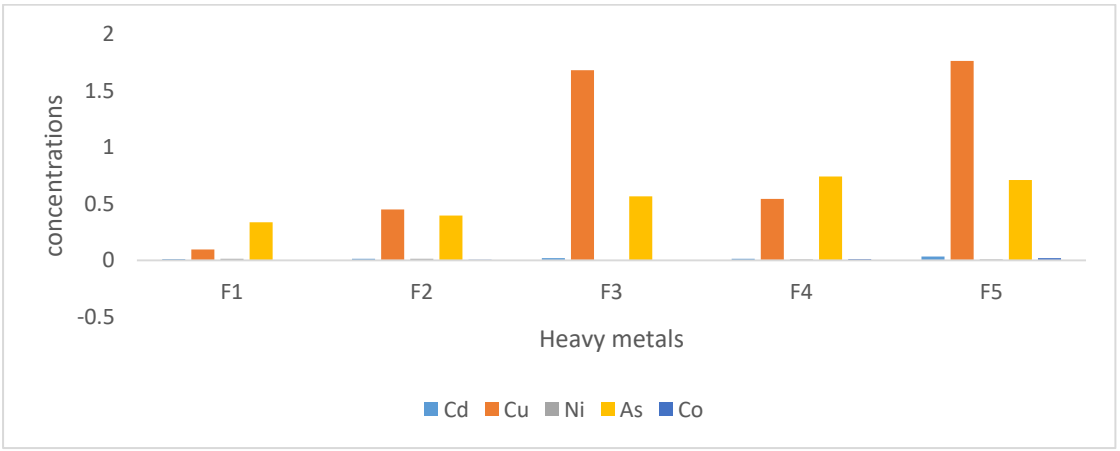

Figure 7a: Concentration of Heavy Metals in Fishes at Nahuta

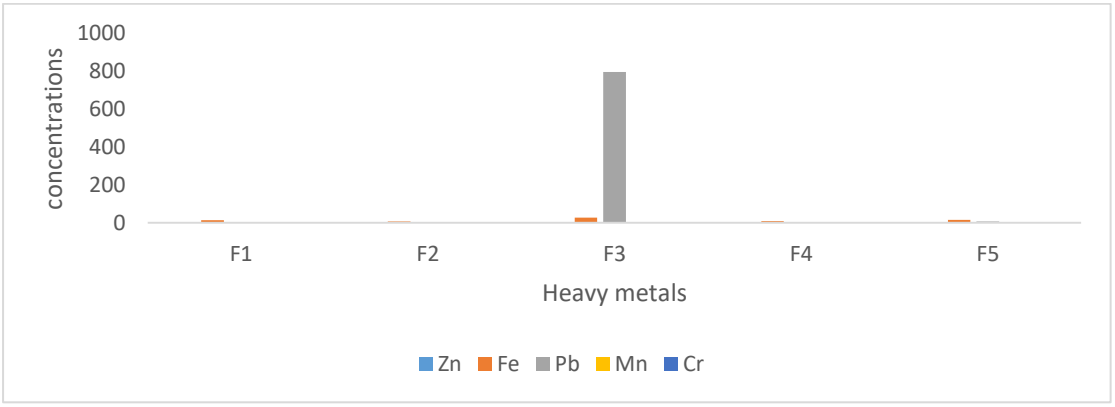

Figure 7b: Concentration of Heavy Metals in Fishes at Nahuta

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Table 2: Comparatives Concentrations of Irrigated and Raining Seasons Sample Polluted by Heavy Metals (ppm)

Metals	I B	RS B	Fish	I M	RS M	I O	RS O	I R	RS R	I T	RS T
Cd	0.34	0.012	0.019	0.013	0.015	0.009	0.023	0.008	0.030	0.096	0.032
Cu	0.071	0.058	0.91	0.031	0.044	0.123	0.065	0.054	0.085	0.022	0.085
Ni	0.037	0.061	0.01	0.012	0.016	0.035	0.010	0.024	-0.004	0.041	0.085
As	1.54	0.62	0.55	0.296	0.299	0.68	0.46	0.10	1.23	0.92	1.23
Co	0.13	0.009	0.008	-0.029	0.033	0.04	-0.013	0.010	0.055	0.048	0.055
Zn	0.34	0.36	1.48	0.33	0.39	0.44	0.45	0.18	0.29	1.78	0.299
Fe	6.58	13.16	14.7	2.89	3.10	1.03	1.85	5.0	5.70	5.70	5.70
Pb	0.10	0.10	162.2	0.18	0.15	0.23	1.41	0.066	0.57	0.64	0.056
Mn	0.15	0.25	0.87	0.23	0.071	0.59	0.018	1.00	0.074	0.088	0.0744
Cr	0.17	0.021	0.024	0.015	0.015	0.018	0.013	0.016	0.015	0.016	0.015

Key:

IB: Irrigated Beans
RS B: Raining Season Beans
I M: Irrigated Maize
RS M: Raining Season Maize
I O: Irrigated Okro
RS O: Raining Season Okro
I R: Irrigated Rice
RS R: Raining Season Rice
I T: Irrigated Tomatoes
RS T: Raining Season Tomatoes

Comparatives Concentrations of Irrigated and Raining Seasons Sample Polluted by Heavy Metals (ppm)

Analysis from the above table revealed that concentrations of Fe was too high in fish exposed 13.16 ppm and raining season cultivated beans at Nahuta Galena mine area while the concentration of irrigated beans, raining season rice and both irrigated and raining season tomatoes were 6.58 ppm, 5.7 ppm . Heavy metals of As, Pb, Zn exhibits higher concentration in almost all irrigated and raining season cultivated and commonly consumed crops at Nahuta. Cd, Cu and Ni concentration were slightly above WHO recommended levels, while Co, Mn and Cr concentrations in edible crops at Nahuta remain nontoxic in almost all the edible crops with range values of 0.01 ppm to 0.05 ppm. Results also exposed that fish surviving within the Nahuta Galena mine lake should be avoided completely due high concentrations of toxic heavy metals that could be poisoning.

Raining season cultivated crops held higher concentrations of heavy metals than irrigated crops due to effects of percolations and erosion process, hence pollution affect the edible crops at the vicinity of Galena mine area which are generally toxic when frequently absorbed as food.

4. CONCLUSION

Heavy metals contents of plants and aquatic animals are generated from Galena mineral, soil sediments were too high and harmful, therefore edible plants and animals growing at the mining vicinity should be minimized to reduce poisoning effects. Percolation and erosion of heavy metals also affected mostly raining season and some irrigated edible crops.

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