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Heavy Metals Concentration in Fluted Pumpkin (*Telfairia Occidentalis)* Grown and Consumed in Camp-2 Akamkpa Local Government Area of Cross River State, Nigeria

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ABSTRACT: There are environmental and public health risk consequences, if plants take up nutrients as well as pollutants from the soil, which they can bio-accumulate. The Present study was carried out to assess the heavy metals concentration in vegetables plant called fluted pumpkin (*Telfairia Occidentalis*) grown and consumed in Camp2 Community of Akamkpa local government area of Cross River State (Nigeria). The plant samples were collected at the study sites in three locations, heavy metals analysis was carried out using atomic absorption spectrophotometer (AAS) after a wet digestion. Heavy metals such as Cadmium (Cd), Lead (Pb), Mercury (Hg), and Chromium (Cr), Arsenic (As), Nickel (Ni) in vegetable plant were determined. The result shows that the mean value of Nickel, lead and Cadmium in vegetable plant were significantly ($p<0.05$) higher in Camp2 compared to the control site. Hence these values were above WHO standard (0.1mg/l) and FAO/WHO standards of (0.2mg/kg) while others were within joint FAO/WHO standard limit. The uptake of these heavy metals from the soil to the plant through transfer factor (TF) could be the reason why the plants were deficient in minerals component in Camp2 compared to the control site. Consuming vegetable plants on contaminated environment could bring about negative impact on both animals and human health.

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Quarry sites are growing concern in Akamkpa communities, as their impact on the ecosystem contributes to the degradation of the environment and pose a health hazard to the surrounding populations at large. Most affected are those living around the quarry sites due to the potentials of the waste to pollute water, food sources, land, air and vegetation (UN-Habitate, 2008). Akamkpa communities are exposed to a lot of environmental and health conditions (Uwah *et al.*, 2011). Some of the problems result from the current inability of urban authorities to adequately manage the quarry site. This has resulted in uncontrolled and unmonitored waste in the communities, with the consequences of contamination and subsequent pollution of the environment by heavy metals. Heavy metals have become a source of global concern due to their widespread distribution effects on the ecosystem (Lisk, 1998). Most of the waste comprises of organic materials, in considerable proportions of particles which are known to be real sources of heavy metal. Furthermore, heavy metals are non-biodegradables and can accumulate in soils at toxic concentrations that affect plant and animal life (Katatas *et al.*, 2006). Trace metals may enter the human body via consumption of contaminated water or crops grown on contaminated land (Dudka and Miller, 1999). Metals such as lead, mercury, cadmium and copper are cumulative poisons which cause environmental hazards and are reported to be exceptionally toxic. These metals are the major source of oxidative stress in cells and play an important role in the etiology of diverse human pathologies such as carcinogenesis (Frenkel, 1992).

Exposure to heavy metal toxicity leads to brain damage, mental retardation, cerebral palsy, lung cancer, gastrointestinal abnormalities, dermatitis and death of the unborn feotus (USEPA, 2007). Many metals have been shown to directly modify or damage DNA by forming DNA adducts that induce chromosomal breaks (Chakarabarti and Subarmanian, 2001). The quarry sites where all these activities take place is been contaminated with environmental toxicants which eventually finds its way to the neighborhoods as animal's feed. Stray chicken, pigs, goats, dogs and cats roam within the affected land eating the toxic matter and becoming vectors of pests and parasites that eventually transfer to surrounding homes, causing diseases to both animals and humans. Therefore, the objective of this study is to assess the concentration of heavy metals in fluted pumpkin

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(*Telfairia Occidentalis)* grown in camp2 village Akamkpa Local Government Area of Cross River State, Nigeria.

MATERIALS AND METHODS

Study Area: The study area is located in the Southern Senatorial District of Cross River State within latitude $5^0 24^1$N and longitude $8^0 12^1$E. The topography of the area is strongly undulating while the vegetation is typically rainforest which is gradually detorriating via quarry activities. Camp2 in Mfamosing Village is located at Akamkpa Local Government Area of Cross River State. The community is located close to the quarry site of Mfamosing rich in industrial activities with a distance of 36km from calabar to Camp2. The control site is 122km from calabar to ugep, Central Senatorial District of Cross River State within the latitude $5^0 48^1$N and longitude $8^0 5^1$E. The village is populated by the Yakurr people. Ugep is believed to be the largest village in Africa by land mass (Obono, 2004). Also, added that the population is indeed predominantly Christian. The predominant occupation of the people of Camp2 and Ugep is farming with over 70% of its people being engaged in various forms of agriculture. The major agricultural produce includes cassava, yam, vegetables, rice, plantain etc. The high yielding quarry operations and tourism potentials of the people of Akamkpa has placed the state in vintage economic position and stability. Hence, the local government is blessed with natural resources that could promote economic growth in the state.

Sampling points and their locations: Selecting lines were selected to examine the characteristic features of the areas were water could be found around that region. About six (6) sampling points three (3) each were used in the two study areas in Ugep and Camp2 Akamkpa Local Government Area. This was to enable us investigate the potential source of pollution, so that we would establish the impact of industrial waste from the quarry site to the host community.

The following factors were determined within the sampling points.

- Proximity: This has to do with the location of the sampling points from point A – B – C in relation to L_1, L_2 and L_3 respectively.
- Purpose: This has to do with what the water source is used for (either for domestic, agricultural or industrial purposes).
- Population: The size of the population in the villages that depend on both the water and plants that are grown in the communities

*Plant Sample collection***:** The vegetables were collected at the study site, in three locations. They were packed into a clean polythene bags for laboratory preparation. The vegetables were placed under running tap water to wash off the soil particles and other debris, then rinsed with distill water. The samples were then cut into smaller pieces and then air dried at room temperature in enclosed chamber for four days, and then pulverized into powders using a stainless grinder. The ground plant sample were then collected and labeled in polythene bags then placed in a desiccator awaiting laboratory analysis.

Sample preparation: The samples were cut into small pieces, air dried for 4 days in the laboratory. The dried samples were pulverized separately and sieved with 1mm sieve. Digestion of these samples (1g each) was carried out using 25ml of concentrated nitric acid and 5ml of perchloric acid to near dryness at 80ºC on a hot plate. The digest was filtered separately and made up to 50ml mark with distilled water, hence ready for elemental analysis with Atomic Absorption Spectrophotometer (SOLAAR 969AA).

Soil sample: Collection and preparation: The soil samples were collected using soil Auger at different locations (Melville and Welsh (2001) at the depth of 0-15cm – 0-30cm. Three samples of the soil were then taken from the same location where the vegetable plants were collected. The 0-15cm depth was taken for the average root zone for nutrient uptake and heavy metal burden by crops. The soil samples were weighed filtered and sieved. Digestion of the soil samples (1g each) was also carried out using 25ml of concentrated nitric acids and 5ml of per chloric acid to near dryness at 80-90 degrees on hot plate. The digest was filtered separately and made up to 50ml mark with distilled water, and ready for elemental analysis with Atomic Absorption Spectrophotometer (SOLAAR 969AA). (Meliville and Welsh, 2001).

Plate 1: Pumpkin leaves harvested in camp2 study site cultivated by the farmers

Plate 2: Pumpkin leaves harvested in control site (Ugep) cultivated by the farmers

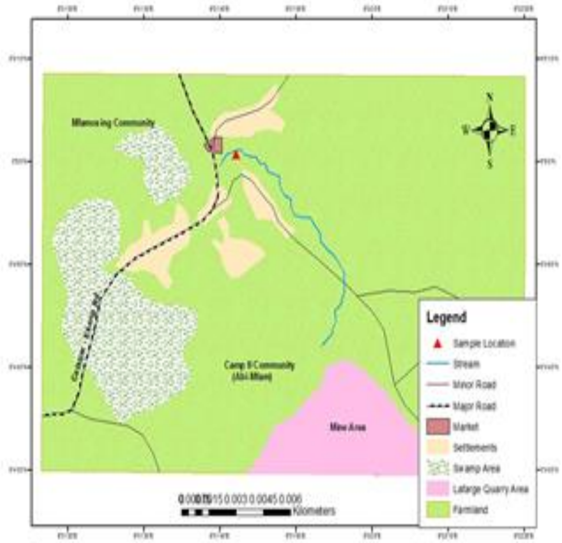

Fig 1: M. 1: Map of camp2 showing the features of the quarry site.

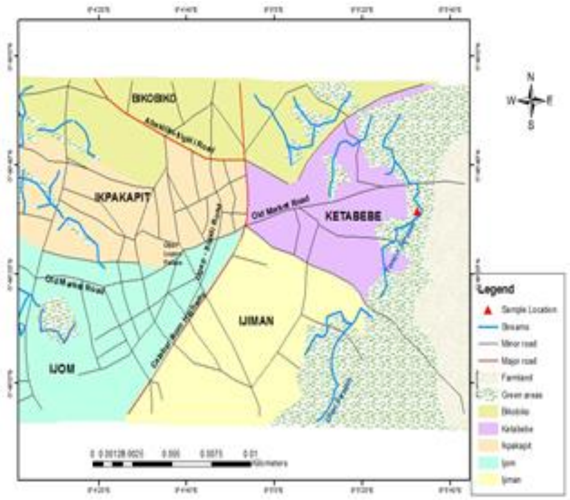

Fig 2: M. 1: Map of camp2 showing the features of the quarry site.

M. 2: Map of the Control Site: Source: Geographic Information System (GIS) Laboratory, Department of Geography and Environmental Science, University of Calabar.

Statistical Analysis: Statistical analysis the recorded data were subjected to one-way analysis of variance (ANOVA) to assess the influence of different variables on the concentrations of heavy metals in the vegetables tested. Statistical significance of means was computed using Pair Samples t-test, with a significance level of $P < 0.0$. Statistical analysis of data was done by SPSS 17.

RESULTS AND DISCUSSION

Table 1 shows the association between the heavy metals in the plant and the soil sample. Cd level in the plant correlate positively with Ni in the soil (r = 0.988**, 0.00). The same observation was recorded for Cd in plant vs Cr in soil (r = 1.000**, 0.012), Pb in plant vs Cd in soil (r = 0.993*, 0.00), Cr in plant vs Cd in soil (r = 0.889*, 0.018), and Cr in plant vs Pb in soil (r = 0.966**, 0.006). Conversely, there were negative correlations between Cd in plants vs Pb in soil (r = -0.936**, 0.006), Ni in plant vs Cd in soil (r = -0.910**, 0.012), Ni in plant vs Pb in soil (r = -0.937**, 0.006), and Cr in plant vs Ni in soil (r = -0.880*, 0.021).

From figure 3, plant sample Cd and Ni levels recorded from the experimental site (AKAMKPA) were significantly ($P<0.05$) higher than that of the control site (UGEP), whereas Pb and Cr level were significantly lower than that of the control site. There was no significant difference in the level of Hg and As recorded from both sites.

In figure 4, soil Ni and Cr levels were significantly ($p<0.05$) higher at the experimental site compared with the control site, whereas the Pb and Cd levels were significantly lower at the experimental site than the control site. No significant difference was observed for Hg and As from both sites ($p>0.05$).

Table 1: Association between the heavy metals in the plant and soil samples

	Correlation Coefficient (r)	p– value
Cd in plant vs Ni in soil	0.988**	0.000
Cd in plant vs Cr in soil	1.000**	0.012
Cd in plant vs Pb in soil	-0.936**	0.006
Ni in plant vs Cd in soil	-0.910*	0.012
Ni in plant vs Pb in soil	-0.937**	0.006
Pb in plant vs Cd in soil	0.993*	0.000
Cr in plant vs Cd in soil	0.889*	0.018
Cr in plant vs Ni in soil	-0.880*	0.021
Cr in plant vs Pb in soil	0.996**	0.000
Cr in plant vs Cr in soil	-0.907*	0.013

**Indicates that data are statistically significant at p < 0.05; **Indicates that data are statistically significant at p < 0.01*

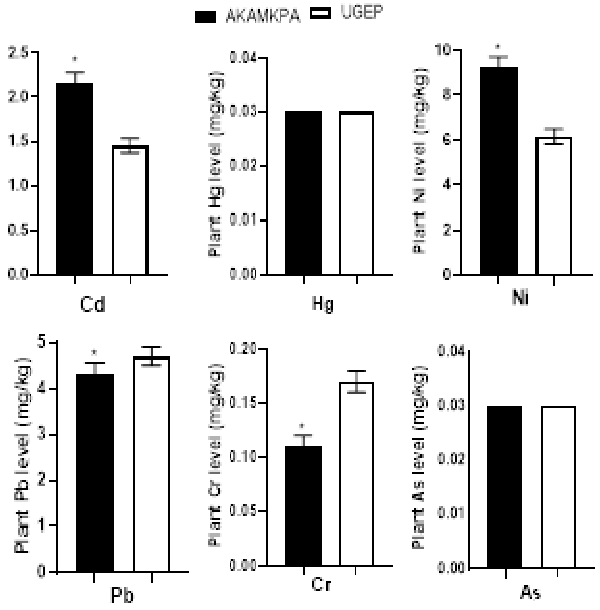

Figure 3: Heavy metal levels in the plant samples collected from experimental site (AKAMKPA) and the control site (UGEP). Bars represent mean ± SD (n=3). Bars with (*) are statistically distinct from the control site.

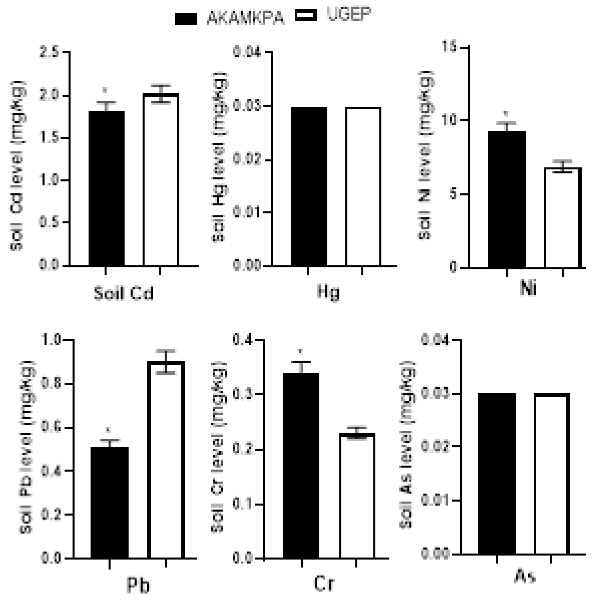

Figure 4 Heavy metal levels in the soil samples collected from experimental site (AKAMKPA) and the control site (UGEP). Bars represent mean ± SD (n=3). Bars with (*) are statistically distinct from the control site.

The heavy metals that are commonly found in plants and soil samples include; Cd, Pb, As, Hg, Cr, Ni, etc. When these heavy metals accumulate in the soil, they severely inhibit the biodegradation of organic contaminants, and then possess a great risk to plants and animals in the ecosystem through direct ingestion of toxicants by animals or contact with contaminated soil. Increase in the concentration of these heavy metals in plants and animals' tissues can lead to varying toxic responses, for instance, Cadmium and Mercury are associated with renal damages and Cadmium can also affect the activity of several enzymes in the body; while Nickel and Arsenic are associated with increased risk of cancer and Chromium is associated with allergic dermatoid in humans (Thomspon and Kelly, 1990). Therefore, evaluating the heavy metals content of plants and soil samples is very essential, especially around quarry site. Vegetables form part of the human diet because they are a source of nutrients such as protein, vitamins, iron, calcium and other nutrients in human health (Marshal, 2004). Heavy metal contamination of food items is one of most important aspects of food quality assurance (Khana and Khanna, 2011). The high concentration of heavy metals (Cd, Ni, and Pb) in both plant and soil samples may be due to anthropogenic factors within these areas, or due to the quarrying activities that has cause the release of metals contaminations within the farmlands. However, cultivating soil within this area close to the quarry site is not advisable as the cultivated plants will be adversely affected by these heavy metals, which may bio-accumulate and become potentially toxic if these plants are ingested by man or animals. Food contamination has been a challenging factor to producers and consumer lives. However, the main sources of heavy metals in vegetable crops are their transfer factors or growth media via soil, air, water and plants from which these heavy metals are taken up by the roots. The impact of heavy metals has also become apparent due to long term consumption of contaminated vegetables. Proper monitoring of heavy metals in vegetables and other food items should be checked to avoid excessive buildup of these toxicants in the food chain (Alan *et al.*, 2003). Vegetables also take up heavy metals in qualities that could result in a lot of clinical problems to the consumers (Bahemuka and Mubofu, 1999). Vegetables grown on heavy metal contaminated sites can accumulate higher amounts of metals than those grown in free uncontaminated sites because of the fact that they tend to absorb these metals through the roots (Mapanda *et al.*, 2005). Heavy metals are persistent in the environment due to their bioaccumulation in food-chains. They are easily accumulated mostly in the edible parts of leafy vegetables as compared to the grains or fruits crops (Alloway, 1997). The rate of heavy metal uptake from the soil to the vegetables could have been affected by other factors such as pH, climatic conditions. And this in turn would affect the content of heavy metals recorded (Cui *et al.*, 2004). Variation in transfer factor may also have contributed to the differences in the element uptake by the vegetables, (Ghosh and Singh, 2004). Lead concentration in the soil at the control site is higher than that of Camp2 site, indicating significant accumulation of the toxic metal in soil. High root to shoot translocation of Pb in this study indicate that *T. occidentalis* have vital characteristic to be used in phyto-extraction of this metal as indicated by (Yoon *et al.,* 2006). Translocation factor, bio-concentration factor and bioaccumulation values had been used to evaluate the potential of plant species for phyto-extraction and phyto-stabilization (Luh and Jones, 2009). The normal and phyto-toxic concentration of Pb were reported by (Srinivas *et al.,* 2009), which were 0.5 – 10 and 30 – 300mg/kg. This present result may indicate that the plants are tolerant of these heavy metals. The observed significant in Pb concentration on *T. occidentis* leaves from the control site and Camp2 site were compared to the report by other researchers. The control site may be attributed to the influence of agricultural activities and industrial effluent in the community. Nickel concentration in the soil and plant were observed to be higher in camp2 village compared with the control site. Although literature shows that Nickel in plant is highly mobile and is likely to accumulate in both soil and plant (Premarathana *et al.,* 2005). Reported that vegetable have more nickel than animal product. According to (Okoronkwo *et al.,* 2005), the acceptable range of nickel daily intake is 3.7mg/kg daily. In this present study the soil and vegetable in the study area Camp2 and the control site were within the reported safe range of 3.7mg/kg. The mean metal concentration of nickel in the vegetable ranged from 3.67±1.41mg/kg to 7.59±1.24mg/kg in *T. occidentalis*. Similarly, (Naser *et al.,* 2009), reported nickel level ranging from 2.3 to 37.80mg/kg in the various vegetable. (Singh et al., 2004). Reported values of between 22.59mg/kg and 24.47mg/kg in the vegetable under study. On the other hand, in Bangladesh reported lower levels of Nickel than those of this study to be within 7.59±1.24mg/kg in soil and plants (ATSDR, 2005). There is also evidence of uptake and accumulation in certain plants (Martin *et al.,* 2003). Intake of too large quantities of nickel by human from plants grown on nickel rich soil has higher chances of inducing the development of cancer of the lung, oxidative stress, birth defects, and prostrate as well as inducing respiratory failures.

Conclusions: Consuming vegetable plants on contaminated environment could bring about negative impact on both animals and human health. Thus, vegetable grown in this communities are deficient in essential minerals due to high level of heavy metal toxicity in the land as resident had no knowledge on the health risks posed by environmental toxicants in food.

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