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CADMIUM UPTAKE BY *TELFAIRIA OCCIDENTALIS* HOOK F. (CUCURBITACEAE) GROWN IN CADMIUM - POLLUTED SOIL

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ABSTRACT

Five seedlings of locally purchased *Telfairia occidentalis* Hook f. (fluted pumpkin) were cultivated in cadmium polluted soils. Leaves of the plant were plucked after 5 weeks of growth from five replicate treatments and an untreated control. These leaves were air-dried, digested and analyzed spectrophotometrically for cadmium. Fifty milligrams per litre (50mg/l) dilution of stock solution of cadmium had mean level of accumulation (± S. E.) of 2.28 ± 1.49 mg/kg while 15 mg/L and 4.5 mg/L gave cadmium levels of 1.96 ± 1.60 mg/kg and 1.25 ± 0.01 mg/kg respectively. Crude protein yields of 86.66 ± 3.30 mg/kg, 87.70 ± 1.89 mg/kg and 88.89 ± 1.93 mg/kg were obtained for the replicate treatments of 50mg/L and 4.5mg/L cadmium respectively. Anova tests showed that the differences between cadmium levels accumulated for control and treatment plants were significant (no overlap in standard error) at 5% level of probability. There were no such significant differences ($P \leq 0.05$) for the amount of crude protein yields when the control was compared to the treatments. *T. occidentalis* therefore poses a threat of cadmium poisoning to the population of the Niger Delta Area where the vegetable is commonly grown and consumed.

Keywords: polluted soils, Cadmium, Anova Test, Niger Delta, *T. Occidentials*

INTRODUCTION

Some enzymes contain metals in their structures and substitution of one of these metal ions by another of equal size and charge inhibits the activity of such an enzyme (El-Ichiro, 1974). Zinc is a metalloenzyme and is known to be substituted by cadmium. Although there are similar chemical properties between the two metals the cadmium containing enzyme does not function properly. Bert and David (1972) demonstrated that adenosine triphosphate, alcohol dehydrogenase, amylase, carbonic anhydrase, peptidase activity in carboxypeptidase as well as aspartate amino-transferase were among the enzymes inhibited by cadmium ions.

When ingested, the effects of cadmium are devastating in humans and animals. Clinical manifestations include high blood pressure, kidney damage, destruction of testicular tissue and destruction of red blood cells (Bryce Smith, 1977). Humans may come in contact with cadmium in various ways. It is used in the manufacture of alloys in electroplating to prevent rusting, in production of dyes and pigments and in production of nickel batteries (Odiete. 1999).

With the increase in industrial activities in the Niger Delta area and the concomitant indiscriminate discharge of wastes, this environment is now loaded with trace metals including cadmium (Shore, 1995; Loez *et al.*, 1995). Discharged wastes are known to be transformed in the environment depending on the nature of the receiving environment. As noted by Udosen (1998) speciation of a metal such as cadmium may occur in a reducing environment resulting in its adsorption to plants.

Therefore, plants may accumulate trace metals and this, according to Rao (1980), is dependent on the inherent qualities of the plant, the content of the trace metal in the soil and location, among other things. Since cadmium is a bioaccumulated trace metal (Odiete, 1999), it follows that if it is accumulated in vegetables widely cultivated and consumed in cadmium – polluted areas, humans who consume these stand a risk of poisoning. One such vegetable is *Telfairia occidentalis* which is commonly consumed and popular among the Niger Delta population. The environmental matrix of this area according to Wegwu (1999) comprises heavy industrialization, high population figures, and indiscriminate discharge of trace metal-containing wastes. Indeed, Obute *et al.*, (2001) have reported that lead is accumulated by *T. occidentalis* grown in such environment.

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We have attempted in this investigation, to ascertain the degree of uptake of this metal by *Telfairia occidentalis* grown in cadmium – polluted soil. The implications of accumulation of the metal on human health will be highlighted.

MATERIALS AND METHODS

Telfairia occidentalis seeds purchased from the fruit market in Port Harcourt were sorted out into batches of equal sizes and weights. From these batches five seeds were randomly selected and germinated in polyethylene bags containing sieved, sterilized soil collected from Choba, in four groups of three replicates.

A stock solution of cadmium (Analytical grade) was prepared from a salt of the metal Serial dilutions of 50ml/L, 15ml/L and 4.5 ml/L were prepared from the stock. These were used to spike three groups of the germinated seeds respectively. The last group was spiked with deionized water only to serve as a placebo. The set was allowed to stand for five weeks with daily watering with the respective spiking solutions.

After five weeks, the leaves (the part mostly eaten) were plucked, air-dried and equal weights from each of the groups were digested and analyzed for cadmium content. A Brick Scientific Atomic Absorption / Emission Spectrophotometer (200A Model) was used for analysis. These samples were further subjected to the Kjeldahl method of crude protein estimation to determine the effects of accumulation of cadmium on protein yield. Results were subjected to ANOVA analysis.

RESULTS

Results showed that *T. occidentalis* progressively accumulated cadmium, with higher soil concentrations giving higher accumulations compared to the control (Table 1). Anova tests revealed that the differences noticed for the various concentrations were markedly significant at $P \leq 0.05$.

The same trend was not observed for the crude protein content of the samples. Table 2 shows that although the higher cadmium concentration yielded lower amounts of protein than the lower concentrations, this trend appeared not to be linear. At 15mg/L cadmium the amount of protein yielded was the least of the treatment samples. Analysis of variance, however, showed that the differences observed in the amounts of crude protein were not significant ($P \leq 0.05$).

Table 1. Mean (± S.E.) levels of Cadmium accumulated by *T. occidentalis* leaves.

Treatment mg/L	Mean Accumulation / Range ± S.E.**
Control	$1.25^{a} \pm 0.01$ (0.53 – 1.5)
4.50	$1.57^{b} \pm 0.49$ (0.73 – 3.3)
15.00	$1.96^{c} \pm 0.60$ (0.42 – 2.69)
50.00	$2.28^{a} \pm 1.49$ (1.45 – 3.62)

* Values with different superscripts are significantly different $P \leq 0.05$.
**Values are means of five replicates.

Table 2. Mean (±S.E.) Levels of Crude protein following treatment with different concentrations of Cadmium.

Treatment with Cadmium (ml/L)	Mean Crude Protein yield (mg/kg) ± S.E**
Control	$95.57^{a} \pm 1.86$ (90 – 105)
4.50	$88.89^{a} \pm 1.93$ (86.66 – 90.00)
15.00	$87.77^{a} \pm 1.89$ (86.66 – 90.00)
50.00	$86.66^{a} \pm 3.30$ (83.33 – 90.00)

* Values with the same superscripts are not significantly different ($P \leq 0.05$).
**Values are means of five replicates.

DISCUSSION

Although the Federal Environmental Protection Agency (FEPA) allowed limits of cadmium in the soil are not listed, that for discharge into surface water is < 1ml/L. The level in the soil spiked with deionised water was 1.25mg/L. this presupposes that the soil was already highly polluted with cadmium. It means that *T. occidentalis* produced from such soil may already have accumulated this trace metal in high amounts. However, as shown in Table 1 there was progressive increase of the accumulation with increase in the exogenous levels of cadmium which is instructive as to the high risk the population of Choba is exposed to in this trace metal. With further industrialization in this environment there is an expected rise in the levels of the metal that would impinge on the environment. With the submissions of Bryce-Smith (1977) on the effects of cadmium poisoning on humans, the threat posed already cannot be wished away.

Nonetheless, *T. occidentalis* appears to still do well in this environment. Obute *et al.*, (2001) suggested a maximum threshold beyond which it appears that *T. occidentalis* stops accumulating lead (another trace metal). Such an observation is probably not applicable in the case of cadmium since it appears that the higher the soil concentration the higher the accumulated amount.

Another surprising trend was in the proximate crude protein yielded by these concentrations. As shown in Table 2, there was reduction of protein yield with increase in the concentration of cadmium in the soil. However, statistical analysis revealed that such differences based on cadmium concentrations were not significantly different ($P \leq 0.05$). It follows that the differences were probably by chance and chance alone. The implication of such results is that despite the bioaccumulation of cadmium in *T. occidentalis* the plant's metabolic processes may not be adversely affected. There probably is a sequestering mechanism innate in the plant for this purpose. This may explain why the plant still does well in this environment. On the contrary, this assertion cannot be extrapolated to the humans and animals that consume the plant leaves. Our results here highlight the need for the industries to treat and remove all trace metals in their wastes and effluents before discharging into the environment.

It may be concluded that cadmium is bioaccumulated by *T. occidentalis* (a popular vegetable consumed in the Niger Delta area). While the metal appears not to interfere with the metabolism of the plant, its bioaccumulation still poses a big threat of cadmium poisoning to the population in this area.

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