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Evaluation of Cyanide and Heavy Metal Absorption from Cassava Processing Waste Water by Pumpkin Leaf

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Abstract
This study investigate if cyanide and heavy metal concentrations from cassava processing effluent could be absorbed by pumpkin plant and then retained in pumpkin leaf to a level above safe limit by WHO/FAO for human consumption. In this work, soil was obtained, conditioned to have same profile and then kept in two sets of containers. Pumpkin was planted in these sets of containers. One set was used as control and the second set used in watering the pumpkin with cassava effluent. The control was watered with effluent free water. The pumpkin at maturity was tested for cyanide and heavy metal concentrations (zinc, copper, nickel, lead, iron and chromium). The result showed all parameters except zinc, had values above WHO/FAO safe limit. Therefore, effluent affected pumpkin if consumed by human could pose health challenge.
Keywords: *Pumpkin, Cyanide, Heavy metal, Cassava effluent, Soil.*

1. Introduction

Apart from cassava being a staple food in many African countries, it is also used as livestock feed particularly for monogastrics. Its usage in most agro-industry is common because of having high content of level of non-starch polysachlaride (NSP). The NSP includes cellulose, pectin, hemicellulose, and lignin. Cassava by-products are high in components such as hydrogen cyanide (HCN), polyphenols (tannins) and phyate and low in proteins. The effect of these components on the animals may include low digestibility, reduction in the performance of animal and poor intake of feed (Alawa and Amadi, 1991; Adegbola and Oduozo, 1992; Banjoko *et al.*, 2008; Iyayi *et al.*, 1997). In Nigeria today, 15 million tons of cassava are used for processing of cassava fermented product. The roots are normally peeled to get rid of the outer coverings; and nearly every community depends on it as a source of food. Cassava is used in the production of garri and fufu when fermented. Metcalf and Eddy (2004) stated that odour in fermented cassava wastewater is offensive. Cassava effluent with low odour concentration may not necessary harm the human body but may cause physiochemical stress to human, poor appetite to cassava consumption as food, impaired respiration etc. When cassava is processed after harvesting, the fermented water from cassava processing is poured on the soil environment without proper treatment especially in the rural areas. These fermented cassava water (wastewater) are also known as effluents. The amount of cassava waste produced in a day depends on the processing method used. The toxic compound in cassava is the cyanide. Generally, cyanide could be used in producing insecticide, synthetic rubber, rodenticides, fumigant, paint finishing, perfume, bleaches, riot control agent, weedicides, dyes, cement, pigment, fertilizer, etc. Pumpkin can cause increase in antioxidant capacity and iron bioavailability (Irwin, 1997; Dias *et al.*, 2005).

It has been suggested that pumpkin flour could be used as an emulsifier because of its affinity for oil. Pumpkin seeds are deficient in sulphur containing amino acids (cysteine and methionine), but has a higher content of rare amino acids such as citrullin, carboxyphenylainine, B-pyrazolalanine, y-aminobutyric acid and ethylasparagine (Fruthwirth and Hermetter, 2007; Noor and Komath, 2009). Trace amount of vitamins A and E, and other minerals like potassium, magnesium, calcium, zinc, iron, selenium, copper and molybdenum, have been detected in pumpkin seeds. High enough levels of iodine and selenium were measured in pumpkin seeds to cover the recommendation daily value for adults. The pumpkin seeds contain also fatty acid, crude protein, oil and fibre, etc.
The recommended threshold level of some elements for the production of crop is presented in Table 1.

Table 1: Threshold Acceptable Levels of Some Trace Elements in Crops (FAO, 1985)

Symbol/ (Element)	Maximum Acceptable Concentration (mg/l)
Cd (cadmium)	0.01
Co (cobalt)	0.05
Cr (chromium)	0.10
Ni (nickel)	0.20
Zn (zinc)	2.00

Research work has less emphasis on the effects of cyanides to humans when these crops are consumed. It is therefore a matter of importance to evaluate the effects of the concentration of heavy metal and cyanide from cassava waste water; in view of the fact that they are discharged untreated on the soil, near homes where cassava is being processed, and might have effect on agricultural plants such as pumpkin (*Telferia occidentalis*) commonly grown near homes on cassava effluent soil of which easy access for consumption is the primary aim of planting.

2. Materials and Methods

2.1 Materials and Equipment

Raw material used was pumpkin (*Telfena occidentalis*). The apparatus involved in this study were burettes, pipettes (1 ml, 10 ml, 25 ml), mercury-in-glass Celsius thermometer, pH-meter (HACH model), water-checker, conical flasks, beakers, white polyethylene bottles, steam bath, oven, desiccator, emission-photometer (FEP), Atomic absorption spectrophotometer (AAS) and Unicam 8625 UVVIS spectrometer.

2.2 Methods

(i) Determination of Cyanide

5 g of sample was made into a paste by grinding. 50 ml of distilled water was used to dissolve the paste and then corked in a conical flask. The extract was filtered after keeping it overnight. A test tube was used to pour in 1 ml of the filtered sample; then 4 ml of alkaline was added and subjected to incubation for 5 minutes in a bath until reddish brown colour was developed. Also, a blank was prepared using 1 ml of distilled water and 4 ml alkaline. A spectrophotometer at 490 nm was used to read the absorbance. The cyanide concentration was obtained by using a prepared cyanide standard curve developed from a mixture of 5 – 50 mg KCN and 25 ml of 1N HCl.

(ii) Determination of Heavy Metal Concentrations

The heavy metal concentrations were carried out based on APHA (1998).

(iii) Experimental Procedure

The soil was obtained and conditioned by testing and ensuring that it had same profile; before it was transferred into six containers for planting of the pumpkin (*Telfena occidentalis*) purchased from a local market. The untreated effluent from cassava processing to be used in watering the plant was collected and its physicochemical properties analyzed following standard method of APHA (1998). Out of the six containers, three were used as control by watering using effluent free water and remaining three were watered with the untreated cassava effluent. Pumpkin leaf at maturity was tested for the physicochemical properties earlier tested in the waste water from cassava processing. These include cyanide and heavy metal concentrations such as copper, zinc, nickel, chromium, lead and iron. The data obtained were analyzed using statistical software packages such as Statistical Package for Social Scientists [SPSS] (2011) and Microsoft Excel ^{TM}.

3. Results and Discussion

The values of cyanide/ heavy metals concentrations in the pumpkin leaf are presented in Figure 1. These values were compared with the control alongside WHO/FAO safe limits (WHO, 2000; FAO, 1985).

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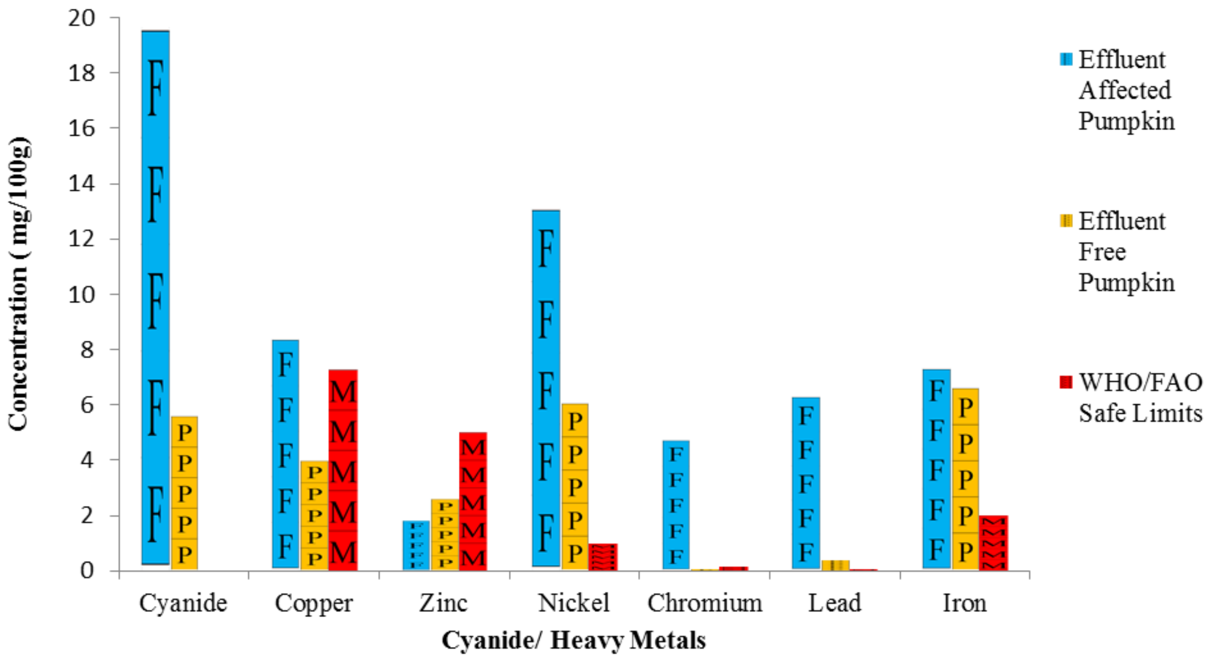

Fig. 1: Bar showing cyanide/heavy metal concentrations in both effluent affected and effluent free pumpkin (control).

From Figure 1, the concentration of cyanide in effluent affected pumpkin leaf was higher than effluent free pumpkin leaf. The observed content of cyanide in effluent affected pumpkin leaf may be detrimental to human and livestock health. Cyanide has the tendency to form complexes thereby inhibiting the activities of enzymes. Cu is a micronutrient that acts as biocatalyst; and is required for the pigmentation of the body apart from Fe. It prevents anaemia and also maintains in the body central nervous system that is healthy. Concentrations of copper in effluent affected pumpkin leaf recorded the highest value when compared to that of the control and WHO/FAO safe limits (7.3 mg/ 100 g). Effluent affected pumpkin leaf recorded 8.38 mg/100g while effluent free pumpkin leaf recorded 3.97 mg/100g. The observed value in effluent affected pumpkin leaf may pose health challenge. In vegetables, high concentration of Zn could cause renal damage, vomiting, cramps, etc. When vegetables are consumed regularly, it can prevent deficiency of zinc and so minimize any associated adverse effect in not having adequate Zn. This effect may include retardation of growth, synthesis of protein and delaying of sexual maturation (Akinyele and Osibanjo, 1982; ATSDR, 1994; Barminas *et al.*, 1998). Concentration of zinc in effluent affected pumpkin leaf was lower than that of the control but within WHO/FAO safe limits (5.0 mg/ 100 g). Effluent affected pumpkin leaf had 1.81 mg/100g while effluent free pumpkin leaf recorded 2.62 mg/100g. Nickel is considered to be an essential element that could have influence on the health of human and animal. Concentration of nickel in effluent affected pumpkin leaf recorded the highest values when compared to that of the control and WHO/FAO safe limits (1.0 mg/ 100 g). Effluent affected pumpkin leaf had 13.12 mg/100g while effluent free pumpkin leaf recorded 6.10 and mg/100g. The observed value may be detrimental to the health of animal and human beings.

Concentration of chromium in effluent affected pumpkin leaf recorded the highest value when compared to that of the control and WHO/FAO safe limits (0.13 mg/ 100 g). Effluent affected pumpkin leaf 4.75 mg/100g while effluent free pumpkin leaf recorded 0.072 mg/100g. Chromium if taken in excess from foodstuffs can result in its accumulation in human kidney and liver; cause the disruption of some biochemical processes that may lead to kidney, bone, nervous and cardiovascular, diseases. The observed concentration may pose health problem to human. Concentration of lead in effluent affected pumpkin leaf recorded the highest value when compared to that of the control and WHO/FAO safe limits (0.03 mg/ 100 g). Effluent affected pumpkin leaf had 6.30 mg/100g while effluent free pumpkin leaf recorded 0.357 mg/100g. Lead is a soil contaminant and in human being it will accumulate with time in bones, liver, aorta, spleen and kidney. It may enter into the human body to attain 65%, 15% and 20% as a result of uptake of food, air and water, respectively; it can cause severe health problem. Concentration of iron in effluent affected pumpkin leaf recorded the highest value when compared to that of the control and WHO/FAO safe limits (2.0 mg/ 100 g). Effluent affected pumpkin leaf had 7.33 mg/100g while effluent free pumpkin leaf recorded 6.62 mg/100g.However, excess quantity of iron may cause increase in the rate of pulse, blood coagulation, drowsiness and hypertension (Afzal *et al.,* 2011; Ghani, 2011). The observed value in effluent affected pumpkin leaf may cause health challenge.

4. Conclusions

The cyanide and heavy metal (Cu, Fe, Cr and Ni) in cassava processing effluent were absorbed and retained by the pumpkin grown on effluent affected soil. The concentrations of these parameters were found to be more than acceptable limit by WHO/FAO for consumption by human; hence could pose health challenge.

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