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Research Paper

The Influence of Cyanide and Heavy Metal Concentration from Cassava Processing Waste Water on Maize

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ABSTRACT: This study attempts to find out if heavy metal concentration and cyanide from untreated cassava waste water when discharged on land where maize plants are grown could get accumulated to an extent that may likely pose challenge to human when the maize grains are eaten. In this study, soil samples were taken and conditioned to have same profile. The conditioned soil samples were divided into two sets with each set in three different containers. One set was the control watered with effluent free water and the second set watered using cassava effluent water. The maize plants when matured were harvested and analysis carried out on these two sets of maize for cyanide and heavy metal concentrations. Result revealed that the concentration (2.93 mg / 100 g of zinc and 6.16 mg /100 g of copper were lesser than WHO/FAO safe limits (5.0 mg / 100 g), 7.3 mg /100 g, respectively. The rest [cyanide (7.41 mg / 100 g), nickel (7.24 mg / 100 g), chromium (2.57 mg /100 g), lead (4.51 mg / 100 g) and iron (2.83 mg /100 g)] were higher than the WHO/FAO safe limit. Maize recorded the concentration of heavy metal in this order: Ni > Cu > Pb > Fe> Cr > Zn. Therefore, cassava effluent water should be treated before discharged or avoided on land where maize plants are grown; so as to minimize health challenges when eaten by human.

KEYWORDS: Cassava effluent, Cyanide, Heavy metals, Maize, Soil.

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I. INTRODUCTION

Cassava is the most widely distributed major food crop with a high contents of cyanogenic glycosides. It is also known as manioc (*Manihots esculentz*), yucca tapioca, or guacamate. Cassava has high content of carbohydrate. Cyanide in cassava contains 1 mg/g cyanide while cereal and grains contains cyanide of 0.001 to 0.45 µg/g, and 0.07 to 0.3µg/g for soya proteins. It is toxic to human and is a substance that is formed in combination with other chemicals in the environment. Hydrogen cyanide liquid is colourless and its characteristic odour is similar to that of bitter almond. It is miscible in water. Since cassava contains anti-nutritional factors and toxins, it therefore requires proper preparation for consumption to avoid the residual cyanide from causing acute cyanide intoxication, death or partial paralysis [1, 2]. However, organic cyanide salts are often used in metallurgical industrial activities such as metal surface treatment; and also in mining industries (example is gold extraction) which consume large amount of water and the effluents always contains cyanide that must be treated before disposal to the natural environment. Cassava wastewaters are generated in large quantity because cassava are used for several purposes like food for man and utilized extensively for industrial purposes too as it can be used in production of plywood, sweetness, monosodium glutamate, adhesives, alcohol, paper, amino acids, etc. In processing cassava, the major problem is disposal of wastewater because of the high content of cyanide, which varies due to some factors such as: plant varieties, edaphics, climatic and other conditions. The cyanide present in cassava can be characterized as bitter or sweet according to the amount cyanide present. The content of cyanide in cassava is in form of glycoside that is linamarin (98%) and lotaustralin (7%) [3, 4, 5, 6].

Waste water is an inevitable substance released during cassava starch processing. They are either a by-product of initial production or they arise when the cassava tubers are indiscriminately discharged to a nearby water body. The waste water contains cyanide and the most serious problem of cyanide itself is it's potentialities of poisoning drinking water when trapped in the ground. The effluent water also contains some heavy metals which may be detrimental to human health due to its accumulation in some organs [7, 8]. It is of importance in

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this research to know the extent of retention of this harmful chemical on edible plant such as maize grown in the environment where the waste effluents from cassava processing is disposed of. Maize is a cereal food grain that is produced in Africa and many other countries of the world. It contains mineral, protein, sugar, oil, vitamins B and vitamin E [9, 10]. About 98% of starch in maize is located in Endosperm. The nutritional properties of maize may change depending on the type of process used and such process includes cooking, refinement, supplementation, etc. Generally, diet changes if rapid may affect the composition of the body positively or negatively. Some positive aspects include the decrease in the mortality of infant, under nutrition, stunning and wasting. The negative aspect could be associated with obesity, cardiovascular disease, etc.

The raw starch granules from cassava and maize may affect the extent of in vitro digestion by bacterial α-amylases and fungal amyloglucosidase. The different sizes of raw starch granules from maize and cassava when examined suggest that as the granules become smaller, the extent of in vitro digestion by fungal amyloglucosidase and bacterial α-amylasesbecome more [11]. The composition of maize has been reported by various researchers [12]. In conventional irrigation, the water may have trace element that may be ignored. However, in using waste water especially from cassava processing outfit, if not treated before disposal on land may likely affect the quality of the plant that absorbed such effluent. The recommended thresholds of some trace elements in crops have been reported by FAO [13]. Therefore, it is imperative to attempt to find if the discharge of untreated cassava effluent on land area where maize plants are grown would cause accumulation of cyanide and heavy metal concentration from the effluent on the maize. The accumulation of these metals and cyanide at a higher percentage in the maize could on consumption cause health challenges on human and perhaps animals.

II. MATERIALS AND METHODS

2.1 Materials and Equipment

Raw material used was maize (*Zea mays*) in this study. The apparatus employed 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) Preparation of Cassava Effluent for Heavy Metal Concentration and Cyanide Determination

10 ml of cassava effluent sample was measured and poured into a digestion flask. 10 ml of aqua regia acid was added to the sample and then heated for one (1) hour using a hot plate. The digested sample was thereafter cooled and transferred into 100 ml volumetric flask. Distilled water was used to make up the volume to 100 ml. Atomic absorption spectrophotometer was used to determine the concentrations of heavy metals in the digested sample. The procedure was repeated for water sample as control.

(ii) Preparation of Maize for Heavy Metal Concentration and Cyanide Evaluation

Effluent affected maize was harvested and washed using distilled water to remove any suspended particle. The maize was oven dried for 24 hours at temperature of 70^0C after the leafy stalk was removed. Two (2) grams of maize was grounded in a pestle and mortar. The ground sample was digested using HNO_3 and H_2O_2 in a 3:1 ratio. The digestion of the sample was carried out in a hot plate operated at temperature of 93^0C. The heating was carried out in manner that would not allow the sample mixture to boil. When the sample got dried and had s dry mass that was whitish brown in colour; the sample was then cooled. The digested sample was mixed with a 3:1 ratio of HCl and distilled water solution. The digested mixture was filtered using Whatman filter No.42; and the filtrate analyzed for cyanide content and concentration of heavy metal such as zinc, nickel, chromium, lead and iron using atomic absorption spectrophotometer. The same procedure was repeated for effluent free maize samples.

(iii) Procedure

Maize –sweet corn (*Zea mays*) *saccharat strut* was purchased for planting in containers. The soil used for the planting of the maize in the container was conditioned to enable the soil in each container to have the same profile. Six containers were used out of which three was used as control. The other three were watered using cassava processing effluent. The effluent and soil physicochemical properties were determined on the completion of the experiment, the matured maize was harvested and determination of its cyanide and heavy metals contents were carried out. The cyanide content and heavy metal concentration in the maize and effluent water were carried out using Wang and Filled method and APHA method, respectively [14, 15, 16].

2.3 Data Analysis

The experimental data were analyzed using dedicated statistical software package such as Microsoft Excel TM. Descriptive statistical tool such as bar chart which is inherent in this software package was used to discuss the results obtained.

III. RESULTS AND DISCUSSION

Cyanide/ Heavy Metals Concentrations in Crops

The values of cyanide and heavy metals concentrations in the maize were compared with the control alongside WHO/FAO safe limits [17, 13] and is presented in Figures 1.

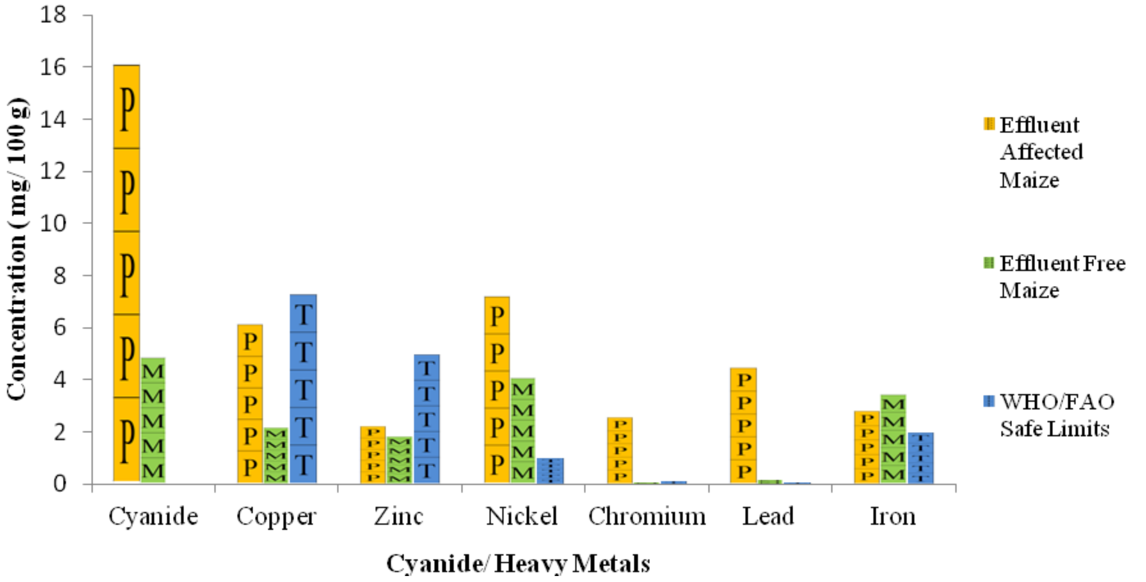

Figure 1: Bar chart showing cyanide/heavy metal concentrations in both effluent affected and effluent free maize (control)

From Figure 1, the concentration of cyanide in effluent affected maize was higher than effluent free maize. Maize had cyanide content of 17.41 mg /100g. Cyanide has the tendency to form complexes thereby inhibiting the activities of enzymes. The observed content of cyanide in effluent affected maize may be detrimental to human and livestock health.

Concentration of copper in effluent affected maize recorded lowest value when compared to that of the control and WHO/FAO safe limits (7.3 mg/ 100 g). Effluent affected maize recorded 6.16 mg/100g while effluent free maize recorded 2.19 mg/100g. Heavy metal such as Cu acts as a biocatalyst and could prevent anaemia and may help in the maintenance of central nervous system if present in acceptable values by WHO. The observed value in effluent affected maize may not pose health challenge.

Concentration of zinc in effluent affected maize was higher than that of the control but lesser than WHO/FAO safe limits (5.0 mg/ 100 g). Effluent affected maize had 2.21 mg/100g while effluent free maize recorded 1.84 mg/100g. However, Zn is required to assist the immune system to function. Therefore, it is detrimental to have Zn deficiency in diet. The Zn dietary allowance recommended is 15 mg/day and 12 mg/day for men and women, respectively [18].

Nickel is an essential trace element required to enhance the health of man and animal. Concentration of nickel in effluent affected maize recorded the highest value when compared to that of the control and WHO/FAO safe limits (1.0 mg/ 100 g). Effluent affected maize had 7.24 mg/100g while effluent free maize recorded 4.11 mg/100g respectively. The observed value may be detrimental to the health of animal and man.

Concentration of chromium in effluent affected maize recorded the higher value when compared to that of the control and WHO/FAO safe limits (0.13 mg/ 100 g). Effluent affected maize had 2.57 mg/ 100g while effluent free maize recorded 0.053 mg/ 100g respectively. Excess intake of chromium by human could cause kidney and liver to accumulate it. The chronic accumulation of this metal could disrupt some biochemical process that may lead to disease of nervous, cardiovascular and kidney system. The observed concentration may pose health problem to human.

Concentration of lead in effluent affected maize recorded the highest value when compared to that of the control and WHO/FAO safe limits (0.03 mg/ 100 g). Effluent affected maize had 4.51 mg/100g while effluent free maize recorded 0.160 mg/100g. More so, the concentration of lead in plant tends to increase with increase soil lead. It can cause diseases of bones, aorta, liver, spleen, kidney, etc.

Concentration of iron in effluent affected maize recorded the highest values when compared to that of the control and WHO/FAO safe limits (2.0 mg/ 100 g). Effluent affected maize had 2.83 mg/100g while effluent free maize recorded 3.47 mg/100g. When the intake amount of iron is in excess, it could cause increase in the rate of pulse and may also cause blood coagulation, drowsiness and hypertension. The observed value in effluent affected maize may cause health challenge.

IV. CONCLUSION

The high percentage of some major heavy metal concentration (Ni, Cr, Pb and Fe) and cyanide accumulated in maize watered with cassava waste water may pose health challenge(s) based on WHO/ FAO safe limit if the maize grains are consumed by human.

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