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# Effects of Organic Chelates on Hydrogen Cyanide Reduction in Cassava *(Manihot esculenta* Crantz)

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***Abstract***
*The study investigated the potentials of organic chelates used in enhancing micro nutrients in cassava to reduce the cyanide concentration in cassava Root. The study used EDTA as standard chelate, Bontera as a commercial organic chelate and periwinkle effluents (PE) and Smoke Solution (SS) as local organic chelates. The cultivars used were TME419 and TMS3168/UMUCASS/36 also known as YELLOW ROOT (YR). One hundred (100ml) of 100µg of zinc obtained from zinc oxide and 100µg of iodine obtained from potassium iodide were added separately and combined to 5000ml each of deionized water, 1ml/L Bontera, 1ml/L EDTA, Periwinkle effluents and Smoke solution. The treatments were applied through foliar application at 3 months after planting, repeated 3 weeks later and 7 months after planting. From the results obtained, it indicates that to reduce hydrogen cyanide concentration in cassava using chelates; EDTA did better among the inorganic chelates used, followed by EDTA + ZnO followed by KI + ZnO, then by EDTA + KI +ZnO followed by ZnO followed by KI and the least was combination of EDTA and KI. While the organic chelates that performed best was periwinkle effluents, followed by Bontera and the least among them was Smoke solution. When organic and inorganic sources were combined; BT+ ZnO performed best followed by PE + KI, BT +ZnO, PE +ZnO, SS + ZnO, SS+ KI+ ZnO, PE+ KI+ ZnO and least performed BT+ KI+ ZnO. The study also revealed that organic chelates have the potential of reducing hydrogen cyanide in cassava plant.*

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## I. Introduction

Cyanides are poisonous chemicals found in cassava. It is toxic if the cassava is not properly prepared to eliminate it. Cyanogens are found in 3 forms in cassava; cyanogenic glucoside (95% linamarin and 5% lotaustratin), cyanohydrins and free cyanide (Poulton, 1988). Sweet cassava contains less than 50ppm hydrogen cyanide, while bitter cassava may contain up to 400ppm (Wheatley *et al.*, 1993). Cyanogenic glycosides are reduced to release poisonous hydrogen cyanide (Poulton, 1988). Cyanide poisoning can cause impairment of thyroid gland and nerve function and can also lead to paralysis and damage of organs. In humans, the acute lethal dose of hydrogen cyanide ranged from 0.5ppm to 3.5ppm of the body weight (Kwok, 2008). Chronic cyanide intoxication may lead to the development of certain uncomfortable conditions including disturbance of thyroid functions and neurological disorder (Kwok, 2008). High cyanide concentration increases the effects of iodine deficiency induced infections. According to Cardoso *et al* (2005), flour produced by heap fermentation reduced cyanide concentration to 12.5- 16.5%, while retention in processed root (garri) is 1.8 – 2.4%. But this level is still poisonous enough to harm human health among those that consumes/mostly cassava resulting from poverty and what they produce. Since cassava is a major staple food crop that feeds large populace in the world; number fifth crop that feeds the world (Reddy, 2008) and number one in Nigeria (Ikuli and Akonye, 2019), it is therefore necessary to look for better ways to eliminate or reduced cyanide concentration to the barest minimum that can be utilized for a better healthy life.

The objective of the study is to determine the potentials of natural chelates to reduce cyanide concentration in cassava.

## II. Materials And Methods

**Land Preparation and Plot Layout** The research was conducted at University of Port Harcourt, University Park, Port Harcourt Latitude $4^{o}\ 54^{1}\ 33^{11}$ N, Long. $6^{o}\ 54^{1}\ 39^{11}$ E and Lat.$4^{o}\ 54^{1}\ 30^{11}$ Long.$6^{o}\ 54^{1}\ 32^{11}$ E from December, 2017 to December, 2018.

**Land Preparation and Plot Layout**
A total land area of 1062$m^2$ was cleared, ploughed and was partitioned into 60 plots. The plot size is 2m x 5m with twenty (20) treatments and three replicates. The distance in-between treatment is 1m and replicates 1.5m apart. Treatments were arranged in a Randomized Complete Block Design (RCBD).

**Planting Material and Planting**
Cassava (*Manihot esculenta* Crantz) stem cuttings TME 419 and TMS3168/UMUCAS/36 (Yellow root; PRO-vitamin A) were obtained from the University of Port Harcourt, Faculty of Agriculture Teaching and Research Farm.

**Treatment Material**
Ethylenediaminetetra-acetic acid (EDTA), Potassium iodide (KI), Zinc oxide (ZnO), Hydrochloric acid (HCl) and Nitric acid were obtained from BENERCO Enterprise Alakahia, Port Harcourt, Rivers State.
Bontera; A microbial soil enhancer was obtained from Organico, A division of Amka Products in South Africa was used as a commercial organic chelate.
Smoke solution used as local organic chelate was locally prepared from dry wood particles
Periwinkle extract used as local organic chelate 2 obtained from Omuchiolu Aluu Local market

**Treatment Preparation**
1. First the glass wares were treated with HCl to remove all trace of iron and contaminants in it.
2. Zinc oxide and potassium iodide used as zinc and iodine fertilizers were diluted to 100µg of zinc and iodine concentration fortifying solutions were prepared in the following steps:

**ZnO**
1. Zinc oxide (ZnO) weighing 6.23 was dissolved in 20ml nitric acid, added deionized water to 1000ml level (solution A):
2. Five millilitres(5ml) of solution A was diluted in 1000ml of deionized water (solution B):
3. Ten millilitres (10ml) of solution B was further diluted in 100ml of deionized water to give 1ml = 100µg (solution C).
4. One hundred millilitres (100ml) of solution C was added to 5000ml each of deionized water, 1ml/L Bontera, 1ml/L EDTA, Periwinkle effluents and Smoke solution.

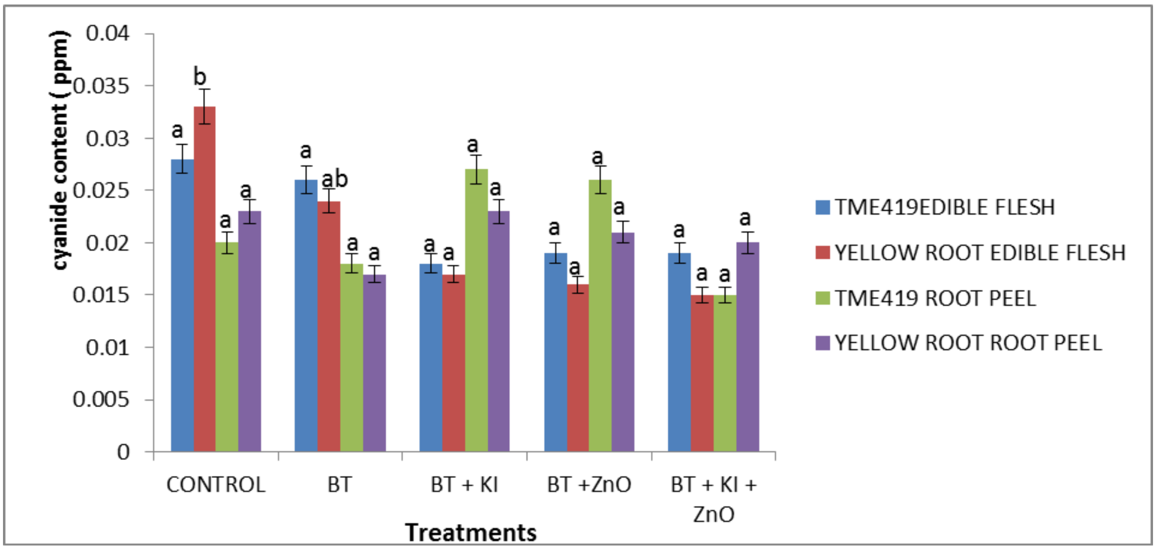
**KI**
1. Potassium iodide (KI) weighing 6.541g was dissolved in 500ml of redistilled water and diluted to 1ml = 10mg of iodine (solution A):
2. Ten millilitres (10ml) of solution A was diluted in 100ml of redistilled water to get 1ml = 1mg (solution B):
3. Ten millilitres (10ml) of solution B was diluted in 100ml of redistilled water to give 1ml = 100µg (solution C).

One hundred millilitres (100ml) of solution C was added to 5000ml each of deionized water, 1ml/L Bontera, 1m/L EDTA, Periwinkle effluents and Smoke solution.

**Treatment Application**
The prepared treatment solutions were applied through foliar application with the aid of a snack sprayer on the planted plants at early Tuberization and bulking stage of the plant development .i.e. the third month after planting and repeated application after three weeks.
Application was repeated on the 7$^{th}$ month (Late Tuberization and bulking stage of the plant).
The method of Essers *et al* (1993) was adopted to determine the cyanide concentration.
SAS Software (2012) was used for the statistical analysis.

## III. Results And Discussions

Organic chelates reduced hydrogen cyanide content in cassava roots in almost all the treatments. From the results obtained, it indicates that to reduce hydrogen cyanide concentration in cassava using chelates; EDTA is the best, followed by EDTA + ZnO followed by KI + ZnO, then by EDTA + KI +ZnO followed by ZnO followed by KI and the least among the inorganic sources was combination of EDTA and KI. While the organic chelates that performed best was periwinkle effluents, followed by Bontera and the least among them was Smoke solution. When organic chelates and inorganic sources were combined; BT+KI performed best followed by PE + KI, BT +ZnO, PE +ZnO, SS + ZnO, SS+ KI+ ZnO, PE+ KI+ ZnO and least performed BT+ KI+ ZnO.




Blocks with like alphabet(s) are not significantly difference at 0.05level of probability

**Figure 1: Hydrogen Cyanide (ppm) in the edible flesh and root peel of Cassava Treated with Bontera (BT), BT + KI, BT +ZnO, BT + KI + ZnO**

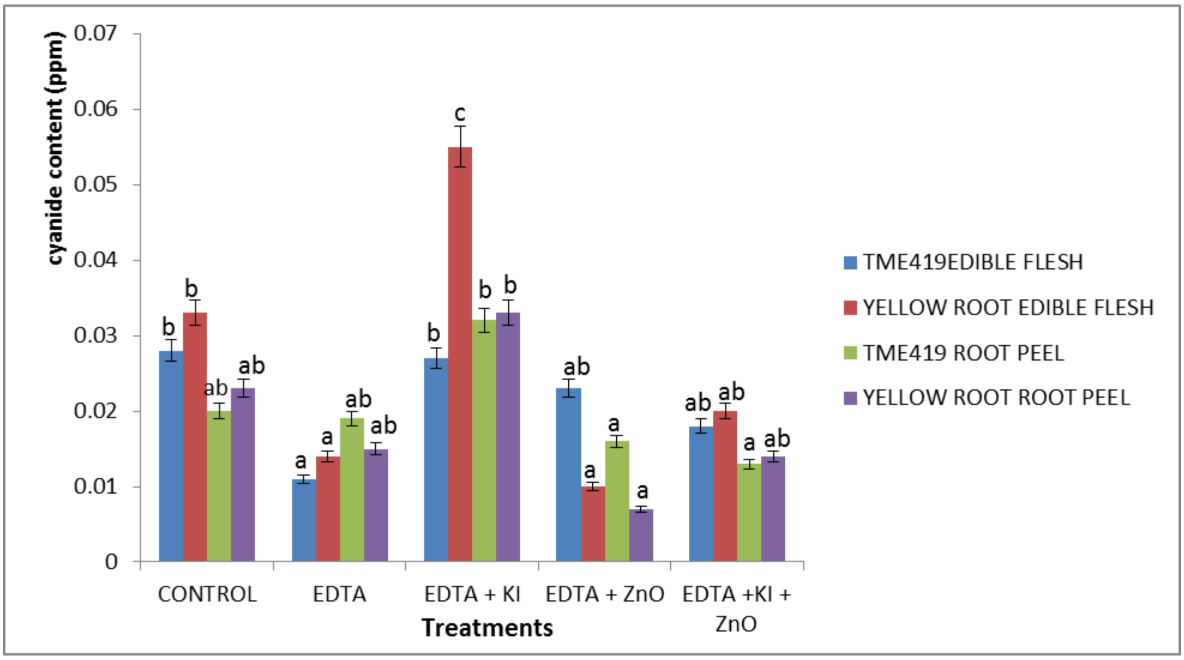



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**Figure 2: Hydrogen Cyanide (ppm) in the edible flesh and root peel of Cassava Treated with EDTA, EDTA + KI, EDTA +ZnO, EDTA + KI + ZnO**

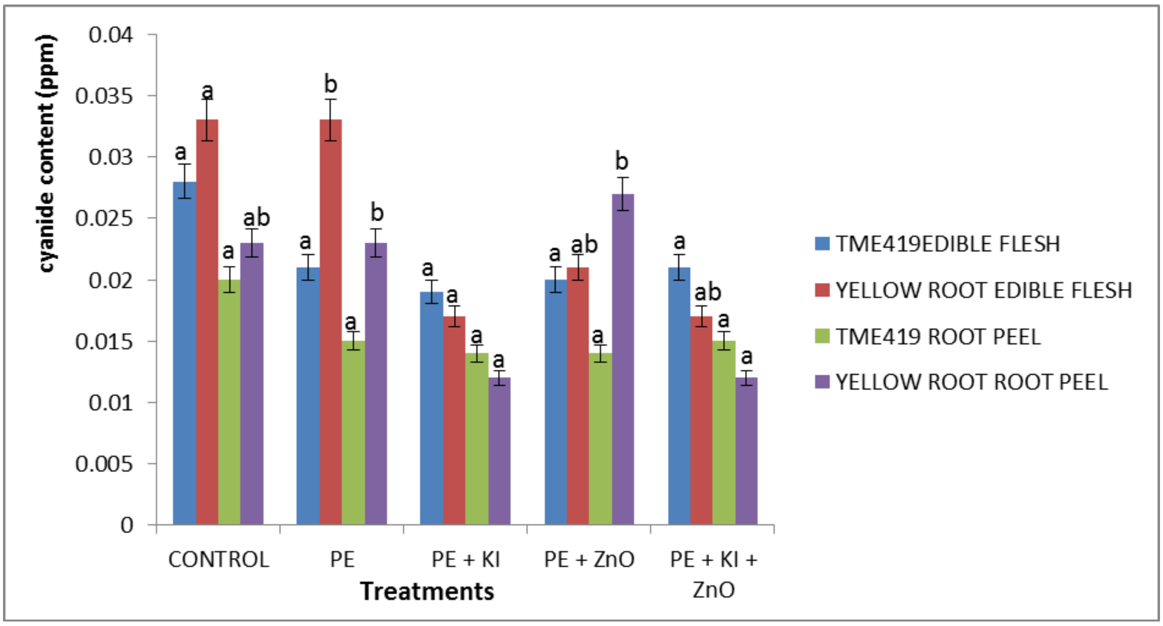


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**Figure 3: Hydrogen Cyanide (ppm) in the edible flesh and root peel of Cassava Treated with Periwinkle Effluents (PE), PE + KI, PE +ZnO, PE + KI + ZnO**

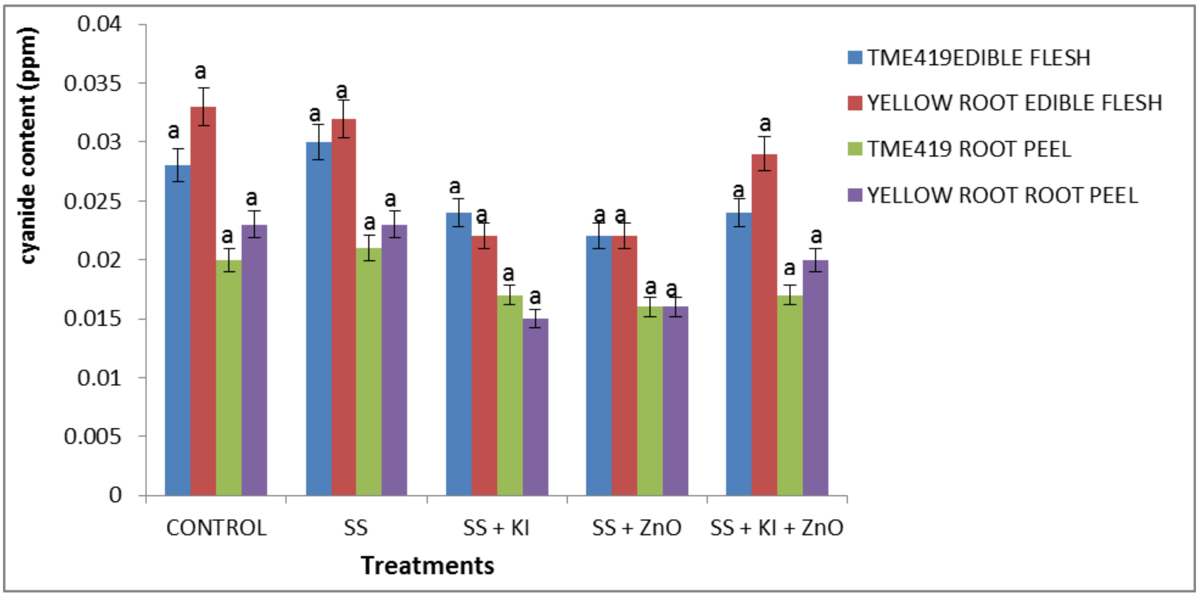


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**Figure 4: Hydrogen Cyanide (ppm) in the edible flesh and root peel of Cassava Treated with Smoke solution (SS), SS + KI, SS +ZnO, SS + KI + ZnO**

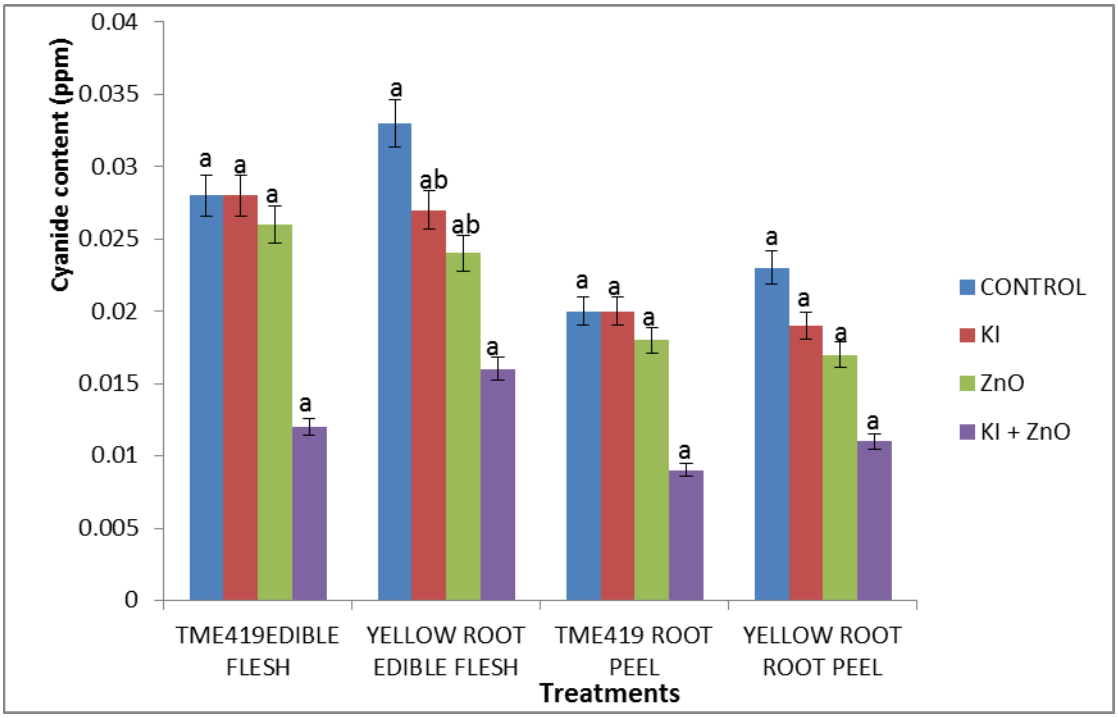


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**Figure 5: Hydrogen Cyanide (ppm) in the edible flesh and root peel of Cassava Treated with Potassium iodide (KI) and Zinc oxide (ZnO) separately and combined**

## IV. Discussion

Generally, the study revealed that organic chelates reduce cyanide concentration in cassava, although, even the control hydrogen cyanide concentration in the edible root was less than the poisonous level. And this places these cultivars as excellent cassava cultivars for biofortification to enhance micronutrients security among those that eat cassava as a staple food crop.

### CYANIDE EFFECT ON HUMAN HEALTH

Small amount of hydrogen cyanide in the body can be converted to thiocyanate, which is less harmful and is excreted in urine. Small concentration of cyanide can also combined with other chemicals like oxygen to form vitamin $B_{12}$ which helps to maintain healthy nerves and red blood cells. Large amount of cyanide prevent cells from using oxygen and eventually kill the cells. And this causes oxygen deficiency in the system. The heart, respiratory system and the central nervous system are the most susceptible to cyanide poisoning. One of its acute effect is cardiac arrest (Hendry-Hofer *et al*, 2019). Chronic cyanide intoxication can induce malfunctions of the thyroid gland and neurological disorder (Kwok, 2008), hence reducing the cyanide concentration in cassava, will free the populace from the risk of these aforementioned health challenges, especially those that consume mostly cassava as their major staple. This will also protect industrial harmony and avoid disasters like ban. For example, according to Kwok (2008), the Piranha brand crackers and snacks manufactured by Tixana Australia Pty Ltd was banned as a result of high cyanide content.

### Effect of cyanide on Cassava Root

High cyanide concentration also cause root rot in cassava. This is because, cyanide resist respiration. It enhances inactivating oxygen thereby inhibiting the uptake of oxygen and ATP generation (Verma and Verma, 2007). And this affects its physiological activities which often lead to rapid senescence, wilting and deterioration of roots. Reducing the cyanide concentration in cassava will facilitate overcoming the risk of root rot resulting from high cyanide content in the plant and prolong the shelf life of the root.

## V. Conclusion

The use of organic chelates in improving nutritional content in cassava has proved to be an excellent way to reduce the cyanide content in cassava as indicated in this study; the cyanide concentration in all the treatments were less than the poisonous concentration (0.5 – 3.5mg/kg human body weight). The use of organic chelates should be encouraged in cassava production in order to produce cassava Roots with less cyanide concentration, for good health in human and also slow down senescence and Root deterioration in cassava.

Among all the treatments EDTA+ZnO was the best but base on availability, accessibility and application, form (inorganic nature) and cost; periwinkle effluents is recommended as the best chelates among those chelates used in the study to reduce cyanide concentration in cassava Root.

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