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Improving Nutrients Absorption Promoter Using Organic Chelates

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ABSTRACT

The study investigated the potentials of organic chelates used in enhancing micro nutrients in cassava to improve the availability of Vitamin C which is a nutrient absorption promoter. The study used EDTA as standard chelate, Bontera as a commercial organic chelate and periwinkle effluents 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. The bioavailable Vitamin C in the edible root ranged from 0.18mg/g (EDTA + ZnO; YR; KI + ZnO in TME419) to 0.71mg/g (SS + ZnO + KI in YR). The study revealed that Smoke Solution did better individually (0.67mg/g; TME419) and in combination with other nutrients sources (0.71mg/g; SS + KI + ZnO: YR) in improving Vitamin C availability. The study also revealed that organic chelates have the potential of providing nutrients absorption promoters that will facilitate the absorption of nutrients in which they enhanced the availability in food crops.

INTRODUCTION

Vitamins C is an essential vitamin needed by the human body. Vitamin C prevents lungs cancer, oral cavity cancer oesophagus cancer, stomach and colon cancers (Yong *et al*, 1997; Smithers *et al*, 1998; Byers and Mouchawar, 1997; Schorah 1998). Humans at different age, body weight and conditions require vitamin C differently, but the overall RECOMMENDED NUTRIENT INTAKE (RNI) is 45mg/day. While the World Health Organisation (WHO) recommends 400mg/day. According to Baker *et al* (1969) and Kallner *et al* (1979), at saturation the whole body of an adult male contains 20mg/kg or 1500mg. Vitamins C is a nutrient absorption promoter. Its deficiency causes poor utilization of nutrients in food diet, especially foods rich in anti - nutrients. The most recommended tool to combat malnutrition is biofortification (Welch and Graham, 2000; Graham *et al*, 2001; Boius *et al*, 2003; Graham, 2003; Genc *et al*, 2009; Ikuli *et al*, 2017; Ikuli *et al*, 2019a and b). The number one food that feed Nigeria (Ikuli and Akonye, 2019) and the fifth that feeds the world (Reddy, 2008) is cassava, hence cassava is an excellently fit crop for biofortification of essential nutrients that are deficient in the society. But increasing the nutrients biologically in cassava which is also rich in antinutrients like goitrogen; an anti- iodine, polyphenols, saponins, fibers, phytate and other inhibitors will danish the effort without simultaneously providing absorption promoters to control the activities of the anti – nutrients in the staple produced. For a remarkable success of biofortification, the program plan must include absorption promoters of that nutrient to encounter the inhibitors. To achieve this, sources of these nutrients in question must be identified. According Ikuli *et al* (2019b), the use of natural resources for biofortification is the best because it makes nutrients enrichment in food crops simple and fast as the rural farmers that produce the bulk of food consumed carryout the biofortification themselves with ease and resources readily available in their environ.

It is therefore necessary to identify and determine the amount of nutrients absorption promoters or the potentials of the natural resources in making Vitamins C available together with the nutrients they are used to biofortify the crop.

The objective of the study is to determine the potentials of natural chelates to promote the availability of Vitamins C in the edible root of cassava through foliar application.

MATERIALS AND METHODS

Land Preparation and Plot Layout

The research was conducted at University of Port Harcourt, University Park, Port Harcourt Latitude 4º 54¹ 33¹¹ N, Long. 6º 54¹ 39¹¹ E and Lat.4º 54¹ 30¹¹ Long.6º 54¹ 32¹¹ E from December, 2017 to December, 2018.

Land Preparation and Plot Layout

A total land area of 1062m^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 7th month (Late Tuberization and bulking stage of the plant).

After harvest, samples of the Cassava root (peel and flesh) were collected for biochemical analysis digested and analyzed for bioavailable Vitamin C using High Performance Liquid Chromatography (HPLC) by the Association of Office Analytical Chemists (AOAC, 2006) official methods of analysis.

SAS Software (2012) was used for the statistical analysis.

RESULTS AND DISCUSSIONS

The vitamin C content in the edible root in control was 0.31mg/g in TME419 and 0.31mg/g in YELLOW ROOT. When only iodine was used to treat the cultivars, the vitamin C content in TME419 increased by 58.06% and increased by 61.29% in YELLOW ROOT. When the cultivars were treated with only Bontera, the vitamin C content increased by 12.9% in TME419 and increased by 22.58% in YELLOW ROOT. When only EDTA was used to treat the cultivars, the vitamin C content in TME419 increased by 38.71% and by 25.81% in YELLOW ROOT. When periwinkle effluents was used to treat the cultivars, the vitamin C content in TME419 decreased by 38.71% but increased by 54.84% in YELLOW ROOT. When only smoke solution was used to treat the cultivars, the vitamin C content in TME419 increased by 116.13% and increased by 19.35% in YELLOW ROOT. When iodine was added to Bontera, the vitamin C content decreased by 3.23% in TME419 but there was no change in YELLOW ROOT. When iodine was added to EDTA, the vitamin C content in TME419 increased by 109.68% and increased by 116.13% in YELLOW ROOT. When iodine was added to periwinkle effluents, the vitamin C content in TME419 decreased by 9.68% and decreased by 22.58%. When iodine was added to smoke solution, the vitamin C content increased by 32.26% in TME419 and increased by 32.26% in YELLOW ROOT also as presented in Table 1.

Table 1: VITAMIN C (mg/100g) Content in Cassava Flesh when Iodine was added to Chelates

TREATMENT	CULTIVAR TME 419			CULTIVAR YELLOW ROOT		
	Edible flesh	%RNI 45mg/day	%WHO 400mg/day	Edible fresh	%RNI 45mg/day	%WHO 400mg/day
CONTROL	31	68.89	7.75	31	68.89	7.75
KI	49	108.89	12.25	50	111.1	12.50
CHELATE						
EDTA	43	95.56	10.75	39	86.67	9.75
BT	35	77.78	8.75	38	84.44	9.50
PE	19	42.22	4.75	48	106.67	12
SS	67	148.89	16.75	37	82.22	9.25
CHELATE + KI						
BT+KI	30	66.67	7.50	31	68.89	7.25
EDTA+KI	65	144.44	16.25	67	148.89	16.75
PE+KI	28	62.22	7.00	24	53.33	6.00
SS+KI	41	91.11	10.25	41	91.11	10.25

NB:*EDTA(Ethylene diamine tetra acetic acid); BT (Bontera); PE (Periwinkle Extract); SS (Smoke Solution); KI (Potassium iodide);USFDA DV (United State Food and Drug Administration established Daily value); WHO (World Health Organisation)*

When only zinc was used to treat the cultivars, the vitamin C content increased by 6.45% in TME419 and increased in YELLOW ROOT by 54.84%. When zinc was added to Bontera, the vitamin C content in TME419 increased by 19.35% and decreased by 41.94% in YELLOW ROOT. When zinc was added to EDTA, the vitamin C content in TME419 increased by 12.90% and decreased by 41.94% in YELLOW ROOT. When zinc was added to periwinkle effluents, the vitamin C content in TME419 increased by 19.35% and increased in YELLOW ROOT by 25.81%. When zinc was added to smoke solution, the vitamin C content in TME419 increased by 22.58% and increased by 32.26% in YELLOW ROOT as presented in Table 2.

Table 2: VITAMIN C (mg/100g) Content in Cassava Flesh when Zinc was added to Chelates

TREATMENT	CULTIVAR TME419			CULTIVAR YELLOW		
	Edible flesh	%RNI 45mg/day	%WHO 400mg/day	Edible flesh	%RNI 45mg/day	%WHO 400mg/day
CONTROL	31	68.89	7.75	31	68.89	7.75
ZnO	33	73.33	8.25	48	106.67	12.00
CHELATES						
EDTA	43	95.56	10.25	39	86.67	9.75
BT	35	77.78	8.75	38	84.44	9.50
PE	19	42.22	4.75	48	106.67	12.00
SS	67	148.89	16.25	37	82.22	9.25
CHELATES +ZnO						
BT+ZnO	37	82.22	9.25	31	68.89	7.25
EDTA+ZnO	35	77.78	8.75	18	40.00	4.5
PE+ZnO	37	82.22	9.25	39	86.67	9.75
SS+ZnO	38	84.44	9.50	41	91.11	10.25

NB: *EDTA(Ethylene diamine tetra acetic acid); BT (Bontera); PE (Periwinkle Extract); SS (Smoke Solution); RNI (Recommended Nutrients Intake); WHO (World Health Organisation)*

And when iodine and zinc were combined to treat the cultivars, the vitamin C content in TME419 decreased by 41.94% and decreased by 25.81% in YELLOW ROOT. When both iodine and zinc were added to Bontera, the vitamin C content decreased by 29.03% in TME419 and decreased by 6.45% in YELLOW ROOT. When both iodine and zinc were added to EDTA, the vitamin C content in TME419 decreased by 16.13% and decreased by 9.68% in YELLOW ROOT. When both iodine and zinc were added to periwinkle effluents, the vitamin C content in TME419 decreased by 3.23% and decreased by 19.35% in YELLOW ROOT. When iodine and zinc were added to smoke solution, the vitamin C content in TME419 remained the same but increased by 129.03% in YELLOW ROOT as presented in Table 3.

Table 3: VITAMIN C (mg/100g) Content in Cassava Flesh when both Iodine and Zinc were added to Chelates

TREATMENT	CULTIVAR TME419			CULTIVAR YELLOW		
	Edible flesh	%RNI 45mg/day	%WHO 400mg/day	Edible flesh	%RNI 45mg/day	%WHO 400mg/day
CONTROL	31	68.89	7.75	31	68.89	7.75
KI+ZnO	18	40.00	4.50	23	57.11	5.75
CHELATES						
EDTA	43	95.56	10.75	3	86.67	9.75
BT	35	77.78	8.75	38	84.44	9.50
PE	19	42.22	4.75	48	106.67	12.00
SS	67	148.89	16.25	37	82.22	9.25
CHELATES + KI+ZnO						
BT+KI+ZnO	22	48.89	5.50	29	64.44	7.25
EDTA+KI+ZnO	26	57.78	6.50	28	62.22	7.00
PE+KI+ZnO	30	66.67	7.50	25	55.56	6.25
SS+KI+ZnO	31	68.89	7.75	71	157.78	17.75

NB: *EDTA(Ethylene diamine tetra acetic acid); BT (Bontera); PE (Periwinkle Extract); SS (Smoke Solution); KI (Potassium iodide);RNI (Recommended Nutrients Intake); WHO (World Health Organisation)*

Vitamin C and Human Health

Vitamin C is an antioxidant and vital nutrient that has many functions. It helps in production of collagen. It helps to reduce oxidative stress and enhance wound healing. Vitamin C enhance fertility. Vitamin C protects sperm from oxidative damage and enhance mobility and assists in ovarian function through the antioxidant mechanism and also improve absorption of iron (Karyn, 2021). As an antioxidant, Vit. C reduce free radicals in the body system and protects their damage. As a result prevents the growth of cancerous cells. It enhance formation of protein used to make skin tendons, ligaments and blood vessels for wound healings and amendments. Vitamin C facilitates absorption processes thereby ensuring judicious utilization of nutrients in consumed foods by the human body.

CONCLUSION

All the chelates improved Vitamin C in both cultivars used in the study except periwinkle effluents that reduced in TME419 when applied alone, but increased sodium (Na) availability which is also another absorption promoter. From the study, it is clear that Smoke Solution is the best promoter for availability of Vitamin C among all the chelates used. The use of organic chelates should be encouraged as it can be easily applied by the rural farmers who are the bulk producers of the food consumed, recycle natural resources lying waste in the environment which are readily available.

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