



Evaluation of Effects of Different Levels of *Craseonycteris Thonglongyai* Compost on the Concentrations of Some Mineral Elements in the Leaf of *Corchorus Olitorius* (Jute Mallow)

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ABSTRACT

Leafy vegetables are among the major sources of micronutrients that are required for development and maintenance of good health. The concentrations of micronutrients in vegetables mostly depend on soil nutrient compositions among other environmental and genetic factors. It is against this background that this present research was conducted to investigate the effects of different levels of *Craseonycteris thonglongyai* compost on the concentrations of some mineral elements (Fe, Zn, Cu, Ca, Mg, Na and K) in the leaf of *Corchorus olitorius*. The different levels of the compost used included the control (no application), 25, 50 and 75 g per 10 kg soil. Leaves of *Corchorus olitorius* were harvested at market maturity and analysed for mineral contents. Atomic Absorption Spectrophotometer (AAS) was used for the determination of Fe, Zn, Cu, Ca and Mg while Na and K in the vegetable were analysed with Flame Photometer. Results showed that different concentrations of *C. thonglongyai* compost in the soil significantly ($P < 0.05$) increased the concentrations of Fe, Mg, K and Na in the leaves of the plant. However, application of different levels of the compost had no significant ($P > 0.05$) effect on the Cu content in the vegetable, whereas the concentrations of Zn and Ca decreased significantly ($P < 0.05$) with increased application of the droppings. The results of this study revealed that application of different levels of *C. thonglongyai* influenced the bioaccumulations of some mineral elements in the leaf of *Corchorus olitorius*.

Keywords: *Corchorus olitorius*, *Craseonycteris thonglongyai*, compost, Mineral elements

INTRODUCTION

Leafy vegetables form an integral part of human diets, as they are among the major sources of vitamins, minerals and dietary fibre useful for maintenance of good health and prevention of diseases (Antia *et al.*, 2006; Musa *et al.*, 2014). Leafy vegetables enjoy special importance in human diets in Asia and Africa, as they can be grown easily under harsh environmental conditions through subsistence crop management practices prevalent in these regions (Schipper, 2000).

Corchorus olitorius is popular as vegetable cultivated in dry, semi-arid regions and in humid areas of Africa. The vegetable grows well in sandy, loamy and clay soils. Furthermore, this plant does well in acid, neutral and basic (alkaline) soils (Schipper, 2000; Facciola, 1990). The vegetable is widely consumed as a healthy vegetable in Japan, because it has been noted to contain abundant quantities of

carotenoids, vitamins B₁, B₂, C and E, and minerals (Musa, 2012).

Mineral elements are important and major classes of food necessary for maintenance of physiochemical conditions are essential for life (Malhotra, 2006). They form an integral component of functionally important organic compounds like Fe in haemoglobin and Zn in insulin (Delvin, 1997). Some other minerals (trace metal ions) play significant roles in the activity of some protein (notably enzymes) and other biochemical roles in the biological systems (Ezeonu *et al.*, 2002; Obiajunwa *et al.*, 2005). They are also essential for normal functioning of

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the heart, muscles, nerves, and in the maintenance of body fluid composition among others (Prohp *et al.*, 2006). Deficiencies of mineral elements in the diet have manifested in different forms of disease conditions such as goiter, rickets and other forms of metabolic dysfunctions (Prohp *et al.*, 2006).

Though plants are the major sources of minerals in our diets, they are not synthesized in plants, but are absorbed from the soil and the atmosphere. Therefore, the amount of minerals in plants mostly depends on the nutrient content and compositions of the soil in which they were grown among other environmental factors (Aliyu and Morufu, 2006). It is for this reason this experiment was conducted to investigate the effects of different levels of *C. thonglongyai* compost on the concentrations of selected minerals (Fe, Zn, Cu, Ca, Mg, Na and K) in the leaf of *Corchorus olitorius*.

METHODOLOGY

Study Area

Pot experiment was conducted in the experimental farm of the Faculty of Agriculture, Ibrahim Badamasi Babangida University Lapai, Niger State, Nigeria. Lapai is situated in the Southern Guinea Savanna region, on latitude 8° 49'N and longitude 6° 41'E. The raining season of Lapai occurs between April – October with mean annual rainfall of 1334 mm. The peak rainfall of between 300-330 mm is usually recorded in August and September, while the maximum mean monthly temperature of Lapai (30-40°C) is usually March and the minimum (22.3°C) in August.

Soil Sampling and Analysis

Soil sample used for the present experiment was obtained from 3 different locations in the main campus of Ibrahim Badamasi Babangida University, Lapai, where the surface soil (0-20 cm) was mixed and sieved to remove debris. The physico-chemical properties of the soil sample and *C. thonglongyai* compost were analysed according to the method of Juo (1979).

Source of *Corchorus olitorius* Seeds and *Craseonycteris thonglongyai* Compost

The seeds of *C. olitorius* were obtained from the Teaching and Research Farm of Faculty of Agriculture, Ibrahim Badamasi Babangida University, Lapai, Niger State. The compost of *C. thonglongyai* was collected into a polythene

sack from a cave in Faso village of Edati Local Government Area of Niger State, Nigeria.

Fertilizer Treatment

The dried droppings of *C. thonglongyai* were pulverized into powder and used to grow *C. olitorius* in pot experiment at four different levels, namely, control (No application), 25, 50 and 75 g per 10 kg soil.

Planting, Experimental Design and Nursery Management

Ten seeds of *C. olitorius* were planted per bag containing 10 kg soil and treated with different levels of *C. thonglongyai* compost. The plants were thinned to 2 per pot after germination. Complete randomize design (CRD) was adopted using four treatments (four levels of soil fertility). Each treatment has 10 pots replicated 3 times making total of 120 pots for the experiment. The plants were watered twice daily (morning and evening) and the surrounding was weeded regularly while the pot were lifted from time to time to prevent the roots of the plants from growing out of the container.

Analytical Methods

The estimation of mineral elements (Zn, Cu, Mg, Ca, Fe, Na, and K) in the samples was carried out according to the method described by Ezeonu *et al.* (2002). Briefly, fresh leaves of *C. olitorius* were harvested separately from the experimental plot and dried in an oven maintained at 110°C for 24 hours. Exactly 0.50 g of each of the dry powdered samples was weighed into different boiling tubes and 5.00 cm³ of the digestion mixture (concentrated perchloric and nitric acid in a ratio of 1:2) was added to each of the tubes. The resulting mixtures were swirled and left in a fume cupboard overnight. The mixtures were then digested on a hot plate at 150°C for 2 hours or until frothing stopped. The samples were then cooled for 10 minutes, after which 3.0cm³ of 6.0 M HCl was added and the samples were further digested for another 1½ hour, and allowed to cool. The content of each tube was then made up to 50 cm³ with distilled deionized water in a volumetric flask and later transferred into sample bottles. The samples were analyzed for Zn, Cu, Ca, Mg and Fe using Atomic Absorption Spectrophotometer (Alpha 4A AAS), whereas Flame Photometer (Jenway PFP7) was used for Na and K.

Statistical Analysis

Analysis of variance (ANOVA) was carried out using SPSS statistical package to determine variation between different levels of *C. thonglongyai* dung on the concentrations of some mineral elements in the leaf samples of *C. olitorius*. The DUNCAN's Multiple Range Test (DMRT) was used to compare sample means, where significant difference was accepted at values of $p < 0.05$.

RESULTS

Physical and Chemical Properties of Soil

Result of analysis of the soil used for pot experiments is presented in Table 1. Soil pH shows that the soil is slightly acidic. The texture class of the soil is sandy loam which signifies that it has a moderate water holding capacity. Organic carbon, total nitrogen, CEC (cation exchange capacity), Na, Ca and K contents of the soil were low while available phosphorus of the soil was high. However, the concentration of Mg is of the soil was moderate.

Table 1: Physical and chemical properties of the soil (0 – 20 cm) used for pot experiment

Parameters	Values
Sandy (g kg ⁻¹)	93.27
Silt (g kg ⁻¹)	5.97
Clay (g kg ⁻¹)	0.38
Textural class	Sandy loam
pH (H ₂ O)	6.72
pH (CaCl ₂)	5.97
Organic carbon (g kg ⁻¹)	4.64
Total nitrogen (g kg ⁻¹)	0.18
Available phosphorus (mg kg ⁻¹)	51.90
Na ⁺ (cmol kg ⁻¹)	0.23
K ⁺ (cmol kg ⁻¹)	0.07
Mg ²⁺ (cmol kg ⁻¹)	1.42
Ca ²⁺ (cmol kg ⁻¹)	1.18
Acidity (cmol kg ⁻¹)	0.15
CEC (cmol kg ⁻¹)	2.97
EC (cmol kg ⁻¹)	1.32

CEC = Cation exchange capacity, EC = Exchangeable cations. Values represent means of triplicate determinations

Physical and Chemical Properties of *Cruseonycteris thonglongyai* Compost

Analysis of *C. thonglongyai* compost used for pot experiment showed that it is slightly basic in

H₂O with very high organic carbon content. The total nitrogen, potassium, magnesium and sodium and available phosphorus in the sample were very high, whereas calcium was low (Table 2).

Table 2: Physical and chemical properties of the *Cruseonycteris thonglongyai* compost

Parameters	Values
Sandy (g kg ⁻¹)	72.15
Silt (g kg ⁻¹)	18.56
Clay (g kg ⁻¹)	10.30
Textural class	Loam
pH (H ₂ O)	7.66
Organic carbon (g kg ⁻¹)	32.50
Total nitrogen (g kg ⁻¹)	7.60
Available phosphorus (mg kg ⁻¹)	8744.30
Na ⁺ (cmol kg ⁻¹)	3.18
K ⁺ (cmol kg ⁻¹)	12.90
Mg ²⁺ (cmol kg ⁻¹)	3.84
Ca ²⁺ (cmol kg ⁻¹)	2.84
Acidity (cmol kg ⁻¹)	1.32
CEC (cmol kg ⁻¹)	22.91
EC (cmol kg ⁻¹)	3690

CEC = Cation exchange capacity, EC = Exchangeable cations. Values represent means of triplicate determinations.

Effect of different levels of *Cruseonycteris thonglongyai* compost

Result of analyses of effects of different levels of *C. thonglongyai* compost on concentrations of some minerals in *C. olitorius* is presented in Table 3 below. The concentrations of Fe, Mg, Na and K in the leaf samples of *C. olitorius* increased significantly ($p < 0.05$) with increased application of the compost. However, the concentrations of the mineral elements in the vegetable treated with 50 g of *C. thonglongyai* compost did not differ significantly ($P > 0.05$) from that treated with 75 g.

Similarly, the results showed that whereas application of different levels of *C. thonglongyai* compost had no significant ($P > 0.05$) effect on Cu content in *C. olitorius*, the concentrations of Zn and Ca decreased significantly ($P < 0.05$) with increase application of the compost except that the concentration of Zn in the vegetable fertilized with 50 g of the compost did not differ significantly ($P > 0.05$) when compared with that treated with 75 g.

Table 3: Effect of different levels of *Craseonycteris thonglongyai* compost on concentrations of some mineral elements in *Corchorus olitorius*

Mineral elements (mg kg ⁻¹)	Levels of <i>Craseonycteris thonglongyai</i> compost (g)			
	Control (0)	25	50	75
Fe	0.78 ± 0.14 ^a	2.21 ± 0.20 ^b	2.33 ± 0.10 ^{bc}	2.73 ± 0.06 ^c
Zn	4.28 ± 0.08 ^c	2.03 ± 0.22 ^b	1.44 ± 0.14 ^a	1.41 ± 0.06 ^a
Cu	0.24 ± 0.04 ^a	0.19 ± 0.02 ^a	0.22 ± 0.03 ^a	0.34 ± 0.07 ^a
Ca	405.31 ± 3.47 ^c	314.58 ± 13.06 ^b	310.44 ± 32.89 ^b	235.11 ± 16.72 ^a
Mg	41.611 ± 1.50 ^a	50.28 ± 1.00 ^b	50.93 ± 3.23 ^b	58.69 ± 2.99 ^b
Na	2.64 ± 0.53 ^a	10.53 ± 0.08 ^b	23.16 ± 0.11 ^c	24.73 ± 0.52 ^c
K	213.60 ± 9.60 ^a	229.50 ± 2.50 ^{ab}	240.40 ± 1.20 ^b	244.80 ± 9.60 ^b

Mean values on the same row with different superscript are significantly different ($p < 0.05$)

DISCUSSION

Significant increase in the concentrations of Fe, Mg, Na and K in the leaf samples of *C. olitorius* with increasing application of *C. thonglongyai* compost implies a direct interaction between the soil nutrients and nutrients uptake by the vegetable. This is because the *C. thonglongyai* compost as organic manure contains some microorganisms and nutrients that are able to recondition the soil for nutrients uptake and promote plant health (Musa *et al.*, 2016). This observation corroborates the reports of Ojeniyi and Adeniyi (1999), Kansal *et al.* (2005) and Safaa and Abd El Fattah (2007) indicating that nitrogen in the increased mineral content in the leaves of maize, spinach and lettuce plants, respectively.

Further, Okpara *et al.* (2007) observed that nitrogen and phosphorus in the soil increase the bioaccumulation of mineral nutrients in *Sesamum indicum* L. It is imperative to acknowledge that the *C. thonglongyai* compost contains very high concentrations of nitrogen and phosphorus, essential nutrients for plant growth and development. It is well documented that *C. thonglongyai* compost is used to control nematodes and acted as fungicide in the soil, by breaking down fungi alongside other organic materials and thus mend soil, keeping the plant sound and disease free (Emerson *et al.* 2007). Plants with good health and free of diseases with sufficient nutrients in the soil have been associated with high nutrients uptake from the soil for their physiological and metabolic activities (Musa *et al.* 2016; Heldt, 2005).

The decrease in the concentrations of Zn and Ca in the leaf of *C. olitorius* treated with *C. thongongyai* compost which is variance with the above submission corroborates with the reports

that high concentration of phosphorus in the soil decrease the uptake of Zn and Ca by plants (Hamiton, *et al.*, 1993; smart-fertilizer.com, downloaded 02/10/2016). Hamiton *et al* further stressed that the uptake of Zn by plants is negatively correlated with the phosphorus content in the soil. High concentration of phosphorus in the soil forms complex with Ca and reduce the uptake of Ca by the plants (smart-fertilizer.com, downloaded 02/10/2016). Similarly, high level of competing ions such as K⁺, Na⁺ and Mg²⁺ decrease the Ca⁺ uptake by plants. It is also known that Na can replace the absorbed calcium, damage the soil structure and decreases Ca availability (smart-fertilizer.com, downloaded 02/10/2016). Therefore, the reduction in concentrations of Zn and Ca in the leaf samples of *C. olitorius* treated with different levels of *C. thonglongyai* compost could be attributed to the high concentrations of phosphorus, Mg²⁺, K⁺ and Na⁺ in the compost.

Conclusion

In Conclusion, this study reveals that the application of different levels of *C. thonglongyai* compost in the cultivation of *C. olitorius* significantly elevated the Fe, Mg, Na and K in the leaf of the vegetable and decreased the Zn and Ca uptake in the plant. However, the concentration of Cu in the vegetable was not significantly affected.

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