Published March, 2017

EFFECT OF *Craseonycteris thonglongyai* DUNG ON THE CONCENTRATIONS OF SOME MINERAL ELEMENTS IN THE LEAF OF *Hibiscus sabdariffa* (ROSELLE)

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ABSTRACT

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Leafy vegetables form an essential component of our meal as they are among the major sources of micronutrients such as vitamins, minerals, amino acids and antioxidants required for normal metabolic activity in the body and promote good health and improve productivity of individual. The concentration of micronutrients (particularly minerals) in vegetables generally depends on the nutrients content of the soil since mineral elements are not synthesized by plants. The present study was designed to evaluate the influence of different levels of Craseonycteris thonglongyai droppings on the uptake of some mineral elements, namely, calcium (Ca), copper (Cu), iron (Fe), magnesium (Mg), sodium (Na), potassium (K), and zinc (Zn) in the leaf of Hibiscus sabdariffa grown in a pot experiment. The levels of the dung used for growing the vegetable were control (no application), 25, 50 and 75 g per 10 kg soil. The leaves of the vegetable were harvested at market maturity and the mineral elements evaluated for Na, K, Ca, Cu, Fe, Mg and Zn. The results showed that the concentrations of Fe, Zn, Cu, Ca, Mg and K in the leaves of H. sabdariffa increased significantly ($p < 0.05$) with increased application of different levels of C. thonglongyai dung. The present study suggests that application of C. thonglongyai dung increased the concentrations of the mineral element in the leaves of H. sabdariffa.

Keywords*: Hibiscus sabdariffa, Craseonycteric thonlongyai dung, Market maturity, Mineral elements.*

INTRODUCTION

Vegetables form an essential component of our meal by providing minerals such as calcium, zinc, magnesium, ir//on and other important nutrients for human health. Leafy vegetables are commonly used in daily diet for their nutritional values and other health benefits (Musa, 2010; Musa *et al*., 2016). *Hibiscus sabdariffa* (roselle) belongs to the family of malvaceace and is one of the common vegetables in India, Indonesia and many tropical regions (Schippers, 2000; Babatunde, 2003). *Hibiscus sabdariffa* is widely grown in the North-Eastern and central regions of Nigeria (Akanya *et al*., 1997). The plant performs satisfactorily on relatively infertile soils but for economic purposes, a soil well supplied with organic materials and essential nutrients is important in the productions (Adanlawo and Ajibade, 2006). It can tolerate relatively high temperature throughout the growing and fruiting periods. The plant requires an optimum rainfall of approximately 45- 50cm distributed over a 90 - 120 day of growing period (Tindal, 1986). There are two botanical varieties of *H. sabdariffa* known in Nigeria. They include red variety in which the calyx is used for the preparation of "sobo" drink and the green variety which calyx and leaves are used in stew and sauces (Adanlawo and Ajibade, 2006; Ojokoh, 2006). The leaves and calyx of the green variety are very rich in vitamin C and riboflavin with some major mineral elements (Babalola, 2000; Musa, 2010). The concentrations of nutrients in *H. sabariffa* like in other vegetables depend on physical and chemical properties of the soil. It is against this backdrop the present study was conducted to evaluate the impact of different levels of *Craseonycteris thonglongyai* dung on the concentrations of some mineral elements in the leaf of *Hibiscus sabdariffa*.

MATERIALS AND METHODS

Study site and environment

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

Soil sampling and analysis

The surface (0 – 20cm depth) soil sample used for the study was obtained from 3 different locations at the Main Campus of Ibrahim Badamasi Babangida University, Lapai, Nigeia. The soil was mixed and sieved to remove debris. The physico-chemical properties of the soil and *C. thonglongyai* dung were analyzed according to the method of Juo (1979). Briefly, the particle sizes were analyzed using hydrometer method; pH was determined

potentiometrically in the water and 0.01M $CaCl_2$ solution in a 1: 2 soil/ liquid using a glass electrode pH meter and organic carbon by Walkey-Black method (Juo, 1979). Exchange acidity (H^+ and Al^{3+}) was determined by titration method (Juo, 1979). Exchangeable Ca, Mg, K and Na were leached from the soil sample with neutral 1N NH_4OAc solution before they were analysed. Sodium and potassium were determined by flame emission spectrophotometry while Mg and Ca were determined by E.D.T.A versenate titration method (Juo, 1979). Total nitrogen was estimated by Macrokjedal procedure and available phosphorus by Bray No 1 method (Juo, 1979).

Source of *Hibiscus sabdariffa* seeds and *Craseonycteris thonglongyai* dung

Dung of *C. thonglongyai* which the local farmers around this environment used as organic fertilizer was collected into a polythene sack from a cave where the animals live in colony in Faso village of Edati Local Government Area of Niger State and seeds of *Hibiscus sabdariffa* were acquired from Teaching and Research Farm of Faculty of Agriculture, Ibrahim Badamasi Babangida University Lapai, Niger State.

Manure treatment and application

Dried dung of *Craseonycteris thonglongyai* were ground into powder and used to grow *Hibiscus sabdariffa* in pot experiment at four different levels including control (No application), 25, 50 and 75 g per 10 kg soil.

Planting, experimental design and nursery management

Six seeds of *H. sabdariffa* was planted in 10kg bag of soil containing different levels of bumblebee bat droppings and thinned to 2 per pot after germination. Completely Randomized Design (CRD) was adopted using four treatments. Each treatment has ten (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 kept clean regularly to avoid pest. The pots were lifted from time to time to avoid the roots of the plants from growing out of the pot.

Estimation of mineral elements

The evaluation of mineral elements (Zn, Cu, Mg, Ca, Fe, Na, and K) in the samples was carried out according to the method depicted by Ezeonu *et al.* (2002). Briefly, fresh leaves of *H. sabdariffa* were harvested separately from the experimental plot and dried in an oven maintained at 110^oC for 24 hours. Exactly 0.50 g of each of the dry powdered samples was weighed into different boiling tubes and 5.00 cm^3 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 150^0C for 2 hours or until frothing stopped. The samples were then cooled for 10 minutes, after which 3.0cm^3 of 6.0 M HCl was added and the samples were further digested for another $1^1/_2$ hour, and allowed to cool. The content of each tube was then made up to 50 cm^3 with distilled deionized water in a volumetric flask and later transferred into sample bottles. The samples were analyzed for Na and K using Flame Photometer (Jenway PFP7), while Atomic Absorption Spectrophotometer (Alpha 4A AAS) was used for Zn, Cu, Ca, Mg and Fe.

Statistical analysis

Analysis of variance (ANOVA) was done using SPSS statistical package to evaluate distinction between different levels of *C. thonglongyai* dung on the concentrations of some mineral elements in the leaf samples of *H. sabdariffa*. The Duncan's Multiple Range Test (DMRT) was used to compare treatment means at $p < 0.05$.

RESULTS

Physical and chemical properties of the soil

Table 1 shows the characteristic of the soil used for the potted experiment. The texture of the soil is sandy loam which indicates that it has a moderate water holding capacity. The pH of the soil showed that the soil is slightly basic in water and acidic in $Cacl_2$. The organic carbon, cation exchange capacity (CEC), total nitrogen, exchangeable sodium (Na), Calcium (Ca) and potassium (K) of the soil were low whereas magnesium content of the soil was moderate. However, available phosphorus in the soil was high.

Physical and Chemical Properties of C. thonglongyai dung

Analysis of *C. thonglongyai* dung used for the experiment showed that the total nitrogen, potassium, magnesium and sodium and available phosphorus in the sample were very high, however, calcium was low. The dung is slightly basic in H_2O with very high organic carbon content (Table 2).

Effect of different levels of C. thonglongyai dung on the concentrations of mineral elements

The results showed that application of different levels *C. thonglongyai* dung significantly ($p < 0.05$) increased the Fe concentration in the leaves of *H. sabdariffa*, however, the Fe content in the vegetable treated with 25, 50 and 75 g of the dung per 10 kg soil were not significantly different from each other (Table 3).

The concentrations Zn and Na in *H. sabdariffa* were not affected with different concentration of *C. thonglongyai* dung in the soil except that the Zn content in the vegetable increased significantly ($p<0.05$) with application 75 g of the dung per 10 kg soil (Table 3).

Similarly, the concentration of Cu in the vegetable increased significantly with increase application of the dung, however, the concentration of the element in *H. sabdariffa* treated with 25 g of the dung did not differ

significantly with that of 50 g. The mean of 0.37, 0.51, 0.51 and 1.23 mg kg-^{1} were recorded for control, 25, 50 and 75 g application of *C. thonglongyai*, respectively (Table 3).
Application of 25 g of the dung had no significant ($p > 0.05$) effect on the concentration of Ca in the leaves of *H. sabdariffa*, however, the mineral content increased significantly ($p < 0.05$) when the vegetable was treated with 50 and 75 g of *C. thonglongyai* dung The concentration of Ca in control, 25, 50 and 75 g per 10 Kg soil were 182.55, 219.58, 411.90 and 400.38 mg kg-^{1}, respectively (Table 3).
The result also showed that the concentration of Mg in the leaves of *H. sabdariffa* was elevated significantly ($P < 0.05$) with increased application of the dung except that the Mg content in the leaves of the vegetable treated with 75 g of the dung was significantly lower ($p < 0.05$) compared with that of 50 g. Mean of 28.58, 38.93, 47.48 and 36.60 mg kg-^{1} were recorded for control, 25, 50 and 75 g per 10 kg soil, respectively (Table 3).
Similarly, application of different levels of *C. thonglongyai* dung significantly ($p < 0.05$) increased the concentration of K in the leaves of the vegetable; however, the K content in the leaves of *H. sabdariffa* cultivated with 50 g dung was significantly ($p > 0.05$) different with that of 75g (Table 3).

Table 1: Physical and chemical properties of soil used for the experiment.

Parameters	Values
Sand (%)	93.27
Silt (%)	5.95
Clay (%)	0.3.56
Textural class	Sandy loam
pH (0.1M $CaCl_2$)	5.98
pH (H_2O)	7.41
Organic carbon (%)	4.60
Nitrogen (%)	0.17
Available phosphorous (mg kg-^{1})	51.85
Sodium (cmol kg-^{1})	0.21
Potassium (cmol kg-^{1})	0.08
Magnesium (cmol kg-^{1})	1.40
Calcium (cmol kg-^{1})	1.15
Cation exchange capacity (cmol kg-^{1})	2.99
Exchangeable cation (cmol kg-^{1})	131

Values represent mean of replicate determinations

Table 2: Physical and chemical properties of *C. thonglongyai* dung used for the experiment

Parameters	Values
Sand	72.17
Silt (%)	17.56
Clay (%)	10.27
Textural Class	Loam
pH (H_2O)	7.67
Organic carbon (g kg-^{1})	32.00
Total nitrogen (g kg-^{1})	7.00
Available phosphorous (mg kg-^{1})	8745.301
Sodium (cmol kg-^{1})	3.16
Potassium (cmol kg-^{1})	11.92
Magnesium (cmol kg-^{1})	3.66
Calcium (cmol kg-^{1})	2.80
Acidity (cmol kg-^{1})	1.30
Cation exchange capacity (cmol kg-^{1})	22.84
Exchangeable cation (cmol kg-^{1})	3678

Values represent mean of replicate determinations

Table 3: Effect of different levels of *C. thonglongyai* dung on concentrations of some mineral elements in *H. sabdariffa*

Mineral elements	Levels of *C. thonglongyai* dung (g)			
(mg kg-^{1})	Control (0)	25	50	75
Fe	1.36a	1.63b	1.77b	1.78b
Zn	0.32a	0.31a	0.35ab	0.39b
Cu	0.37a	0.51b	0.51b	1.23c
Ca	182.55a	219.58a	411.90b	400.38b
Mg	28.58a	38.93b	47.48c	36.60b
Na	9.00a	9.47a	8.60a	8.27a
K	136.67a	163.33b	244.80c	246.67c

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

DISCUSSION

The observed increase in the concentrations of Fe, Zn, Ca, Cu, Mg and K in *H. sabdariffa* with increased application of bat dung is in consonance with previous reports (Arisha *et al*., 2003; Masarirambi *et al*, 2010; Funda *et al*., 2011 Mofunanya *et al*., 2015) to the effect that organic fertilizer increased mineral contents in vegetables. Arisha *et al*. (2003) further stress that organic manures activate many species of living organisms, which release phytohormones and may stimulate the plant growth and nutrients uptake. Similarly, Magkos *et al*. (2003) reported high concentrations of minerals such as Fe, Ca, P, Mn, Mg, Zn, Cu and K in organic vegetables. Masarirambi *et al*. (2010) attributed the increase in the concentrations of Zn, Fe and Ca in *Lactuca sativa* produced by bounce back compost to the balanced quantity of nutrients in the bounce back compost.

The increase in the concentrations of these minerals in *H. sabdariffa* with increased application of *C. thonglongyai* dung suggests a direct interaction between the soil nutrient contents and bioaccumulation by plant. This is because the *C. thonglongyai* dung contain (particularly nitrogen, phosphorus and potassium) essential nutrients required for plant growth and development. It is also well documented that the dung contained some microorganisms that are capable of amending and reconditioning the soil for nutrient uptake nutrients and support plant health (Musa *et al*., 2016). This finding corroborates the reports of Mofunanya *et al*. (2015), that application of manure increased mineral contents in *Amaranthus spinosus*. There is also a strong fact that the dung act as fungicide in the soil, by breaking down fungi alongside other organic materials and thereby recondition soil, keeping the plant healthy and disease free (Musa *et al*., 2016; Heldt, 2005). Plants with good health and free of diseases with adequate nutrients in the soil have been associated with high nutrients uptake from the soil for their physiological and metabolic activities.

CONCLUSION

The application of different levels of *C. thonglongyai* dung significantly increased the concentrations of Fe, Zn, Ca, Cu, Mg and K in *H. sabdariffa*. It therefore follows that the uptake and bioaccumulation of the minerals in *H. sabdariffa* can be enhanced by cultivating the vegetable with *C. thonglongyai* dung.

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