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Full Length Research Paper

COMPARATIVE STUDY OF THE EFFECTS OF *CRASEONYCTERIS THONGLONGYAI* COMPOST AND CHEMICAL FERTILIZER ON SOME ANTIOXIDANT CONSTITUENTS IN THE LEAF OF *CERATOTHECA SESAMOIDES* (FALSE SESAME)

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ABSTRACT

Application of manure to enrich the nutrient contents of soil is a common practice by vegetable growers as it improves the soil fertility and plant yield. Thus, farmers are engaged in application of different types of organic and chemical fertilizers. The objective of this study is to evaluate the effects of *Craseonycteris thonglongyai* compost (organic manure) and chemical fertilizer on the concentrations of some antioxidants(β-carotene, carotenoids, tocopherol, chlorophyll, lycopene and ascorbic acid) in *Ceratotheca sesamoides* in a pot experiment. The leaves of *C. sesamoides* were harvested at market maturity and subjected to standard analytical procedures. The concentrations of β-carotene, tocopherol, chlorophyll, lycopene and carotenoids were determined by spectrophotometric method while titrimetric method was used to evaluate ascorbic acid content in the samples. The results showed that the concentration of lycopene in the leaves of *C. sesamoides* increased significantly ($p < 0.05$) with the application of both *C. thonglongyai* compost and chemical fertilizer, however, the concentration of the compound was significantly ($p < 0.05$) higher in the vegetable cultivated with *C. thonglongyai* compost compared to chemical fertilizer. Application of chemical fertilizer

significantly ($p < 0.05$) decreased the β-carotene and ascorbic acid contents in *C. sesamoides* whereas; *C. thonglongyai* compost significantly ($p < 0.05$) elevated their concentrations in the leaves of the vegetable. While application of chemical fertilizer had no significant ($p > 0.05$) effect on the concentrations of chlorophyll, carotenoid and tocopherol in the vegetable, the concentrations of these parameters increased significantly ($p < 0.05$) with application of *C. thonglongyai* compost. The results suggest that application *C. thonglongyai* compost increased the concentrations of the antioxidants in *C. sesamoides* compared chemical fertilizer. Thus *C. thonglongyai* compost is a better fertilizer in the improvement of the antioxidant contents in *C. sesamoides* than chemical fertilizer.

Keywords: Antioxidants, *Craseonycteris thonglongyai* compost, chemical fertilizer and *Ceratotheca sesamoides.*

INTRODUCTION

Vegetables are the fresh and edible portions of herbaceous plants which are important food and highly beneficial for the maintenance of health and prevention of diseases. They contain valuable food ingredients which can be successfully utilized to build up and repair the body. Vegetables are valuable in maintaining alkaline reserve of the body. They are valued mainly for their high carbohydrate, vitamin, mineral and antioxidant contents. There are different kinds of vegetables; they may be edible roots, stems, leaves, fruits or seeds and each group contributes to diet in its own way (Robinson, 1990).

Vegetables make up a major portion of the diet of humans in many parts of the world and play a significant role in human nutrition, especially as sources of phytonutriceuticals: vitamins (C, A, B1, B6, B9, E), minerals, dietary fiber and phytochemicals (Quebedeaux and Eisa, 1990; Craig and Beck, 1999;Wargovich, 2000; Dias and Ryder, 2011). Some phytochemicals of vegetables are strong antioxidants and are thought to reduce the risk of chronic disease by protecting against free-radical damage, by modifying metabolic activation and detoxification of carcinogens, or even influencing processes that alter the course of tumor cells (Craig and Beck, 1999; Wargovich, 2000; Dias and Ryder, 2011; Southon, 2000). Vegetables in the daily diet have been sturdily linked with inclusive good health, enhancement of gastrointestinal wellbeing and vision, reduced menace for some forms of cancer, heart disease, stroke, diabetes, anaemia, gastric ulcer, rheumatoid arthritis and other degenerative diseases (Dias, 2012).

Ceratotheca sesamoides is a flowering plantin the genus of *Ceratotheca*. It is indigenous to Africa and grows both as a wild weed and locally cultivated species, and is commonly referred to as false sesame

owing to its similarities with sesame (*Sesamumindicum*). The plant is most cultivated in the African Savannah and other semi-arid areas on the continent and is found across Africa in both tropic and sub-tropic regions, usually growing in sandy soils of south of the Sahara. The vegetable has numerous hairs on the stem, its pink flowers often brimming with brown and purple dots and a sub-erect growth habit (Falusi*et al.,* 2002). The leaves are consumed for their nutritional and medicinal benefits while the seeds can be employed to produce cooking oil. It is a slim upright herb with green leaves and pink, lilac flowers. The fruit produced by the plant is similar to that of *Sesamum* and is found in the form of a laterally flattened capsule with slender horns (Bedigian and Adetula, 2004*).* These horns distinguish it from *Sesamum* that lacks such a feature. False sesame is a dicot native to northern parts of West Africa (Fasakin, 2004). *Ceratotheca sesamoides* is a plant with many uses and applications. The plant has edible shoots and leaves that can be eaten whole or in part, raw or cooked and are a rich source of proteins, vitamins, minerals and antioxidants. When cooked directly in soups the mucilage containing leaves help to minimize nutrient loss. Generally, because of the impoverish nature of Nigerian soils due to constant use for the cultivation of crops, vegetable growers apply both chemical and organic fertilizers to improve the nutrients content of the soils and the yield of their crops. *Craseonycteris thonglongyai* compost is one of organic fertilizers used to improve the nutrient contents of soil to enhance plant growth and development because of exceptional high concentrations of plant nutrients which are nitrogen, phosphorus and potassium. The compost also contains some of microorganisms whose activities in the soil improve soil quality for nutrients uptake by plants (Musa *et al.,* 2016; Musa, 2016 a).Although both synthetic and *C. thonglongyai* compost are used for growing vegetables, the influence of these fertilizers on the concentrations of micronutrients and antioxidants in the vegetable have not been evaluated. It is against this background this research was conducted to examine the effects chemical fertilizer and *C. thonglangyai* compost on the concentrations of some antioxidants (chlorophyll, carotenoid, tocopherol, lycopene, ascorbic acid and β-carotene) in the leaf of *Ceratotheca sesamoides*.

MATERIALS AND METHODS

Study Area

Pot experiment was carried out during raining season at Biochemistry Department, Ibrahim Badamasi Babangida University, Lapai, Niger State. Lapai is located within the latitude of 8^{o} 49'Nand longitude 6^{o} 41'E with a raining season which starts from April to October and Mean annual rainfall of 1334mm (52 inches). August and September records the highest rain of 300mm to 330mm (11.7 inches). The mean monthly temperature of Lapai in

March is 30-40^{o}C (highest) and lowest in august at 22.3^{0}C.

Soil Sampling and Analysis

The soil sample used for this analysis was obtained from three (3) different locations of the surface soil (0 – 20cm depth) at back of Biochemistry Department IBB University, Lapai. The soil was bulked together, and 10kg of the soil sample were weighed into 90differentpolythene bags for the cultivation of *Ceratotheca sesamoides*. Soil analysis was done to evaluate the physical and chemical properties of the soil according to the method of Juo (1976).

Source of *Ceratotheca sesamoides*Seeds and *Craseonycteris thonglongyai* Compost

The seed of *Ceratotheca sesamoides* was obtained from Department of Crop Science, Faculty of Agriculture, Ibrahim Badamasi Babangida University, Lapai, Niger State. Whereas, the compost of *Craseonycteris thonglongyai*was collected into a polythene bags from a cave in Faso village of Edati Local Government Area of Niger State, Nigeria.

Manure Treatments

The air-dried composts of *C. thonglongyai* were ground into powder and 50g was used to fertilize the vegetable in a pot experiment. While the chemical fertilizer was applied at a recommended dose of 30mg N/kg soil, 30mg P_2O_5/kg soil and 30mg K_2O/kg soil(National Horticultural Research Institute; NIHORT, 1983).

Planting, Experimental Design and Nursery Management

Ten (10) seeds of *Ceratotheca sesamoides* were planted in 10kg polythene bag of soil. Complete randomized design (CRD) was adopted using three treatments. The treatments were control (no fertilizer application), chemical fertilizer and *C. thonglongyai* compost applications. There were 10 pots per treatment which were replicated three times and this gave a total of 90 pots for the experiment. The plants were thinned to 2per pot after germination and watered twice daily (morning and evening) using watering can except on rainy days where no water was added. Chemical fertilizer and organic manure were applied after two days thinning. The pots were also raised from time to time in order to avoid penetration of the roots from growing out of pots. The surrounding and inside the pots were weeded regularly to avoid harbouring of pest.

Analytical Procedure

Carotenoid and lycopene contents in the samples were estimated by the method described by Zakaria *et al.* (1979). The concentration of tocopherol in the leaves of the vegetable was estimated by the Emmerie-Engel reaction as reported by Rosenberg (1992) while that of chlorophyll was evaluated by the method of Whitney *et al.* (1990). The ascorbic acid content in the samples was determined by 2, 6-

dichIorophenol method of Jones and Hughes (1983). The concentration of β-carotene in the leaves of the vegetable was determined by ethanol and petroleum ether extraction method as described Musa *et al*. (2010).

Statistical Analysis

Data was analyzed using statistical package for social science (SPSS) version 16 and presented as means± SEM. Comparisons between different treatments was done using Analysis of Variance (ANOVA). Duncan's Multiple Range Test (DMRT) was used for mean values separation and the level of significance was tested at $P < 0.05$.

RESULTS

Physico-chemical properties of soil.

The result of soil analysis used for the pot experiment is presented in Table 1. The soil texture is sand soil which infers that the soil has poor nutrient- and water-holding capacity while its water-infiltration capacity, aeration and workability are good. The total nitrogen, magnesium and calcium contents are very low while organic carbon and sodium are low. However, the concentrations of potassium and available phosphorus are high. The soil pH showed that the soil is strongly acidic in water and slightly basic in calcium chloride. Cation exchange capacity, which measures the nutrient holding capacity is very low while base saturation is very high.

Table 1: Physico-chemical properties of the soil (0 – 20 cm depth) used for pot experiment

Parameters	Values
Sand (%)	93.27
Silt (%)	5.95
Clay (%)	0.78
Textural class	Sand
pH (H_2O)	5.98
pH ($CaCl_2$)	7.41
Organic carbon (g kg^{-1})	4.60
Total nitrogen (g kg^{-1})	0.17
Available phosphorus (mg kg^{-1})	51.85
Na^+ (cmol kg^{-1})	0.21
K^+ (cmol kg^{-1})	1.15
Mg^{2+} (cmol kg^{-1})	0.08
Ca^{2+} (cmol kg^{-1})	1.40
Acidity (cmol kg^{-1})	0.15
CEC (cmol kg^{-1})	2.99
EC(cmol kg^{-1})	2.84
Base saturation (%)	94.98

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

Chemical properties of *C. thonglongyai* compost

Table 2 shows the chemical properties of *C. thonglongyai* compost. The concentrations of organic carbon, total nitrogen, phosphorus, sodium and potassium are very high. However, the concentration of magnesium is high while the calcium is low. The pH of the compost is slightly basic.

Table 2: Chemical properties of the *Craseonycteris thonglongyai* compost

Parameters	Values
pH (H_2O)	7.67
Organic carbon (g kg^{-1})	32.00
Total nitrogen (g kg^{-1})	7.00
Available phosphorus (mg kg^{-1})	8745.39
Na^+ (cmol kg^{-1})	3.16
K^+ (cmol kg^{-1})	11.92
Mg^{2+} (cmol kg^{-1})	3.66
Ca^{2+} (cmol kg^{-1})	2.80

Values represent means of triplicate determinations.

Concentrations of antioxidants in *Ceratotheca sesamoides*

The results obtained showed that the application of chemical fertilizer has no significant effect on the concentration of chlorophyll in the leaf of *Ceratotheca sesamoides*, however, its concentration increased significantly ($P<0.05$) with the application of *Craseonycteris thonglongyai* compost. The mean values of chlorophyll in the vegetable for control, chemical fertilizer and *C. thonglongyai*compostapplicationswere4. 92±0.85, 5.92±1.10 and 8.76±0.92mg/100g, respectively (Table 3).

Similarly, whereas application of *C. thonglogyai* compost significantly ($p < 0.05$) increased the concentrations of carotenoid and tocopherol in *C. sesamoides*, treatment with chemical fertilizer has no significant effect on these parameters in the vegetable (Table 3).

The concentration of lycopene in the leaves of *C. sesamoides* increased significantly with treatment with both chemical fertilizer and *C. thonglongyai* compost, however, the lycopene content in the vegetable fertilized with the compost was significantly ($P<0.05$) higher compare to that those of chemical fertilizer. The mean values of 107.33±20.33, 217.55±22.47 and 443.25±30.53 mg/g were recorded for lycopene in the vegetable for control, chemical fertilizer and *C. thonglongyai* compost, respectively (Table 3).

While the application of chemical fertilizer significantly ($P < 0.05$) decreased the concentrations of ascorbic acid and β-carotene in *C. sesamoides*, the concentrations of these parameters were significantly ($P < 0.05$)

elevated with fertilization with *C. thonglongyai* compost. The mean values of ascorbic in the vegetable for control, chemical fertilizer and *C. thonglongyai* compost were38.66±2.48, 27.93±2.15 and 42.96 ± 0.00 mg/100g, respectively, while the corresponding mean values for β-carotene were 375.59±2.23, 257.97±6.72 and 413.80±27.08 µg/100 g, respectively (Table 3).

Table 3. Effects of *C. thonglongyai* compost and synthetic fertilizer on the concentrations of antioxidants in *C. sesamoides*

Antioxidants	Control	Chemical fertilizer	*C. thonglongyai* compost
Chlorophyll (mg/100g)	4.92±0.85[a]	5.92±1.10[a]	8.76±0.92[b]
Carotenoid(mg/g)	2809.3±647.24[a]	2767.67±199.94[a]	3146.93±647.24[b]
Tocopherol (µg/kg)	0.20±0.00[a]	0.23 ± 0.03[a]	0.30±0.00[b]
Lycopene(mg/g)	107.33±20.33[a]	217.55±22.47[b]	443.25±30.53[c]
Ascorbic acid(mg/100g)	38.66±2.48[b]	27.93±2.15[a]	42.96±0.00[c]
β-carotene (µg/100g)	375.59±2.23[b]	257.97±6.72[a]	413.80± 27.08[c]

Mean values on the same row with the same superscript are not significantly different ($p > 0.05$).

DISCUSSION

The high concentrations of chemical constituents in the compost of *C. Thonglongyai* particularly, the organic carbon, total nitrogen, phosphorus, sodium and potassium justify the use of this organic fertilizer by peasant farmers to improve the nutrient contents of the soil for improvement of plant growth and development for maximum yield (Musa *et al*., 2019).

The significant higher concentration of lycopene in *C. sesamoides* treated with chemical fertilizer and *C. thonlongyai* compost compared to control suggest that the amendment of soil with either of the fertilizers improve the concentration of this important antioxidant responsible for protecting the body against oxidative damage to lipids, proteins and DNA (Levy and Sharoni, 2004). This finding corroborates with the submission of Musa *et al*. 2019, who put forward that application of both *C. thonglongyai* compost and chemical fertilizer increased the nutrient contents and compositions of the soil which ultimately improves nutrients availability and their uptake by plant. This results in proper plant growth and development which in turn will increase the formation of nutrients, antioxidants and other plant pigments including phytochemicals which are harnessed by plants to fulfilled ecological purposes and protect themselves from predators and pathogens (Heldth, 2005; Musa, 2016 b; Musa *et al*., 2019).

However, the significant increase in the concentration in lycopene and other antioxidants (chlorophyll, total carotenoid, tocopherol, ascorbic acid and β-carotene) in *C. sesamoides* treated with *C. thonglongyai* compost compared with vegetable treated with chemical fertilizer agrees with the submission of Musa et al. (2019). The author stressed that even though both synthetic fertilizer and *C. thonglongyai* compost improve the concentrations of antioxidants in *Hibiscus sabdariffa,* the compost is the preferred manure as it increases the concentrations of most antioxidants in the vegetable compared to synthetic fertilizer. This observation may be attributed to the fact *C. thonglongyai* compost, being an organic fertilizer releases nutrient gradually and steadily into the soil after decomposition and mineralization of the organic materials. This process reconditioned and enriched the soil for proper nutrients uptake by plant for optimum metabolic activity, unlike chemical fertilizer in which the nutrients are easily lost through leaching which may be responsible to the observed lower content of the antioxidant content in the vegetable grown with chemical fertilizer compared to that of the compost Makinde *et al.*, 2010).

Similarly like any other organic manures, *C. thonglongyai* compost contain microorganisms whose activities in the soil, in addition to mineralization of organic matter, could also release some chemical signals such as hormones

that may stimulate plant growth and nutrients formation (Adekayode, 2004; Ouda *et al*., 2008; Musa *et al*., 2019).

The significant decrease in the concentrations of ascorbic acid and β-carotene in *C. sesamoides* fertilized with chemical fertilizer clearly strengthening the preference of *C. thonglongyai* compost as a better fertilizer in the improvement of the antioxidant constituents in the vegetable over chemical fertilizer. This finding also justifies the recommendation of organic foods over the conventional foods in the maintenance of good health and prevention of degenerative diseases (Musa *et al*. 2019).

CONCLUSION

While the application of chemical fertilizer increased only the concentration of lycopene and decreased the concentrations of ascorbic acid and β-carotene, the concentrations of all the studied antioxidants (chlorophyll, total carotenoid, tocopherol, lycopene, ascorbic acid and β-carotene) increased significantly with the application of *C. thonglongyai* compost. Thus this study suggests that *C. thonglongyai* compost should be a preferred fertilizer over chemical fertilizer in the cultivation of *C. sesamoides* in improving the antioxidant contents in the vegetable.

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