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Effect of compost tea on the quality promotion of sweet corn (*Zea mays* var. Rugosa) in organic cultivation

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ABSTRACT

Purpose: A field experiment was designed to determine the effects of compost tea on the quality parameters of sweet corn produced without the use of mineral fertilizers. **Research method:** This research was conducted in the Taraba State University Teaching and Research Farm, Jalingo, Nigeria in 2023. The fertilizer treatments in this study were 500kg ha^{-1} NPK fertilizer (Control), 1 kg compost per 10 L water compost tea, 1 kg compost per 20 L water compost tea and 1 kg compost per 30 L water compost tea, arranged in Randomized Complete Block Design, replicated thrice. **Findings:** The results indicated that the treatments had significant ($P \leq 0.05$) effects on the physical, chemical and sensory characteristics of the sweet corn evaluated. The mineral (NPK) fertilizer treatment gave highest mean total soluble sugar content (33.13 mg g^{-1}), followed by 1 kg compost per 10 L water compost tea (33.10 mg g^{-1}), then 1 kg compost per 20 L water compost tea (31.72 mg g^{-1}) and 1 kg compost per 30 L water compost tea gave the lowest total soluble sugar content (29.88 mg g^{-1}). Yet, the effects of 1 kg compost per 10 L water compost tea treatment and mineral (NPK) fertilizer treatment were the same ($p > 0.05$). **Research limitations:** There were no limitations to the report. **Originality/Value:** This study illustrated the possibility of utilizing 1 kg compost per 10 L water compost tea concentration to produce a good yield and quality of sweet corn without mineral fertilizers.

INTRODUCTION

Sweet corn (*Zea mays* var. Rugosa) is an increasingly popular vegetable for consumption in many countries i.e. Australia, Canada, USA, Europe, Japan and South-East Asia. Sweet corn has high sugar content in the early dough stage, where the sugars accumulate in the kernels two or three times more than the normal maize (Abou-El-Hassan & El-Batran, 2020) and serves as raw material to many manufacturing industries in the production of materials such as corn syrup and starch as well use as biofuel (Emam et al., 2020). Sweet corn is a very profitable crop for farmers because it is harvested after short time as 65-90 days depending on the cultivars and has a high price for local market and exportation. So it must be considered as important crops in Nigerian economy in the future. Economic value of sweet corn might be double when it is organically produced due to increased consumer demand and limited product availability (Fahrurrozi et al., 2016). Generally, vegetables or crops produced using organic fertilizers are more attractive to the consumer than those produced using inorganic fertilizers. This is due to its free of synthetic chemicals that harm the environment and human health (Abou-El-Hassan & El-Batran, 2020).

The current environmental issues are capturing the world's attention focusing on improving the environmental quality through the adoption of techniques and measures that have reduced impacts on the environment (Kim et al., 2015; Waliczek & Wagner, 2023). Organic cultivation techniques for crops production in the field and greenhouses have been developed in alternative production techniques which employ biological or organic compounds for disease and pest control (Kim et al., 2015). Organic compost has already been established as a recommended fertilizer for improving the productivity of several crops due to its high organic matter content (El-Shaieny et al., 2022).

Compost is a humus-like material produced from aerobic microbiological decomposition of organic material derived from plants and/or animal residues by mesophilic and thermophilic microorganism (Somerville et al., 2018; Kranz et al., 2020). The role of organic matter is very important. Its high content in the soil influences physical properties; assures good value of soil cation exchange capacity (CEC); reduces the mobility of nutrients in soil solution, prevents the loss of useful substances by means of the action of enzymes; avoids the pollution of water table; improves soil porosity; helps the chemical stabilization of structure; and reduces the processes of soil erosion and increases the micro-organisms and enzymatic activity (Kim et al., 2015).

Composts teas are oxygenated compost water extracts obtained through a suitable liquid-phase blowing process. Compost tea is one sources of plant nutrition which is prepared by fermenting compost in water for a period of time in order to extract soluble organic matter, beneficial microorganisms and nutrients in the watery solution (Zaccardelli et al., 2018). Study on compost tea technology began in 1980’s in USA, but field practices comparing the brewing methods are few. Historically, home-made extract of compost tea called “passive” or non-aerated compost tea (NCT) were prepared by suspending a bag of compost in a container of water for 14 days to extract anaerobic microbes and nutrients which are used and applied to promote plant health and vitality in plants (Kim et al., 2015). Recently, aerated compost tea has been brewed in large-scale mechanized equipment for shorter period of time and often supplemented with oxygen, nutrients, and microbial starter cultures to enhance the biological activity of the compost tea which contains aerobic microbes and nutrients (Sujesh et al., 2017). Compost tea is rich of nutrients, organic compounds and beneficial microbes that positively effect on the plant rhizosphere, besides improves soil physical and chemical properties as well as suppress some plant pathogens. It has beneficial effects on plant growth and considered as a soil amendment (Abou-El-Hassan & El-Batran, 2020).

Direct use of compost can create waste and aesthetic problem in small scale gardening and indoor plants. Therefore, compost tea has beneficial effects on plant growth by providing plant nutrients directly. Compost extract is used as an organic foliar fertilizing material. It is used directly on foliage without using compost to the soil. Compost tea inoculates the leaf surface and soil with beneficial microorganisms and to add soluble nutrients to the foliage or to the soil for organisms and the plants present (Abou-El-Hassan & El-Batran, 2020). Compost teas as an effective source of nutrients but there is little scientific evidence to support or disprove this claim.

Compost tea has been cited as an option for conventional and organic growers thought to enhance crop fertility by introducing microorganisms that might aid in soil nutrient retention and extraction, and by adding soluble nutrients, further adding to their potential value as a part of an integrated crop management plan (Kim et al., 2015; Sujesh et al., 2017; Zaccardelli et al., 2018; Palese et al., 2021; Oyewusi & Osunbitan, 2021). Many studies indicated that application of organic extracts enhanced the growth, yield and quality for many crops such as Jasson (2017) on Hypoxis Hemerocallidea and Siphonochilus Aethiopicus, Giménez, et al. (2020) on baby leaf lettuce, Ros et al. (2020) on baby spinach, Khoerunnisa et al. (2022) on Black Rice (*Oryza sativa* L. indica), Carricondo-Martínez et al. (2022) on tomato and Jasson et al. (2023) on Siphonochilus aethiopicus (Schweinf.) BL Burtt. Therefore, the objective of this study was to determine and evaluate the efficacy dose of application of aerated compost teas prepared from mixtures of three composts on the quality promotion of sweet corn.

MATERIALS AND METHODS

Field experiment on sweet corn was carried out at the Teaching and Research Farm of the Taraba State University, Jalingo, Nigeria in 2023. The study site is geographically coordinated at latitude 8° 53′ and 34.2672″ North and longitude 11° 22′ and 37.74″ East. This experiment was performed to improve the efficiency of compost tea by using mix feed stock for producing sweet corn without mineral fertilizers.

Plant material

Seeds of sweet corn (Meilan F1 Hybrid) were planted in the field on flat beds. The experimental area was prepared into flat beds by plowing, harrowing and leveling; each plot measures 2 m×2m (4 m^2). The seeds were planted in September, 2023 at a distance of 0.3 m×0.3 m. The experiment was designed in complete randomized blocks with three replicates.

Table 1. Physical and chemical properties of the used farmland soil, compost and compost tea.

Parameters	Soil	Compost	Compost Tea
Bulk Density (kg/m^3)	1630.00	243.67	-
pH	6.74	8.15	7.52
Electrical Conductivity (dS/m)	2.98	2.36	2.88
Organic carbon (g/kg)	5.41	152.14	29.68
Organic matter (g/kg)	9.20	271.38	51.35
Total N (g/kg)	1.45	16.47	29.74
Total P (g/kg)	6.33	8.96	10.26
K (g/kg)	0.10	8.14	10.47
Ca (g/kg)	0.51	10.52	12.95
Mg (g/kg)	0.16	1.68	1.88
Na (g/kg)	0.05	0.27	0.43

Experimental treatments

i. 500kg ha^{-1} NPK fertilizer (Control) (Sidiky et al., 2019; Donald et al., 2021).
ii. 1 kg of compost per 10 L of water compost tea.
iii. 1 kg of compost per 20 L of water compost tea.
iv. 1 kg of compost per 30 L of water compost tea.

Composting process

Compost used was produced from cow dung, poultry droppings and vegetable wastes collected from the animal farm of the Taraba State University, Jalingo. The composting pile/above ground heap method (2 × 1.5 × 2 m^3) was prepared on a clean ground surface, located under shade. Cow dung, Poultry manure and vegetable wastes in a ratio 5:5:1 was used as feedstock to produce compost. The materials were arranged by keeping proper thickness and finally the heap was covered with banana leaves. The pile was turned manually and watered after every two weeks, during composting process of three months (Girshe et al., 2018).

Preparation of compost tea

From the mature compost obtained, compost tea was produced as described by Ngakou et al. (2014), based on the ratios of 1/10, 1/20 and 1/30 (kg/L: compost/water). Mixture was homogenized for 10 minutes and then filtered through a 0.001 mm mesh sieve. Filtrate obtained was then being left to ferment for four (4) days in a non-aerated condition. The physical and chemical properties of the used farmland soil, compost and compost tea are listed in Table 1.

Sweet corn harvest and sample preparations

At early dough stage (75 to 85 days from planting) the ears were manually harvested. Four ears from each plot were taken randomly at harvest and were husked to measure ear parameters as weight of ear, length of ear, diameter of ear, number of kernel in row and number of row. Sweet corn was directly husked for physicochemical and sensory evaluation. Samples of ear kernels were randomly bulked from each experimental unit to determine some physical properties of the ear kernels which include; Moisture content, Kernel texture (hardness) and Kernel colour. Samples of ear kernels were also randomly bulked from each experimental unit to determine kernel chemical compositions of Total soluble solids, Total soluble sugar, Carotenoids, pH value, Total titratable acidity and Mineral (Iron, Potassium, Calcium, Phosphorus and Zinc) content. Sweet corn for sensory evaluation were also husked and steamed for 30 minutes.

Determination physical properties of sweet corn ear and kernels

Ear mass and dimensional properties

The sweat corn ear mass was determined using a digital precision balance with accuracy of 0.001 g. The dimensional parameters, i.e. the length and diameter of corn ears, were determined using a ruler gauge and a slide calliper. The corn ear diameter was measured in the middle of the corn ear length. Number of kernel in row and number of row per ear were determining by manual counting.

Moisture content

The percentage retention of moisture was analyzed by the process of oven drying method. As much as two grams of corn kernels were weighed and then dried for three hours in the oven at

105°C. This drying is carried out until a constant weight is obtained. The difference between initial and final was considered as moisture and percentage calculated.

$$\text{Moisture content (\%)} = \frac{\text{Initial weight} - \text{Final weight after drying}}{\text{Initial weight}} \times 100 \qquad (1)$$

Texture (hardness)
Hardness was measured by a texture analyzer (TA. XT Plus, Stable Micro Systems, UK). The experiment was conducted using the P6 probe of the texture analyzer with pre-test speed set to 1 mm/s, test speed set to 2 mm s^{-1}, strain set to 40%, and time set to 5 s (Saengrayap et al., 2015).

Color characteristics
The color attributes L* (darkness/lightness), a* (redness/blueness), and b* (yellowness/greenness) of the sweet corn were valuated using a colorimeter (CR-5, Konica Minolta, Osaka, Japan). The sample was equilibrated to room temperature. The colorimeter was calibrated before measurement and the color was measured from three different random positions for each measurement (Kumar et al., 2020). Yellowness Index (YI), Chroma (C*) and Hue (H*) were expressed as shown in Equations (2), (3) and (4).

$$YI = \frac{142.86 \times b^*}{L^*} \qquad (2)$$

$$C^* = \sqrt{{a^*}^2 + {b^*}^2} \qquad (3)$$

$$H^* = \tan^{-1}\left(\frac{b^*}{a^*}\right) \qquad (4)$$

Determination chemical properties of sweet corn kernels
Total Soluble Solids
Sweet corn kernels were homogenized and centrifuged at 3,000 rpm at 4°C for 20 minutes. The supernatants were collected and tested using a digital display refractometer (WYT-32, Quanzhou optical, Quanzhou, China). For each experiment, five sweet corns for each sample were used to determine the total soluble solids (TSS) content (Liu et al., 2021).

Total Soluble Sugar
Experiments were performed according to the method of Calvo-Brenes and O'Hare (2020). Five grams of the ground sample was placed into a 50 mL tube and extracted twice with 25 mL of a mixture of ethanol and water (50: 50, v/v) and centrifuged at 3,000 rpm at 4°C for 20 minutes. The supernatants were combined, and 2 mL of the supernatant was filtered through a 0.2 µm water syringe filter to measure the sugar content.

Carotenoids
Carotenoids were determined according to the method of Deng et al. (2022). The samples were well ground in hexane: acetone (1:1, v/v) solution using a mortar and pestle and extracted on a shaker at 270 rpm for 1 h at room temperature. The supernatant was measured at 450 nm using a spectrophotometer.

pH and titratable acidity

The pH of sweet corn kernel was determined on a filtrate of a 5 g ground sample (80 mesh size) in 20 ml distilled water using a glass electrode digital pH meter (PYE Umicam, England). The meter was switched on and allowed to equilibrate for about 15 minutes and calibrated with pH 4.0 and pH 7.0 buffer solutions before the measurement. The electrode of the pH meter was rinsed with distilled water. The electrode and temperature probe was dipped into each sample and was allowed to display. The displayed pH value for each sample was recorded. The titratable acidity was expressed as sodium hydroxide required neutralizing the acids in a 100 g sample using phenolphthalein as an indicator. Titratable acidity (TA) of reconstituted sample was estimated by diluting the aliquot of the sample with water to a fixed volume and then titrated with 0.1N NaOH using phenolphthalein as an indicator. Percentage acidity was calculated as the percentage of anhydrous citric acid using following formula (Kadam et al., 2010).

$$\text{TA} = \frac{\text{Titre}\times\text{normality of alkali}\times\text{volume made up}\times\text{equivalent weight of acid}\times 100}{\text{Volume of sample taken for estimation}\times\text{weight or volume of sample taken}\times 1000} \quad (5)$$

Maturation index

Maturation index was obtained by dividing total soluble solids by total titratable acidity.

Mineral content

The mineral content (iron, potassium, calcium, phosphorus and zinc) were determined by Atomic Absorption spectrophotometer according to the method of AOAC (2019). Samples (1.0 g) were digested with 6 mL of HNO_3 (65 %), 2 mL of H_2O_2 (30 %) in microwave digestion system for 31 min and diluted to 10 mL with deionized water. A blank digest was carried out in the same way. Due to higher accuracy with respect to time and recovery values, this procedure preferred. The recovery values were nearly quantitative (> 95%) for above mentioned digestion method. An atomic absorption spectrometer with deuterium background corrector was used for elemental analysis. All measurements were carried out in an air/acetylene flame.

Determination sensory properties of sweet corn kernels

A comprehensive survey of the sensory characteristics was conducted based on nine-point category scale where higher score indicates better quality (1 = none; 9 = extreme). Sensory attributes such as sweetness, tenderness, juiciness and general acceptability were evaluated. Random samples of different treatments were presented in three-digit coded plates and were separately evaluated by 12 untrained consumer panelists. The mean scores for each attribute were finally summed to give an overall sensory score known as the Quality Index (QI).

Statistical analysis

The average and standard deviation of each physical, chemical and sensory parameters result were subjected to a mono-factorial variance analysis (ANOVA), and the significance of differences ($P \leq 0.05$) among means was determined with Fisher's Least Significant Difference (FLSD) test. Statistical analysis was performed using an SPSS version 19.0 for Windows (SPSS, Inc., Chicago, IL, USA).

RESULTS AND DISCUSSION

The effects of compost tea application on the physical, chemical and sensory characteristics of freshly harvested sweet corn variety were determined to show sweet corn as a good source of nutrients and antioxidants. Results showed that the fertilizer treatments significantly affected the various physical, chemical and sensory characteristics of freshly harvested sweet corn variety determined at $P \leq 0.05$.

Effects of compost tea on physical properties of sweet corn cobs and kernels

The effects of compost tea on physical properties of sweet corn cobs and kernels are illustrated in Table 2. Results showed that the different fertilizer treatments affected the various physical characteristics of sweet corn cobs and kernels evaluated significantly ($P \leq 0.05$). The treatments of mineral (NPK) fertilizer and 1 kg of compost per 10 L of water compost tea gave the highest values in most of the physical characteristics of sweet corn cobs and kernels compared to other treatments.

Ear characteristics

Effects of different treatments on ear characteristics of sweet corn showed that all the fertilizer treatments produced sweet corn ear with significant ($P \leq 0.05$) differences between them. The 1 kg of compost per 10 L of water compost tea and mineral (NPK) fertilizer treatments produced the highest ear mass, ear length, ear diameter, number of kernel per row and number of row per ear, which gave the best ear characteristics compared to other treatments. The 1 kg of compost per 20 L of water compost tea treatment came in second order, whereas the 1 kg of compost per 30 L of water compost tea treatment produced the lowest values of ear characteristics. The results mentioned that treatment of 1 kg of compost per 10 L of water compost tea produced sweet corn ear diameter similar to the ear diameter produced by mineral (NPK) fertilizers without significant differences between them. The superior treatments of 1 kg of compost per 10 L of water compost tea over 1 kg of compost per 20 L of water compost tea and 1 kg of compost per 30 L of water compost tea treatments can be attributed to its superiority in stimulating vegetable growth of plants, resulting in an increase in photosynthesis and better carbohydrate construction, thus improved yield and ear characteristics of sweet corn. These results are consistent with those obtained by Kim et al. (2015) who investigated the effect of aerated compost tea on the growth promotion of lettuce, soybean, and sweet corn in organic cultivation and reported that application of aerated compost tea from organic compost based using MOVR (the mixture of rice straw compost, vermicompost, and Hinoki cypress bark compost) to the root zone increased the plant shoot and root growths and yield of the red leaf lettuce, sweet corn, and soybean. They mentioned that application of compost teas leads to the production of plants vigor growth, higher nutrient uptake, more tolerant of stress conditions, better in the productivity and yield quality. Thus, compost tea could be used as an agent for promoting plant growth and yield in organic cultivation of crops.

Moisture content

The results of the effects of different fertilizer treatments on mean moisture content of sweet corn kernels showed that all the fertilizer treatments produced sweet corn kernels with significantly ($P \leq 0.05$) different moisture content. The results indicated that the percentages of mean corn kernel moisture content significantly ($P \leq 0.05$) increased with increasing concentration of compost tea. The 1 kg of compost per 10 L of water compost tea treatment gave the highest mean kernel moisture content of 76.77%, followed by the mineral (NPK) fertilizer treatment with mean moisture content of 76.46%, then the 1 kg of compost per 20 L of water compost tea treatment with mean moisture content of 74.80% and lastly the 1 kg of compost per 30 L of water compost tea treatment with mean moisture content of 72.43%. Differences could be from variations in conditions of cultivation. This result is in line with the works of Ndiaye et al. (2017) who carried out the physical and biochemical characterization of sweet corn ears of four varieties grown in Senegal and reported moisture content range of 75.03 ± 1.04% to 80.70 ± 1.2%. Water content in a food is related to the stability index of the food, especially related to food storage. If the water content is higher, the quality and storability of food will be lower (Sinay & Harijati, 2021). This means that the corn cultivar evaluated cannot be stored based on its moisture content.

Kernel hardness

Hardness can reflect the maturity and aging degree of corn during storage and it is likewise a major classification criterion for sweet corn (Zhang et al., 2023). The results of the effects of different fertilizer treatments on sweet corn kernel hardness show that all the four treatment levels of fertilizer concentration were significantly ($P \leq 0.05$) different in their effects on the kernel harness. With regard to sweet corn kernel hardness as affected by different sources of nutrient (organic or inorganic), it was noticed that, kernel hardness increased with the concentration of nutrient. Where, mineral (NPK) fertilizer treatment gave the highest mean value of kernel harness (1874.14 g), followed by 1 kg of compost per 10 L of water compost tea treatment (1872.86 g), then 1 kg of compost per 20 L of water compost tea treatment (1857.63 g) and 1 kg of compost per 30 L of water compost tea treatment gave the lowest mean value of kernel harness (1841.27 g). It remarked that, the increase of hardness of seeds which increase the storage period after harvesting was associated with their high contents of calcium which translocate from leaves to seeds during the period of seeds development. For this reason, average hardness has similar trends as their contents from calcium. Where, increase of calcium concentration causes a strong membranes structure. Since a high proportion of calcium in plant tissue is located in the middle lamella, which gives the strength to the cell walls.

Table 2. Effects of compost tea on physical properties of sweet corn cobs and kernels.

Physical properties	Treatment				P-Value	F-LSD 0.05
	500 kg ha^{-1} NPK Fertilizer	1kg $10L^{-1}$ Compost tea	1kg $20L^{-1}$ Compost tea	1kg $30L^{-1}$ Compost tea		
Ear Mass (g)	362.63^a	360.45^b	331.33^c	303.58^d	0.000	0.0000
Ear Length (cm)	21.50^a	21.11^b	19.80^c	18.56^d	0.000	0.1258
Ear Diameter (cm)	4.90^a	4.88^a	4.19^b	3.63^c	0.000	0.0316
Number of Kernel in Row	38.52^b	39.47^a	32.40^c	32.34^d	0.000	0.0154
Number of Row	16.36^a	15.80^b	15.24^c	14.58^d	0.000	0.0377
Moisture Content (%)	76.46^b	76.77^a	74.80^c	72.43^d	0.000	0.0154
Kernel Hardness (g)	1874.14^a	1872.86^b	1857.63^c	1841.27^d	0.000	0.0844
Kernel Colour						
Lightness (L*)	62.86^d	69.64^a	66.89^b	65.38^c	0.000	0.0377
Greenness (a*)	-2.27^a	-5.38^d	-4.14^c	-2.95^b	0.000	0.0129
Yellowness (b*)	30.73^d	35.80^a	33.44^b	32.52^c	0.000	0.0218
Yellowness Index (YI)	69.84^d	73.44^a	71.42^b	71.06^c	0.000	0.0253
Chroma (C*)	30.81^d	36.20^a	33.70^b	32.65^c	0.000	0.0000
Hue Angle (°)	85.78^a	81.45^d	82.94^c	84.82^b	0.000	0.0000

Row means with the same letters are not significantly different at 5% level.

Kernel colour

Statistical analysis carried out on colour parameters of sweet corn samples cultivated using different type of fertilizer treatment, highlighted that all the samples showed different values with significance differences ($P \leq 0.05$) among them. The L* and b* are used to reflect the freshness of sweet corn (Calvo-Brenes & O'Hare, 2020). The greater the positive L* and b* value, the more the colour tends to be brighter and yellow.

The results from this study showed that 1 kg of compost per 10 L of water compost tea treatment had the best colour, with significant differences compared to the other treatment groups. The L* and b* values of 1 kg of compost per 10 L of water compost tea treatment samples were greater than those of other samples at harvest, which indicated that 1 kg of compost per 10 L of water compost tea treatment could better maintain the brightness of sweet corn. The sweet corn color is mainly due to the presence of a huge number of secondary metabolites, such as phenolic acids, carotenoids, and flavonoids. The different expression of these pigments imparts to sweet corn tissues different colors, from yellow-orange to dark purple-blue, as well as ivory, and cream colors (Zhang et al., 2021).

Effects of compost tea on chemical properties of sweet corn kernels

The effects of compost tea on chemical properties of sweet corn kernels are shown in Table 3. Results showed that the different fertilizer treatments affected the various chemical characteristics of sweet corn kernels evaluated significantly ($P \leq 0.05$). The treatments of mineral (NPK) fertilizer and 1 kg of compost per 10 L of water compost tea gave the highest values in all the chemical characteristics of sweet corn kernels evaluated compared to other treatments except for the pH values.

Total soluble solids

The results in reveal that the mineral and organic fertilizers treatments had a significant ($P \leq 0.05$) effect on total soluble solids percentage. This study confirms that total soluble solids levels of sweet corn kernels were affected by the different fertilizers concentration. For the total soluble solids trait, data clearly show that treatments of mineral (NPK) fertilizer gave the highest total soluble solids of 17.68%, followed by treatment of 1 kg of compost per 10 L of water compost tea with total soluble solids of 17.63%, treatment of 1 kg of compost per 20 L of water compost tea with total soluble solids of 17.32% and lastly, the treatment of 1 kg of compost per 30 L of water compost tea producing the lowest value of total soluble solids of 17.12%. Yet, the effects of 1 kg of compost per 10 L of water compost tea treatment and mineral (NPK) fertilizer treatment were the same ($p > 0.05$) while that of 1 kg of compost per 20 L of water compost tea treatment and 1 kg of compost per 30 L of water compost tea treatment were significantly ($p \leq 0.05$) different. Observed TSS was in close agreement with the value obtained for sweet corn kernels by Evangelista et al. (2017), and Abou-El-Hassan and El-Batran (2020). These results might be due to the role of mineral fertilizers and organic manures in increasing soil porosity, aeration, water holding capacity and cation exchange capacity (CEC), which encourage the biological activities of soil microorganisms and led to break down of organic matter releasing N, P and K and other nutrients to the soil solution. As these nutrients are available in the soil solution, absorption would be higher and nutrients uptake might be stimulated. These results agreed with those reported by Sarhan et al. (2011), Adebayo et al. (2014), and Shafeek et al. (2015) who reported that the highest TSS, total sugars, protein, vitamin C and moisture contents in cucurbits fruits were obtained by increasing the levels of compost used.

Total soluble sugar

The amount of the total soluble sugar detected in sweet corn kernels cultivated by different treatments, was reported in Table 3. Control samples (NPK fertilizer) exhibited higher total soluble sugar content than those treated by different concentration of compost teas. The concentration of the total soluble sugar changed in function of the treatment employed during the cultivation of the plant. In fact, the sweet corn samples treated by mineral (NPK) fertilizer treatment gave the highest mean value of total soluble sugar content (33.13 mg g^{-1}), followed by 1 kg of compost per 10 L of water compost tea treatment (33.10 mg g^{-1}), then 1 kg of compost per 20 L of water compost tea treatment (31.72 mg g^{-1}) and 1 kg of compost per 30 L of water compost tea treatment gave the lowest value of total soluble sugar content (29.88 mg g^{-1}). Yet, the effects of 1 kg of compost per 10 L of water compost tea treatment and mineral (NPK) fertilizer treatment were the same ($p > 0.05$) while that of 1 kg of compost per 20 L of water compost tea treatment and 1 kg of compost per 30 L of water compost tea treatment were significantly ($p \leq 0.05$) different. The results indicated that application of mineral fertilizers as well as 1 kg of compost per 10 L of water compost tea treatment increased kernel compositions of total soluble sugars compared to other treatments. This result may be attributed to the positive role of mineral fertilizers and enriched compost tea in improving vegetable growth and nutritive status of sweet corn plants, which led to increase photosynthesis products that translocation to corn kernels. These results are in harmony with those reveled by Abou-El-Hassan and El-Batran (2020).

Total carotenoids

Statistical analysis carried out on total carotenoids of sweet corn samples cultivated using different type of fertilizer treatment, highlighted that all the samples showed different values with significance differences ($P \leq 0.05$) among them. With regard to total carotenoids of sweet corn sample as affected by different sources of nutrient (organic or inorganic), it noticed that, total carotenoids content of sweet corn increased significantly ($P \leq 0.05$) with the concentration of nutrient. Where, mineral (NPK) fertilizer treatment gave the highest mean value of total carotenoids (449.82 µg g^{-1}) followed by 1 kg of compost per 10 L of water compost tea treatment (447.58 µg g^{-1}), then 1 kg of compost per 20 L of water compost tea treatment (360.97 µg g^{-1}) and 1 kg of compost per 30 L of water compost tea treatment gave the lowest mean value (330.18 µg g^{-1}). These results are in line with those reported by More et al. (2018). Carotenoids concentration is influenced by various factors like species/variety, stage of maturity, part of the plant consumed, cultivar, cooking preparation, time of harvesting (Zhang et al., 2023).

pH value

Concerning the effect of organic and inorganic sources of nutrients on the pH value of sweet corn as were illustrated in Table 3, the pH values generally increased with decrease in nutrients concentration. The Analysis of Variance (ANOVA) showed that fertilizer treatments had significant effects ($p \leq 0.05$) on the pH values of sweet corn kernels produced. The Fisher's Least Significant Difference (FLSD) test indicates that 1 kg of compost per 30 L of water compost tea treatment had the highest mean pH value (6.61) followed by 1 kg of compost per 20 L of water compost tea treatment (6.60), 1 kg of compost per 10 L of water compost tea treatment (6.55) and mineral (NPK) fertilizer treatment (6.54). Yet, the effects of 1 kg of compost per 10 L of water compost tea treatment and mineral (NPK) fertilizer treatment were the same ($p > 0.05$) and that of 1 kg of compost per 20 L of water compost tea treatment and 1 kg of compost per 30 L of water compost tea treatment were also the same ($p > 0.05$). These results are in agreements with the results documented by More et al. (2018).

Titratable acidity

With regard to titratable acidity of sweet corn sample as affected by different sources of nutrient (organic or inorganic), it noticed that the titratable acidity generally decreased with decrease in nutrients concentration. The Analysis of Variance (ANOVA) showed that fertilizer treatments had significant effects ($p \leq 0.05$) on the total titratable acidity of sweet corn kernels produced. The Fisher's Least Significant Difference (FLSD) test indicates that mineral (NPK) fertilizer treatment had the highest mean value of titratable acidity of 0.53%, followed by 1 kg of compost per 10 L of water compost tea treatment with titratable acidity of 0.51%, then 1 kg of compost per 20 L of water compost tea treatment with titratable acidity of 0.47% and 1 kg of compost per 30 L of water compost tea treatment with the lowest mean value of titratable acidity of 0.46%. Yet, the effects of mineral (NPK) fertilizer treatment and 1 kg of compost per 10 L of water compost tea treatment were significantly ($p \leq 0.05$) different while that of 1 kg of compost per 20 L of water compost tea treatment and 1 kg of compost per 30 L of water compost tea treatment were not significantly ($p > 0.05$) different.

Maturation index

Data shown in (Table 3) indicated that the maturation index of sweet corn kernels increased with decreasing concentration of the fertilizer treatments. Statistical analysis carried out on maturation index of sweet corn samples cultivated using different type of fertilizer treatment, highlighted that all the samples showed different values with significance differences ($P \leq 0.05$) among them. The Fisher's Least Significant Difference (FLSD) test indicates that 1 kg of compost per 30 L of water compost tea treatment had the highest mean maturation index (37.23) followed by 1 kg of compost per 20 L of water compost tea treatment (36.85), 1 kg of compost per 10 L of water compost tea treatment (34.57) and mineral (NPK) fertilizer treatment (33.36) and their effects were found to be significantly ($p \leq 0.05$) different.

Mineral composition

In our study (Table 3), the mineral composition of sweet corn showed higher concentrations of phosphorus and potassium; and low concentrations of calcium, zinc and iron. The low concentration of calcium, zinc and iron recorded in this study tallies with the findings of Prasanthi et al. (2017), who found that cereal are poor in these minerals. However, the observed differences in mineral composition in these products may be due to genetic factor and environmental factors like irrigation frequency, soil composition and fertilizer used (Ikram et al., 2010). In our study among the fertilizer treatments, it was found that the mineral contents of the sweet corn variety increased with the concentration of nutrient. The concentration of all the mineral contents evaluated changed in function of the treatment employed during the cultivation of the plant. The Analysis of Variance (ANOVA) showed that fertilizer treatments had significant effects ($p \leq 0.05$) on the mineral composition of sweet corn kernels produced. The Fisher's Least Significant Difference (FLSD) test indicates that the sweet corn samples treated by mineral (NPK) fertilizer treatment gave the highest mean values of phosphorus, potassium, calcium, zinc and iron, followed by 1 kg of compost per 10 L of water compost tea treatment, then 1 kg of compost per 20 L of water compost tea treatment and 1 kg of compost per 30 L of water compost tea treatment gave the lowest mean values of phosphorus, potassium, calcium, zinc and iron. However, the effects of all the fertilizer treatments on the phosphorus, potassium, calcium, zinc and iron contents of sweet corn kernels were found to be significantly ($p \leq 0.05$) different, except the iron contents of mineral (NPK) fertilizer treatment and 1 kg of compost per 10 L of water compost tea treatment which were found to be the same ($p > 0.05$). This finding showed that sweet corn is a good source of these essential minerals, particularly for the iron and zinc which are of public health significance and this further enhanced the nutritional values of the sweet corn hence, its utilization in the production of various corn products or any other cereal-based meal products would not have any detrimental effects on the consumers.

Effects of compost tea on sensory (organoleptic) properties of sweet corn kernels

The organoleptic characteristic is of great importance from the point of food material acceptability by the consumer. The sensory characteristics together with the assessors' ratings are shown in Table 4. The Analysis of Variance (ANOVA) showed that fertilizer treatments had significant effects ($p \leq 0.05$) on the sensory characteristics of sweet corn kernels produced. The Fisher's Least Significant Difference (FLSD) test indicates that the means of scores for all quality attributes, overall acceptability and quality index of all samples were significantly different ($p \leq 0.05$). The degree of Sweetness, Tenderness, Juiciness, overall acceptability and quality index were generally found to be significantly higher in the treatment of 1 kg of compost per 10 L of water compost tea followed by treatment of 1 kg of compost per 20 L of water compost tea, then treatment of 1 kg of compost per 30 L of water compost tea treatment and lastly, treatment of mineral (NPK) fertilizer.

Table 3. Effects of compost tea on chemical properties of sweet corn kernels.

Chemical properties	Treatment				P-Value	F-LSD $_{0.05}$
	500 kg ha^{-1} NPK Fertilizer	1kg 10L^{-1} Compost tea	1kg 20L^{-1} Compost tea	1kg 30L^{-1} Compost tea		
Total Soluble Solids (%)	17.68^{a}	17.63^{a}	17.32^{b}	17.12^{c}	0.000	0.0503
Total Soluble Sugar (mg g^{-1})	33.13^{a}	33.10^{a}	31.72^{b}	29.88^{c}	0.000	0.0818
Total Carotenoids (µg g^{-1})	449.82^{a}	447.58^{b}	360.97^{c}	330.18^{d}	0.000	0.0000
pH Value	6.54^{b}	6.55^{b}	6.60^{a}	6.61^{a}	0.000	0.0252
Titratable Acidity (%)	0.53^{a}	0.51^{b}	0.47^{c}	0.46^{c}	0.000	0.0189
Maturation Index	33.36^{d}	34.57^{c}	36.85^{b}	37.23^{a}	0.000	0.0377
Iron (mg 100g^{-1})	0.62^{a}	0.61^{a}	0.55^{b}	0.52^{c}	0.000	0.0126
Potassium (mg 100g^{-1})	298.53^{a}	296.87^{b}	281.55^{c}	278.02^{d}	0.000	0.0000
Calcium (mg 100g^{-1})	3.87^{a}	3.80^{b}	2.41^{c}	2.01^{d}	0.000	0.0129
Phosphorus (mg 100g^{-1})	121.71^{a}	119.49^{b}	97.93^{c}	89.76^{d}	0.000	0.0000
Zinc (mg 100g^{-1})	0.80^{a}	0.79^{b}	0.60^{c}	0.45^{d}	0.000	0.0064

Row means with the same letters are not significantly different at 5% level.

Table 4. Effects of compost tea on sensory (organoleptic) properties of sweet corn kernels.

Sensory (Organoleptic) properties	Treatment				P-Value	F-LSD $_{0.05}$
	500 kg ha^{-1} NPK Fertilizer	1kg 10L^{-1} Compost tea	1kg 20L^{-1} Compost tea	1kg 30L^{-1} Compost tea		
Perceived Sweetness Scores	7.17^{d}	9.00^{a}	8.02^{b}	7.48^{c}	0.000	0.0129
Perceived Tenderness Scores	7.38^{c}	8.46^{a}	7.60^{b}	7.34^{d}	0.000	0.0069
Perceived Juiciness Scores	8.15^{d}	8.53^{a}	8.40^{b}	8.22^{c}	0.000	0.0126
Overall Acceptability Scores	7.50^{c}	9.00^{a}	7.59^{b}	7.33^{d}	0.000	0.0630
Quality Index (QI)	30.20^{d}	34.99^{a}	31.61^{b}	30.37^{c}	0.000	0.1261

Row means with the same letters are not significantly different at 5% level.

CONCLUSION

The number of kernels per ear is one of the most important physical parameters for producing sweet corn suitable for canning. The 1 kg of compost per 10 L of water compost tea and mineral (NPK) fertilizer treatments gave the best ear characteristics compared to other treatments. Water and sugar contents, reported as the main attributes of the sweet corn quality for processing, also represent important parameters to be considered in selecting variety to avoid Mallard reaction and loss in kernel tenderness. The 1 kg of compost per 10 L of water compost tea and mineral (NPK) fertilizer treatments exhibited the higher content of total soluble sugars compared to other treatments. With regards to analysis of the sensory characteristics of sweet corn, the 1 kg of compost per 10 L of water compost tea treatment specifically, provided improvement for Quality Index which represented the overall sensory score of the sweet corn and thus higher preferences by the consumers. The data obtained in this study allowed presuming that the 1 kg of compost per 10 L of water compost tea should be used as a valid and promising alternative to the use of chemical stimulants in sweet corn cropping systems. It could be concluded possibility utilizing 1 kg of compost per 10 L of water compost tea to produce a good yield and quality of sweet corn without mineral fertilizers. Nevertheless, other studies need to be carried out over several years in order to assess the behavior of studied cultivars in longer terms for canning processing. It would be relevant to consider the edaphic characteristics, in particular by advanced physical and chemical analyses of the soil, for a better adaptation to amounts of fertilization. Further tests need to be conducted in order to collect data on post-harvest storage and suitability for sweet corn production as well as canning processing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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