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Phytochemicals of tomato (*Solanum lycopersicum* var dwarf gem) as influenced by nutritional treatments.

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ABSTRACT

A study on the phytochemical content of tomato (var dwarf gem) variety as influenced by nutritional treatments was carried out at Nnamdi Azikiwe University Awka. Randomisd Complete Block Design was used for the study. Twenty bucketswere filled with 30kg of sandy loamy soil. Goat pellets was used as the organic manure while for the inorganic manure, fertilizer (NPK 15:15:15) was used to treat the soil. There were ten treatments including the Control. The results on the various treatments revealed that for the Saponin content, the highest value of 1.50±0.002, was from the plant treated with organic fertilizer in combination with Phosphorus, Nacl and bicarbonate. Tannin had the highest value of 1.68±0.003 from the plant treated with inorganic fertilizer in combination with Nacl and Bicarbonate. Alkaloid and Flavonoid had their highest values of 4.02±0.010 and 2.61±0.001respectively from the plants fed with organic and inorganic fertilizers. Phenol recorded its highest value of 1.58±0.004 and for Steroid, 2.58±0.004. The lowest shoot phytochemicals was obtained from the Control. There were significant differences among the various treatments, P=0.05. The results from the root phytochemicals revealed that the highest values for Saponin, Steroid and Phenol were from the roots of the plants treated with Oraganic and inorganic fertilizers combined. Tannin was from the plant supplied with organic and inorganic in combination with Nacl and bicarbonate while for the Steroid, was from the plant treated with organic fertilizer only. In all the root experinments, there were significant differences among the various treatments. The lowest was from the Control.

Keywords: Phytochemical, tomato, *Solanum lycopersicum and* nutritional treatments.

INTRODUCTION

Tomato, *Lycopersicum esculentum* Mill. (*Solanum lycopersicum* L.) is one of the most popular and widely consumed important vegetable worldwide. It is grown because of its edible fruit [1, 2, 3, 4]. The crop belongs to the family *Solanaceae,* genus *lycopersicon,* (Solanum) which is a relatively small genus within the large and diverse family consisting of approximately 90genera [5, 6, 7,8] species are native to Ecuador, Peru and the Galapagon Island though most evidence suggests that the site of domestication was Mexico [9,10,11,12]. The plant grows up to 1-3 meters (3-10ft) in height and has a weak stem that often sprawls over the ground. In its native habitat, it is a perennial although often grown outdoors in temperate climate as an annual. In Nigeria, tomato crops are grown both during wet and dry seasons but they attract higher profit during the dry season when the demand is higher than the supply [13,14,15]. However wet season production is affected by damping off. Tomatoes play a vital role in human diet and are a good source of vitamins and minerals. The fruits are eaten raw or cooked and can be processed into soup, juice, sauce, ketchup, puree, paste and powder [16,17,18,19,20]. They also serve as ingredient in stews and vegetable salads. In northern Nigeria, the fruits are sliced and dried for sale.

Tomato (*Solanum lycopersicum* L.) is a widely grown and versatile vegetable throughout the world for taste, colour, high nutritive value and

diversified use. Tomato fruit contains mainly fibre, phytonutrient, vitamin A, C, B complex and carotenoids. Carotenoids include beta-carotene and lycopene, where beta-carotene is a Provitamin and lycopene is a bright red carotene which has antioxidant properties two times higher than beta-carotene in destruction of free radicals [21,22,23,24].

Colour is the most important quality indication of tomato fruits. Pigmentation of red ripe tomato fruit is a result of synthesis of carotenoids, lycopene and B-carotene [25,26,27]. Lycopene in tomato is responsible for the redness and beta-carotene can cause orange colouration. Intense red colour indicates predominant amount of lycopene and high level of antioxidants, which prevents cancerous and cardiovascular diseases [28,29,30]. Tomatoes contain a variety of phytochemicals, including carotenoids and polyphenols. In tomato and tomato products, lycopene is the carotenoid with the highest concentration, but tomato also contain other carotenoids including phytotene, phytofluene and the provitamine A carotenoid and Beta- carotene [31]. Phenolic compounds are secondary metabolites in fruits and vegetables. Saponins are a group of metabolites fond distributed in the plant kingdom and may be considered as part of plants´ defense system. The tannin-containing plant extracts are used in medicine especially in Asia, as natural healing. Phenols are naturally and abundantly found in plants as amazing secondary metabolites. Flavonoids, they belong to a class of plant secondary metabolites having a polyphenolic structure, widely found in fruits, vegetables and certain beverages. Alkaloids are naturally occurring nitrogen-containing organic compound and are also regarded as secondary metabolites synthesized by plants help them to survive and reproduce in their natural environments [32,33,34].

Tomato (*Solanum lycopersicum* L.) serves as a source of livelihood and food to many rural farmers. Farmers prefer to cultivate tomato because of its high demand in the market, good return and reasonably good yield [35,36,37,38]. A positive correlation between the yields of tomato and high income to farmers when it is cultivated on large scale has also been reported by [39,40,41,42]. Owing to high food value, the rise and demand on tomatoes is rising day by day. However, its production is affected by many types of stresses (biotic and abiotic) like diseases caused by fungi, bacteria, viruses and nematodes [38,43,44,45]. There are many environmental stresses which influence negatively on the growth and production of crops. Such other factors include high temperature, draught, salinity and its vulnerability to frequent insects and pests' attacks. Damping off is a serious disease of tomato and other vegetables such as beans, okra, egg plant and flowers with up to 30% yield loss [46,47,48,49,50]. In light of the high economic impact of damping off and negative environmental effects generated by conventional fungicide-based control strategies, there is need to develop alternative and sustainable solutions to manage damping off. Nature has provided a great wealth of resistances that are available in the wild species and many of these resistances are simply inherited [51,52,53,54].

It has been shown that a large variety is present and exploitable from wild *Solanum* species but most of them are still untapped. Human beings from 20th century have created a huge array of morphologically different cultivars and forms from the single species of *Solanum lycopersicum* via plant breeding. Scientists and breeders have also developed modern tomato varieties (mostly hybrids) with all shapes, colours and sizes through research, domestication and breeding activities. The genetic variation present in the wild species has been investigated intensively for specific traits and it is been exploited in tomato breeding [55,56,57,58]. Instead of exporting these genetic materials, there is the need to uphold these qualities in the wild varieties by improving them in quality and

quantity. This is because the wild species have a rich reservoir compared to the cultivated tomato that is genetically poor with >5% of the genetic variation in their wild relatives [59,60,61]]. This study therefore intends to meet the need of quality and quantity improvement of tomato. This is in the context of achieving high yield and long post-harvest shelf life which still present major challenges. According to Davis et al., the intensive breeding of crops with a focus on yield over the past half Century has indirectly led to reduction in flavor and nutrient content. Wild tomato species have tiny fruits made to propagate the species [48,49,50]. The local tomato has high water content. It has sour taste and the skin is usually very thin which results to the fruit becoming very soft and cracks few minutes after harvesting. Interestingly however, it is resistant to common diseases such as damping off. Hence the need to use various propagation techniques and nutritional treatments to improve the local tomato, in order to achieve a bigger, low water content, firmer tomato with thicker skin so as to increase the shelf life of the tomato in Nigeria.

MATERIALS AND METHODS

SOURCE OF MATERIALS

Tomato fruits of the variety dwarf gem used for this experiment were purchased from Agricultural Development Program (ADP) Awka, under special arrangement with an Extension officer with Awka South Local Government. In selecting for seed extraction, efforts were made to collect seeds from self-pollinated variety so as to maintain true to type. The seeds were selected and washed thoroughly with tap water. The washed seeds were air dried under room temperature and stored in air tight plastic containers prior to use. Plastic containers used in this experiment were purchased from a dealer in Eke Awka. The plastic containers were perforated below for easy drainage. However, a mesh (0.2mm-0.5mm) was cut and placed inside the bucket to hold the soil. Prior to planting, the seeds were soaked in water for 3 hours to help imbibition. The different nutritional chemicals were purchased from Gepet Laboratory Chemicals and Equipment Ltd Onitsha while NPK fertilizer 15:15:15 was obtained from ADP Awka. Farm yard manure (goat pellets) was obtained from a goat rearer in Enugwu-Ukwu, Anambra State under special arrangement.

SOURCE OF SOIL

The soil used for planting was collected within abandoned farm land in Nnamdi Azikiwe University Awka.

PREPARATION OF NURSERY

Four plastic containers measuring 48cm×28cm×20cm (L × B × H) were perforated below and filled with loamy soil. The soil filled plastic containers were watered for two days before planting.

PLANTING AND GERMINATION

The seeds were planted by broadcasting method; the broadcasted seeds were then covered with light layer of soil to encourage imbibition. The set-up was watered every 2 days and continued till transplanting.

TRANSPLANTING

A total of twenty plastic buckets were filled with 30kg soil. Each treatment had two buckets. Each bucket had two plants after thinning. So each treatment had four plants. Fourteen plastic buckets were filled with 30kg of soil mixed with 0.32kg of goat pellets mixture. Six similar plastic buckets were also filled with 30kg of soil without the organic manure. All the soil filled plastic buckets were watered daily for three days before transplanting. Following germination of the seeds in the nursery, the seedlings were transplanted after 28 days of growth (28 DAP). Three seedlings were transplanted into each bucket in the evening and watered day and night for 7 days to encourage stabilization. Following stabilization,

the plants were thinned to two per bucket and their respective treatments were applied as in the design.

EXPERIMENTAL DESIGN

Using randomized complete block design, the plastic buckets were separated into treatments including the control. Each treatment comprised of 3 plastic buckets.

The treatments were distributed as below;

I. Control
2. Organic
3. Inorganic
4. Organic + Inorganic
5. Organic + Nacl + Bicarbonate
6. Inorganic + Nacl + Bicarbonate
7. Organic + Inorganic + Nacl + Bicarbonate
8. Organic + Nitrogen + Nacl + Bicarbonate
9. Organic + Phosphorus + Nacl + Bicarbonate
10. Organic + Potassium + Nacl +Bicarbonate

Plants which received inorganic fertilizer treatments were treated with the fertilizer (NPK 15:15:15) 14 days after transplanting (42 DAP). Measurements of growth of the whole plants started seven days after fertilizer application (49 DAP).

FARM YARD MANURE (Goat pellets)

The 30kg of soil contained by each plastic bucket used for organic manure treatments was incorporated with 0.32kg of goat pellets. The manure was mixed with the soil and buckets filled. Thereafter, the set-up was watered for 7 days to aid ammonification before transplanting took place.

PREPARATION OF STOCK SOLUTIONS

Nutrient solution of each treatment was prepared. For each of them, 2mM concentration was used as stock solution. Sources of the minerals included;

i. Nitrogen sourced from Sodium nitrate ($NaNO_3$)
ii. Phosphorus sourced from Sodium biphosphate
iii. Bicarbonate sourced from Potassium hydrogen carbonates (K_2HCO_3)
iv. Salinity sourced from Sodium Chloride (Nacl)
v. Potassium sourced from Potassium nitrate (KNO_3)

INORGANIC FERTILIZER

The inorganic fertilizer used was N.P.K 15:15:15. This was applied as a single dose. It was applied two weeks after transplanting when the plants were already stabilized

Control

Plastic buckets for the control plants had only the 30kg of soil.

TREATMENTS

Application of various supplements (nutritional chemicals) also started 42 DAP when the inorganic fertilizer was applied. The plants were allowed to stabilize for 1week before various measurements started.

PHYTOCHEMICAL STUDIES

Fresh parts of the leaves and stem each were oven-dried for 4hrs at 105°C.The dried samples were ground to a fine powder by the use of a corona grinding machine. The dried powdered samples of the shoot and root were used for quantitative analyses.

QUANTITATIVE DETERMINATION OF THE PHYTOCHEMICALS

DETERMINAITON OF SAPONINS

The saponins in the samples were determined by double extraction gravimetric method [16]. Five grams (5g) each of the powdered samples was mixed with 50mls of 20% aqueous ethanol solution in a flask. The mixture was heated with periodic agitation in water bath for 90 minutes at 550C. It was then filtered through Whatman filter paper (No. 42). The residue was

extracted with 50mls of 20% ethanol and both extracts were poured together and the combined extract was reduced to about 40mls at 900C and transferred to a separating funnel where 40mls of diethyl ether was added and shaken vigorously. Separation was by partition during which the ether layer was discarded and the aqueous layer reserved. Re- extraction by partitioning was done repeatedly until the aqueous layer became clear in colour. The saponins were extracted with 60 mls of normal butanol. The combined extracts were washed with 5% aqueous sodium chloride (NaCI) solution and evaporated to dryness in a pre-weighed evaporation dish. It was dried at 600C in oven and re-weighed after cooling in a dessicator. The process was repeated two more times to get an average. Saponins content was determined by difference and calculated as a percentage of the original sample as follows:

$$\% \text{ Saponin} = \frac{W2-W1}{\textit{Weight of sample}} \times \frac{100}{1}$$

Where:-
W1 = weight of evaporated dish
W2= weight of dish + sample

TANNIN DETERMINATION

The tannin content of the leaves, stem and root were determined using Folin Dennis spectrophotometric method described by Pearson [42].

Two grams (2g) of each of the powdered samplses was mixed with 50ml of distilled water and shaked for 30 minutes in the shaker. The mixture was filtered and the filtrate used for the experiment. Five milliliter (5ml) of the filtrate was measured into 50ml volumetric flask and diluted with 3ml of distilled water. Similarly 5ml of standard tanuric acid solution and 5ml of distilled water was added separately. One milliliter (1ml) of Folin-Dennis reagent was added to each of the flask, followed by 2.5mls of saturated sodium carbonate solution. The content of each flask was made up to mark and incubated for 90 minutes at room temperature. The absorbance of the developed colours was measured at 760nm wavelength with the reagent blank at zero.

The process was repeated two more times to get an average

The tannin content was calculated as follows:

$$\% \text{ Tannin} = \frac{100}{W} \times \frac{AY}{AS} \times \frac{C}{100} \times \frac{VF}{VA} \times D$$

Where:-
W = weight of sample analysed
AY = Absorbance of test sample
AS = Absorbance of standard solution
VF = Total volume of filtrate
C = Concentrate of standard in mg/ml
VA = Volume of filtrate analysed
D = Dilution factor.

DETERMINATION OF PHENOLS

The concentration of phenols in the leaf, stem and roots of *Lycopersicum esculentum* was determined using the folin-ciocaltean colorimetric method described by [42]. 0.2g of each of the produced sample was added into a test tube and 10mls of methanol was added to it and shaken thoroughly; the mixture was left to stand for 15 minutes before filtered using Whatman (No. 42) filter paper. One milliliter (1ml) of the extract was placed in a test- tube and 1ml of folin-ciocaltean reagent in 5mls of distilled water was added and colour was allowed to develop for about 1-2 hours at room temperature. The absorbance of the developed colour was measured at 760nm wavelength. The process was repeated two more times and an average taken.

The phenol content was calculated as follows:

$$\%\text{Phenol} = \frac{100}{W} \times \frac{AU}{AS} \times \frac{C}{100} \times \frac{VF}{VA} \times D$$

Where:-

W = Weight of sample analyzed
AU = Absorbance of test sample
AS = Absorbance of standard solution
C = Concentration of standard in mg/ml
VF = total filtrate volume
VA= Volume of filtrate analyzed
D = Dilution factor.

ALKALOID DETERMINATION

The determination of the concentration of alkaloid in the leaf, stem and roots of *Lycopersicum esculentum* was carried out using the alkaline precipitation gravimetric method described by [16]. Five grams (5g) of each of the powdered samples was soaked in 20mls of 10% ethanolic acetic acid. The mixture was stood for four (4) hours at room temperature. Thereafter, the mixture was filtered through Whatman filter paper (N0. 42). The filtrate was concentrated by evaporation over a steam bath to ¼ of its original volume. To precipitate the alkaloid, concentrated ammonia solution was added in drops to the extract until it was in excess. The resulting alkaloid precipitate was recovered by filtration using previously weighed filter paper. After filtration, the precipitate was washed with 9% ammonia solution and dried in the oven at 600C for 30 minutes, cooled in a dessicator and reweighed. The process was repeated two more times and the average was taken. The weight of alkaloid was determined by the differences and expressed as a percentage of weight of sample analyzed as shown:

$$\%\ \text{Alkaloid} = \frac{W2-W1}{Weight\ of\ sample} \times \frac{100}{1}$$

Where:-

W1 = weight of filter paper
W2= weight of filter paper + alkaloid precipitate

STEROID DETERMINATION

The steroid content of the leaves, stem and root of the plant was determined using the method described by [16]. Five grams (5g) of the powdered sample was hydrolyzed by boiling in 50ml hydrochloric acid solution for about 30minutes.

It was filtered using Whatman filter paper (No. 42). The filtrate was transferred to a separating funnel. Equal volume of ethyl acetate was added to it, mixed well and allowed to separate into two layers. The ethyl acetate layer (extract) recovered, while the aqueous layer was discarded. The extract was dried at 1000C for 5minutes in a steam bath. It was then heated with concentrated amyl alcohol to extract the steroid.

The mixture becomes turbid and was reweighed. Whatman filter paper (No. 42) was used to filter the mixture properly. The dry extract was cooled in a dessicator and re-weighed. The process was repeated two more times and an average was obtained.

The concentration of steroid was determined and expressed as a percentage thus:

$$\%\ \text{Steroid} = \frac{W2-1}{Weight\ of\ sampl} \times \frac{100}{1}$$

Where:-

W_1 = weight of filter paper
W_2= weight of filter paper + steroid.

FLAVONOID DETERMINATION

The flavonoids content of the leaf, stem and roots of *Lycopersicum esculentum*

The solution was allowed to boil for 30 minutes. The boiled mixture was allowed to cool before it was filtered through Whatman filter paper (No. 42). Ten milliliters (10mls) of ethyl acetate extract which contained flavonoids was recovered while the aqueous layer was

discarded. A pre-weighed Whatman filter paper was used to filter the second (ethyl-acetate layer), the residue was then placed in an oven to dry at 600C. It was cooled in a dessicator and weighed. The quantity of flavonoids was determined using the formula:

$$\% \text{ Flavonoids} = \frac{W2 - W1 \times 100}{\text{Weight of sample}}$$

Where:-
W_1 = weight of empty filter paper,
W_2= weight of filter paper + Flavonoids extract

RESULTS

The results of the shoot phytochemical analysis revealed that highest saponin content of (1.50±0.002) was recorded in the plant sample supplied with organic fertilizer in combination with phosphorus, Nacl and Bicarbonate, This was followed by the plant fed with inorganic fertilizer in combination with Nacl and Bicarbonate, with a mean value of 1.45±0.001. The least value which was significantly different from the rest of the treatments was obtained from the Control with a value of 0.43±0.003. It was observed that significant differences exist among the treatments (Table 1).

Table 1: Saponin Composition of tomato shoot as influenced by treatments (mg/g)

Treatments	Mean Shoot Saponin Content of Tomato ± SD
T1	0.43 ± 0.003^{j}
T2	1.22 ± 0.003^{e}
T3	1.19 ± 0.003^{f}
T4	0.68 ± 0.001^{i}
T5	1.39 ± 0.003^{d}
T6	1.45 ± 0.001^{b}
T7	1.43 ± 0.003^{c}
T8	0.74 ± 0.001^{h}
T9	1.50 ± 0.002^{a}
T10	0.83 ± 0.003^{g}

Results are In Means ± SD. Means ± SD followed by similar superscripts are not significantly different at P=0.05.

The result of the Tannin content of the shoot phytochemical revealed that the highest mean value of 1.68 ± 0.003 was obtained from the plant treated with inorganic fertilizer in combination with Nacl and BICA. This was followed by the plants treated with organic fertilizer in combination with Nitrogen, Nacl and BICA, organic fertilizer in combination with Potassium, Nacl and BICA and organic and inorganic fertilizer in combination with Nacl and BICA with the values (1.52±0.002; 1.43±0.005 and 1.42 ± 0.001). The plant treated with inorganic fertilizer gave the least value of 0.44±0.576. This value was significantly different from the results of the rest of the treated plants. (Table 2)

Table 2: Tannin composition of tomato shoot as influenced by treatments (mg/g)

Treatments		Tannin Content (mg/g)
T1		0.75 ± 0.002^{de}
T2		1.07 ± 0.003^{cd}
T3		0.44 ± 0.576^{e}
T4		1.06 ± 0.003^{cd}
T5		1.27 ± 0.002^{bc}
T6		1.68 ± 0.003^{a}
T7		1.42 ± 0.001^{ab}
T8		1.52 ± 0.002^{ab}
T9		1.30 ± 0.003^{bc}
T10		1.43 ± 0.005^{ab}

The result from Alkaloid content of the tomato shoot showed that the highest mean value of 4.02±0.010 was obtained from the plant supplied with organic and inorganic fertilizers. This was followed by the mean value of 3.15±0.00 from the tomato plant grown with organic and inorganic fertilizer in combination with Nacl and Bicarbonate. The least mean value of 1.05±0.043 was obtained from the Control plants (Table 3).

Table 3: Alkaloid Composition of tomato shoot as influenced by treatments

Treatments	Alkaloid Contents (mg/g)
T1	1.05 ± 0.043^{h}
T2	2.81 ± 0.005^{d}
T3	2.18 ± 0.002^{g}
T4	4.02 ± 0.010^{a}
T5	2.19 ± 0.002^{g}
T6	2.63 ± 0.002^{e}
T7	3.15 ± 0.001^{b}
T8	2.89 ± 0.002^{c}
T9	2.81 ± 0.005^{d}
T10	2.56 ± 0.002^{f}

Results are in Means ± SD. Means ± SD followed by similar superscripts are not significantly different.

The result from Steroid content of the shoot showed that the highest content was obtained from the plant grown with inorganic fertilizer with a value of 2.58±0.004. This was followed by the plant treated with organic and inorganic fertilizers with a value of 2.33±0.005. The least mean value of 1.10±0.004 was obtained from the Control plants. (Table 4).

Table 4: Steroid composition of the tomato shoot as influenced by treatments (mg/g)

Treatments	Steroid Content mg/g
T1	1.10 ± 0.004^{j}
T2	2.16 ± 0.005^{d}
T3	2.58 ± 0.004^{a}
T4	2.33 ± 0.005^{b}
T5	2.09 ± 0.003^{f}
T6	2.11 ± 0.004^{e}
T7	2.20 ± 0.003^{c}
T8	1.92 ± 0.003^{g}
T9	1.77 ± 0.002^{i}
T10	1.79 ± 0.002^{h}

Results are in Means ± SD. Means ± SD followed by similar superscripts are not significantly different at P=0.05.

The result obtained from the Phenol content of the tomato shoot showed that the highest mean value of 1.58±0.004 was from the plant treated with organic fertilizer, in combination with Nacl and Bicarbonate. This was followed by the mean value of 1.44±0.001 obtained from the plant grown with organic and inorganic fertilizers in combination with Nacl and Bicarbonate. The Control gave the least mean value of 0.22±0.003 (Table 5).

Table 5: Phenol composition of the tomato shoot as influenced by treatments (mg/g)

Treatments	Phenol Content mg/g
T1	0.22 ± 0.003^{i}
T2	0.40 ± 0.003^{h}
T3	0.79 ± 0.001^{e}
T4	0.86 ± 0.002^{c}
T5	1.58 ± 0.004^{a}
T6	0.76 ± 0.002^{f}
T7	1.44 ± 0.001^{b}
T8	0.71 ± 0.002^{g}
T9	0.79 ± 0.000^{e}
T10	0.82 ± 0.002^{d}

Results are Means ± SD. Means ± SD followed by similar superscripts are not significantly different at P=0.05.

The result from the Flavonoid content of the tomato, *Solanum lycopersicum* revealed that the highest mean value of 2.61±0.001 was obtained from the tomato plant treated with organic and inorganic fertilizers. This was followed by the plant fed with inorganic fertilizer with a mean value of 2.59±0.003. The least mean value of 0.75±0.003 was obtained from the Control plants. (Table 6)

Table 6: Flavonoid composition of the tomato shoot as influenced by treatments (mg/g)

Treatments	Flavonoid Content mg/g
T1	0.75 ± 0.003^{j}
T2	2.39 ± 0.005^{c}
T3	2.59 ± 0.003^{b}
T4	2.61 ± 0.001^{a}
T5	1.10 ± 0.000^{f}
T6	1.40 ± 0.002^{e}
T7	1.99 ± 0.004^{d}
T8	0.97± 0.001^{g}
T9	0.94 ± 0.002^{h}
T10	0.85 ± 0.002^{i}

Results are in Mean ± SD. Means ± SD followed by similar superscripts are not significantly different at P=0.05.

Root Phytochemicals

The results from the root phytochemicals of the tomato plants revealed that the Saponin content was highest in the plant supplied with organic and inorganic fertilizers with a mean value, 3.48±0.002. It was observed that this was followed by the mean value, 2.15±0.002, recorded by the plant grown with inorganic fertilizer. The least value of 0.46±0.003 was obtained from the Control plant. Table 7: Saponin composition of tomato root as influenced by treatments (mg/g).

Treatments	Saponin Content mg/g
T1	0.46 ± 0.003^{j}
T2	1.95 ± 0.002^{c}
T3	2.15 ± 0.002^{b}
T4	3.48 ± 0.002^{a}
T5	1.62 ± 0.002^{d}
T6	1.56 ± 0.001^{e}
T7	1.29 ± 0.003^{f}
T8	1.24 ± 0.001^{g}
T9	1.18 ± 0.001^{h}
T10	1.07 ± 0.002^{i}

Results are in Means ± SD. Means ± SD followed by similar superscripts are not significantly different at P=0.05

The result on the Tannin content of the tomato root revealed that the highest value of 1.53±0.003 was obtained from the plants fed with organic fertilizer in combination with Nacl and Bicarbonate. This was followed by the mean value of 1.45±0.003 got from plant treated with organic manure and inorganic fertilizer in combination with Nacl and Bicarbonate. The treatment with the least tannin content of 0.29±0.004 was the Control plants. (Table 8).

Table 8: Tannin composition of tomato roots as influenced by treatments (mg/g)

Treatments	Tannin Content mg/g
T1	0.29 ± 0.004^{j}
T2	0.62 ± 0.005^{h}
T3	0.57 ± 0.004^{i}
T4	1.09 ± 0.005^{e}
T5	1.53 ± 0.003^{a}
T6	1.31 ± 0.004^{c}
T7	1.45 ± 0.003^{b}
T8	1.27 ± 0.003^{d}
T9	0.64 ± 0.002^{g}
T10	0.96 ± 0.002^{f}

Results are in Means ± SD. Means ± SD followed by similar superscripts are not significantly different at P=0.05.

The result of the Alkaloid content showed that the highest mean value of 1.69±0.009 was obtained from the plants treated with organic manure and inorganic fertilizer. This was followed by the mean value of 1.52±0.010, obtained fertilizer. The least mean value of 0.46±0.003 was from the Control plants. There was however no significant differences in the Alkaloid contents of the plants treated with organic fertilizer, Nacl and Bicarbonate and inorganic fertilizer, Nacl and Bicarbonate and also between the treatments, organic fertilizer, Nitrogen, Nacl and Bicarbonate and organic fertilizer, Phosphorus, Nacl and Bicarbonate, (P=0.05). (Table 9)

Table 9: Alkaloid composition of tomato root as influenced by treatments

Treatments	Alkaloid Content mg/g
T1	0.46 ± 0.003^{h}
T2	1.52 ± 0.010^{b}
T3	1.51 ± 0.005^{c}
T4	1.69 ± 0.009^{a}
T5	1.14 ± 0.001^{e}
T6	1.15 ± 0.004^{e}
T7	1.33 ± 0.002^{d}
T8	1.07 ± 0.003^{g}
T9	1.06 ± 0.004^{g}
T10	1.08 ± 0.002^{f}

Results are in Means ± SD. Means ± SD followed by similar superscripts are not significantly different at P=0.05.The result of the Steroid content of the root of the tomato plant showed that the highest value of 2.01±0.001 was found in the plant fed with organic and inorganic fertilizers combined. This was followed by the plant treated with organic fertilizer with a mean value of 1.76±0.002. The least value of 0.30±0.003 was from the Control plant. (Table 10)

Table 10: Steroid composition of tomato root as influenced by treatments (mg/g)

Treatments	Steroid Content mg/g
T1	0.03 ± 0.003^{j}
T2	1.76 ± 0.002^{b}
T3	1.41 ± 0.001^{c}
T4	2.01 ± 0.001^{a}
T5	1.14 ± 0.002^{e}
T6	0.93 ± 0.001^{f}
T7	1.30 ± 0.003^{d}
T8	0.80 ± 0.002^{g}
T9	0.65 ± 0.002^{i}
T10	0.72 ± 0.002^{h}

Results are in Means ± SD. Means ± SD followed byy similar superscripts are not significantly different at P= 0.05. Results of the root Phenol content showed that the plant grown with organic and inorganic fertilizers had the highest value of 1.41±0.001. This was followed by the plant fed with organic fertilizer with a mean value of 1.38±0.002. The least phenol content was observed in the Control experiment with a mean value of 0.39±0.003. There are significant differences among the various treatments (Table 11).

Table 11: Phenol composition of tomato root as influenced by treatments (mg/g)

Treatments	Phenol Content mg/g
T1	0.39 ± 0.003^{j}
T2	1.38 ± 0.002^{b}
T3	0.99 ± 0.001^{c}
T4	1.41 ± 0.001^{a}
T5	0.48 ± 0.002^{h}
T6	0.46 ± 0.001^{i}
T7	0.82 ± 0.003^{d}
T8	0.65 ± 0.002^{e}
T9	0.52 ± 0.002^{g}
T10	0.53 ± 0.002^{f}

Results are in Means ± SD. Means ± SD followed by similar superscripts are not significantly different at P=0.05. The result of the Flavonoid content of the tomato root revealed that the highest mean value of 1.59±0.003 was obtained from the plants treated with organic fertilizer. This was followed by a mean value of 1.31±0.002 obtained from the plants treated with inorganic fertilizer. The least value of 0.30±0.004 was

obtained from the Control plants. (Table 12).

Table 12: Flavonoid composition of tomato root as influenced by treatments (mg/g)

Treatments	Flavonoid Content mg/g
T1	0.30 ± 0.004^{j}
T2	1.59 ± 0.003^{a}
T3	1.31 ± 0.002^{b}
T4	1.28 ± 0.003^{c}
T5	0.71 ± 0.003^{h}
T6	0.66 ± 0.004^{i}
T7	1.17 ± 0.004^{d}
T8	1.02 ± 0.003^{e}
T9	0.72 ± 0.003^{g}
T10	0.95 ± 0.002^{f}

Results are in Means ± SD. Means ± SD followed by similar superscripts are not significantly different at P=0.05.

DISCUSSION

The results of the phytochemical assay carried out on the shoots and roots of the tomato plants revealed varied concentration of the phytochemicals in different parts of the plant was influenced by variation in treatments. Phytochemicals also known as Secondary metabolites which are non-nutritive plant chemicals are synthesized by plants for their protection against predators and herbivores [8,14,18]. These complex molecules are found in most vitamins and minerals and play significant role in disease prevention. However, recent studies indicate that phytochemicals are associated with the prevention of certain chronic diseases including cardiovascular disease, cancer, diabetes, osteoporosis and vision diseases in human [19,20,30,45]. Phytochemical compounds have the ability to ameliorate various diseases by either preventing such diseases or curing them. The result of the phytochemicals revealed that the saponin content in the root was highest in the plant treated with organic and inorganic fertilizer while in the shoot, the saponin content was highest in the plant treated with organic fertilizer, phosphorus, Nacl and bicarbonate. The least saponin content was found in the Control plants (Table 1). Plant production of biotic compounds is not just affected by genetics but by soil fertility which plays an important role. The relative differences in the release of nutrients from various fertilizers could lead to a difference in the production of Secondary metabolites [30,35,37]. The increase in the production of secondary metabolites under organic fertilization in the present study might be due to high nutrient content of the organic fertilizer used. Plants grown under organic agricultural conditions are reported to have high nutrient content in more cases than conventionally grown plants [38,39,32]. This is considering the fact that some of the chemical reactions in the cells involve minor elements either directly or indirectly. It is known that salinity reduces transport of certain materials up the plant even when they are present in the soil [36,40,47]. This may have influenced the availability of precursors of this secondary metabolites that reduces their content in plants exposed to salinity. This could explain why organic fertilizer treated plants and a mixture of organic and inorganic fertilized plants exhibit higher production of secondary metabolites [44]. Fertilization of course has been reported to have influence on the phyto nutritional quality of crops.

The tannin content was highest in the root and shoot of the tomato plants treated with Organic and inorganic fertilizers, organic fertilizer in combination with Nacl and bicarbonate and inorganic fertilizer in combination with Nacl and bicarbonate respectively. This was followed by Control plant in the fruits. Tannins have been extensively studied in a variety of plants, in which they are generally present in vegetative tissues such as roots, barks and leaves. Organic fertilizer improves nutritional quality and antioxidant content in plants along with improving the soil health [25] advocated the integrated use of organic and inorganic nutrient sources.

[4], reported significantly higher total phenolics in mirionberries grown with organic fertilizer as compared with inorganic fertilizer. Organic manure as opposed to inorganic fertilizer has also been reported to increase the level of secondary metabolites like phenol, flavonoid and antioxidant activity in plant [17, 18, 19]. [15, 19] reported a 19% higher phenolic content for organically produced apples compared to inorganically produce ones. Higher level of phenolic content was also recorded for organically grown strawberries compared to inorganically cultivate ones [28]. All these reported cases have led to growing preference by consumers for organic agricultural produce [36].

This result however is in agreement with the work of [20,25,28]. They reported that treatment with poultry manure and inorganic fertilizer respectively had no effect on the presence or absence of phenols, flavonoid and steroids in the leaves of *Occinum gratissimum*. This observation might be due to the fact that phytochemicals are naturally synthesized chemical compounds in plant tissues and are therefore present in them irrespective of presence or absence of the fertilizer treatments. According to [7,9,11], plants treated with fertilizer tend to have nutrients like nitrogen and phosphorus which are necessary for the synthesis of phenol.

Phenols are one of the major groups of non-nutritive dietary components that have been associated with the inhibition of cancer, athesrosclerosis and age related generative brain disorder [8,14].The presence of phenolic compounds in any plant reflects the anti-microbial effect of the plant [19, 29]. Results of the Alkaloid content showed that it was highest in the shoot and root in the tomato plant treated with organic and inorganic fertilizers. The Control plants gave the least value (table 1)

Research reports [30,36,39,45] showed that availability of plant nutrients can influence the availability of Phytochemical constituents/secondary metabolites in plants. Nutrients in form of organic manure and inorganic fertilizers have been reported to have an influence on phytochemicals and nutritional quality of crops [41,46,50]. The high Alkaloid content in the organic and inorganic treated plant may be as a result of the soil fertility. The low Alkaloid content across the treatments was as a result of the stress caused by Nacl because salinity reduces Alkaloid content .Alkaloids are one of the most diverse group of secondary metabolites found in plants, marine organisms and microorganisms. Alkaloids have been well known for their biological activity since the beginning of human civilization. They were used to cure diseases and at the tip of weapons as toxins. The maximum amount of alkaloid contained in leaves, followed by fruits/seeds, root and bark.

The major essence of crop cultivation is for consumption in order to derive nutrients for proper growth and development of the body. Even though nutrients are derived from food crops, it is not disputable that food crops perform medicinal function in the body. Crop cultivation with the use of different manures gives differences in the nutritional output of crops. This is because the nutrients released from these animal wastes depends largely on the type of feeds and the nutrients contained in such feed [46,48]. Flavonoid was highest in the the shoot of the tomato

plant treated with organic and inorganic fertilizer while in the root, it was highest in the plant treated with organic fertilizer (Table 12). It was also found that the flavonoid content decreased in plants treated with Nacl. This might be because salinity reduces flavonoid content. The flavonoid content of the tomato plants was highest compared to the other phytochemicals. The reason may be because salinity and environmental factors favoured it's production. For healthy growth and optimal yield, nutrients must be available to plants in correct proportion and usable at the right time. To fulfill these requirements, chemical fertilizers and/ or organic manures are needed [50,53,54].

Application of organic fertilizers to plants have been reported to increase the bioactive compounds (and antioxidant) in them [57,59,64]. The increased flavonoid content due to fertilizer application has also been reported in other plants [7,9,15,19]. Flavonoids are found in fruits, herbs, stems, cereals, nuts, vegetables, flowers and seeds [30,34,46]. Flavonoids have been used in natural dyes [45,49], in cosmetics and skin care products [56,58,59] and anti-wrinkle skin agents. Flavonoids are used extensively as anticancer [60], anti-microbial, antiviral, anti angiogenic [61]. It also prevents Cardio-metabolic disorders and the reservation of Cognitive performance with aging (Aguiar et al., 2019). Results of the phytochemical determination showed that the highest Steroid content in the shoot was observed in the tomato plant treated with organic and inorganic fertilizer. This result was in agreement with the findings of [30] who reported that inorganic fertilizer affected the concentration of steroid and in the shoot in the plant fed with inorganic fertilizer. However, the Control plant gave the least Steroid content. This may be because other treatments enriched the soil where the tomato plants grew and yielded higher steroid.

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