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Proximate Composition of Tomato (*Solanum lycopersicum Var Dwarf Gem*) Variety as Influenced by Nutritional Treatments

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ABSTRACT

A study on the proximate composition of tomato (dwarf gem) variety as influenced by nutritional treatments was carried out at Nnamdi Azikiwe University Awka. Randomized Complete Block Design was used for the study. Data was subjected to Analysis of Variance (ANOVA). Twenty buckets was filled with 30kg of sandy loamy soil. Goat pellets was used as the organic manure while for the inorganic fertilizer (NPK 15:15:15) was used to treat the soil. The result of the study revealed that for the Ash and Crude fiber contents, the highest mean values of 1.35±0.002 and 2.08±0.005 were obtained from the fruits of plants treated with organic and inorganic fertilizers in combination with Nacl and Bicarbonate. For the Moisture content, the highest mean value of 31.60±0.036 was gotten from the plants fed with organic fertilizer. The total Carbohydrate and Lipid, had their highest mean of 4.95±0.003 and 1.00±0.050 from the fruits of the plants treated with organic and inorganic fertilizers. The Control of all the treatments gave the least value except the Moisture content that had its least mean value in the plant treated with organic and inorganic fertilizer in combination with Nacl and Bicarbonate. In all the treatments, there were significant differences ($P<0.05$).

Keywords: Proximate, Composition, Tomato, (*Solanum lycopersicum,* Influenced, Nutritional and Treatments.

INTRODUCTION

Tomato, *Lycopersicum esculentum* Mill. Now *Solanum lycopersicum* L. Wild tomato species have fruits made to propagate the species. The local tomato has high water **content [1, 2, 3, 4].** 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 [5, 6, 7, 8]. Hence the need to use various propagation techniques 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 the South-eastern part of the country [9,10,11,12]. Tomato fruit quality is about the constituents especially the nutritional composition. Any effort that will improve the proximate in tomato fruits is encouraged. Such proximates include moisture, Ash, protein, carbohydrates and Fats. Moisture content is an important parameter to determine for a given substance like vegetable. Moisture content expresses the amount of water present in a moist sample. Fruits and vegetables contain high water content so they can help people manage their weight. Therefore consuming foods with high water like vegetable may encourage one to eat less. [13, 14, 15].

Ash content of a plant based food is the function of the mineral element present. Dietary ash has proved helpful in establishing and maintaining acid-alkaline balance of the blood system [16, 17, 18]. The term “total available carbohydrate” may be defined as including all those carbohydrates which can be used in the plant body as a source of energy or as building material, either directly or indirectly after having been broken down by enzymes. Fats are secondary plant products that yield more energy per gram of carbohydrate. Dietary fats are important not only because of their high energy value but the fat-soluble vitamins and essential fatty acids contained in the fat of natural foods. Lipids are one of the major constituents of foods, and are important in our diet for a number of reasons [19, 20]. They are a major source of energy and provide essential lipid nutrients. Fibres are parts of fruits, grains and vegetables which can neither be digested nor absorbed by the human system. Generally, dietary fibres function in the body to slow down the rate of glucose absorption into the blood stream, thereby reducing the risk of hyperglycemia [21, 26, 27, 28]. They also reduce the levels of plasma cholesterol and prevent colon cancer and cardiovascular diseases [9]. The protein content of foods is mostly been determined on the basis of total nitrogen content. Proteins are also the major structural components of many natural foods, often determining their overall texture. They have major role in growth and maintenance. A local variety (dwarf gem) which is of poor quality, has thin skin which easily cracks few hours after harvest, the water content of the tomato is very high, it also has sour taste. However, this variety is resistant to damping off, a common disease among other varieties of tomatoes especially during the rainy season. There is therefore the need, to improve the fruit quality of this local tomato (dwarf gem) to meet the need of Nigerians especially during the rainy season when damping off infection does not allow for appreciable tomato production. One of the methods that can improve fruit quality apart from breeding Technique is nutritional manipulation. Nutrients supplied to a plant influence its yield. Treatments such as salinity, bicarbonate supply and nitrogen source are each able to affect the proximate constituents of the fruit. Proximate composition of a plant, especially vegetables determines the nutritional quality and need of the plant. This research is therefore aimed at influencing the proximate composition of the dwarf gem tomato variety through physiological manipulation-nutrient supply [4, 9].

MATERIALS AND METHODS

SOURCES 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. 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 reduce soil erosion. 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

Soil 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 germination. 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 ten treatments including the control. Each treatment comprised of 6 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 + Bicarbonat
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) fourteen days after transplanting (14 DAT).

PREPARATION OF STOCK SOLUTIONS

The following compounds were used to access improvement in the nutritional content of the plants. For each nutrient, 2mM concentration was prepared

i. For Nitrogen source: Sodium nitrate ($NaNO_3$)
ii. Phosphorus source: Sodium biphosphate
iii. Bicarbonate source: Potassium hydrogen carbonates (K_2HCO_3)
iv. Salinity; Sodium Chloride (Nacl)
v. Potassium source: 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 one week after transplanting when the plants were already stabilize.

Control

Plastic buckets containing 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. For each treatment having two, the plants were used for destructive harvest to measure yield as well as for nutritional analysis.

Proximate Analysis:

The proximate analysis was carried out using various standard methods as below

MOISTURE CONTENT DERTERMINATION

An empty Petri dish was dried in an oven for about 10 minutes and allowed to cool in a desiccators containing calcium chloride for about 20 minutes and then weighed (W_1). The tomato sample (2g) was weighed into the Petri dish (W_2) and placed in an oven at 105^{0}C for 8 hours. It was then brought out, cooled in desiccators and weighed (W_3). The procedure was repeated until a constant weight was obtained. The moisture content was calculated as below:

$$\% \text{ Moisture} = \frac{W2-W3}{W2-W1} \times 100$$

CRUDE FIBER DETERMINATION

The crude fiber was determined using the gravimetric methods of [24]. The crude fiber method gives an estimation of insoluble and indigestible food residue which remains after which the sample has been treated under prescribed conditions. It was determined by consecutive treatment with light petroleum, boiling dilute sulphuric acid, boiling dilute NaOH; dilute HCl, alcohol and ether. The insoluble residue was collected by filtration, dried, weighed and ashed to collect mineral contamination. The defatted sample (2g) obtained during fat determination was air dried and transferred into a 250ml conical flask. 200ml of 1.25% sulphuric acid was added and heated gently for 30 minutes. The flask was rotated every few minutes, in order to mix the content and remove particles from the side. At the end of the 30 minutes boiling period, the acid mixture was allowed to stand for one minute and then filtered using a filter paper. The filtration was so fast and was completed within 2minutes. The insoluble matter was washed with boiling distilled water until the filtrates is free from acid. The insoluble matter was washed back into the flask by means of wash bottle containing 1.25% NaOH and boiled for 30 minutes with the same precaution as those used in the early acid treatment. At the end of the of the 30minutes boiling, the mixture was allowed to stand for one minute and then filtered immediately using a filter paper. The insoluble matter was wash with boiling water until no base is detected in the filtrate. The whole insoluble matter was washed with 1% HCl and finally with boiling water until free from acid, it was then washed twice with alcohol and three times with ether. The insoluble matter was transferred into a dried weighed crucible and then oven-dried at 100^{o}C to constant weight. The crucible and its content was ash in muffle furnace at 550^{o}C and re-weighed. The difference between the weight of ash and the weight of insoluble matter gave the weight of the crude fiber. The crude fibre was calculated as below:

$$\% \text{ Crude fiber} = \frac{Weight\ of\ dried\ insoluble\ matter - weight\ of\ ash}{weight\ of\ sample\ before\ defatting} \times 100$$

CRUDE PROTEIN DETERMINATION

The crude protein content of the sample was determined using the macrokjeldahl method of [24]. The samples were digested with concentrated sulphuric acid, using copper sulphate and sodium sulphate as catalyst to convert organic nitrogen to ammonium ions. Alkali was added and the liberated ammonia was distilled into an excess boric acid. The distillate was titrated with hydrochloric acid or sulphuric acid. One gram (1g) of the dried tomato fruit was weighed and transferred into the kjeldahl digestion flask followed by the addition of 3g of a mixture of sodium sulphate and copper sulphate pentahydrate in the ratio 10:1 as catalyst. Four anti-bumping chips were added to prevent sticking of the mixture to the flask during digestion and also to enhance boiling. The kjeldahl flask content was digested with 25ml concentrated H_2SO_4. The flask was inclined and heated gently at first until frothing ceased, then heated strongly with shakings, at intervals, to wash down charred particles from sides of the flask. Heating was continued until the mixture become clear and free from brown or black colour. This was allowed to cool and the content of the flask made up to 100ml using distilled water. 20ml of this diluted digest was placed in the distillation flask. 50ml of 2% boric acid solution was measured into a conical flask, and few drops of screened methyl red indicator were added into the conical flask. The conical flask and its content were placed on the receiver, so that the end of the delivery tube dips just below the level of the acid. Few pieces of granulated zinc and anti-bumping granules was added to the distillation flask and about 40ml of 40% NaOH solution was run into the flask to make the liquid in the flask alkaline. The content was boiled vigorously until the content of the flask bumps. The distillate was titrated with 0.1N HCl to a purple coloured end point (Vml). The Protein content was calculated as below:

$$\text{Nitrogen (\%)} = \frac{1.4 \text{ x Titre Volume x total volume of digest}}{1000\ x\ \ weight\ of\ Sample\ x\ Aliquot\ distilled} \text{ x } 100$$

Crude Protein (%) = %Nitrogen x 6.25

CRUDE FAT DETERMINATION

The crude fat was determined using soxhlet extraction method of [24]. A 500ml fit round bottom flask was washed and dried in an oven for about 25minutes and allowed to cool in a desiccators before it was weighed (W_1). Five grams (5g) (W) of the sample was weighed

wrapped in a thimble. This thimble and its content were inserted into the extraction column with the condenser. About 350ml of the extracting solvent (n-hexane) was poured into the round bottom flask and fitted into the extraction unit. The flask was heated with the aid of electro thermal heater at 60°C for six hours. Losses of solvent due to heating were checked with the aid of the condenser so that it cooled and refluxed the evaporated solvent. After extraction, the thimble was removed and the solvent salvaged by distillation. The flask and its content were placed on a water bath to evaporate off the solvent. The flask and the residue was transferred to an oven and heated for some minutes to evaporate the remaining solvent and moisture to complete dryness. It was cooled in desiccators and weighed (W_2). The lipid content was calculated as below:

$$\text{Total Lipid} = \frac{W2-W1}{} \text{ x } 100$$

ASH DETERMINATION

Ash represents the inorganic remains after the organic carbonaceous portion and other volatile components have been oxidized and evaporated away. An empty crucible was fire-polished in muffle furnace and allowed to cool in a desiccators containing calcium chloride for 20minutes and then weighed (W_1). Two grams (2g) of the tomato fruit was weighed into the crucible (W_2) and transferred into muffle furnace and heated at 550°C until the sample became completely ash, the crucible was removed and a drop of water was added to expose the unashed portion. The crucible was placed back in the murfle furnace and heated for more 30mins. This was removed and allowed to cool in desiccators after which the crucible with the ash was weighed (W_3). The Ash content was calculated as below:

$$\text{\% Ash} = \frac{W3-W1}{W2-W1} \text{ x } 100$$

DETERMINATION OF TOTAL CARBOHYDRATE

The total percentage carbohydrate content was determined by difference of 100 as reported by [24].

RESULTS

Results of the proximate assay, showed that the Ash content of the fruits varied significantly. The highest Ash content was obtained from the plants treated with organic manure and inorganic fertilizers in combination with Nacl and Bicarbonate, with a value of 1.35 ± 0.002. This was followed by the plants that yielded fruits treated with inorganic fertilizer in combination with Nacl and Bicarbonate, with a value of 1.26 ± 0.003. The least Ash content with a value of 0.31 ± 0.002 was found in the fruit of the Control plant (Table 1)

Treatments	% Ash Composition
T1	0.31 ± 0.002[j]
T2	0.55 ± 0.002[i]
T3	0.65 ± 0.002[h]
T4	0.77 ± 0.002[g]
T5	1.16 ± 0.001[c]
T6	1.26 ± 0.003[b]
T7	1.35 ± 0.002[a]
T8	0.85 ± 0.017[d]
T9	0.81 ± 0.002[f]
T10	0.82 ± 0.003[e]

Results are in Means ± SD. Means ± SD along columns showing different superscripts are significantly different at P=0.05.

Table 1: Percentage Ash Composition Of Tomato Fruits As Influenced By Nutritional Treatments (%)

Results of the Moisture content revealed that the highest value of 31.60±0.036 was found in the fruits treated with organic fertilizer. The value of 31.53±0.010 fruits Moisture content was found in the plant supplied with inorganic fertilizer while the least Moisture content of 30.86±0.010 was observed in the plant treated with organic and inorganic fertilizers in combination with Nacl and Bicarbonate,. The differences among the moisture contents of the fruits of these treated plants were however significant (Table 2).

Table 2: Percentage Moisture Composition of tomato fruits as influenced by nutritional

Treatments	% Moisture Composition
T1	35.28 ± 0.003[d]
T2	31.60 ± 0.063[a]
T3	31.53 ± 0.010[b]
T4	31.33 ± 0.038[c]
T5	30.97 ± 0.017[h]
T6	30.9[i] ± 0.010[hi]
T7	30.86 ± 0.010[j]
T8	31.15 ± 0.026[g]
T9	31.24 ± 0.026[de]
T10	31.21 ± 0.017[f]

Results are in Means ± SD. Means ± SD along columns showing different superscripts are significantly different at P=0.05.

Results on Total Carbohydrate revealed that the highest value of 4.95±0.003 was recorded in the tomato plant fed with organic and inorganic fertilizer. This was followed by the value of 4.79±0.004, obtained from the plant treated with organic and inorganic fertilizers in combination with Nacl and Bicarbonate. The least value of 1.50±0.000 was found in fruits of the Control plants (Table 3).

Table 3: Percentage Total Carbohydrate Composition of tomato fruits as influenced by treatments (%)

Treatments	% Total Carbohydrate Composition
T1	1.50 ± 0.000^{j}
T2	3.48 ± 0.002^{g}
T3	3.53 ± 0.005^{f}
T4	4.79 ± 0.004^{b}
T5	4.32 ± 0.003^{d}
T6	4.95 ± 0.003^{a}
T7	4.47 ± 0.006^{c}
T8	4.02 ± 0.003^{e}
T9	2.38 ± 0.005^{i}
T10	3.11 ± 0.004^{h}

Results are in Means ± SD. Means ± SD along columns showing different superscripts are significantly different at P=0.05.

For total lipids (Fat), the result showed that the highest value of 1.00±0.050 was obtained from the fruits of the plant grown with the organic and inorganic fertilizers. This was followed by the value of 0.96±0.002 from the plant fed with inorganic fertilizer. The least value of 0.40±0.002 was from the fruits of the Control. (Table 4)

Table 4: Percentage Fat Composition of tomato fruits as influenced by treatments (%)

Treatments	% Fat Composition
T1	0.40 ± 0.002^{j}
T2	0.95 ± 0.002^{c}
T3	0.96 ± 0.002^{b}
T4	I.00 ± 0.050^{a}
T5	0.90 ± 0.001^{d}
T6	0.82 ± 0.008^{f}
T7	0.88 ± 0.004^{de}
T8	0.80 ± 0.004^{fg}
T9	0.80 ± 0.004^{fh}
T10	0.80 ± 0.000^{fi}

Results are in Means ± SD. Means ± SD along columns showing different superscripts are significantly different at P=0.05.

The result of Crude fiber content showed that the highest value of 1.45±0.002 was obtained from the tomato plant treated with organic and inorganic fertilizers in combination with Nacl and Bicarbonate. The value of 1.35±0.005 was from the plant supplied with organic fertilizer in combination with Nacl and Bicarbonate. The Control plants gave the least value of 0.73±0.004. Significant differences exist among most of this treatment (Table 5).

Table 5: Percentage Crude Fiber Composition of tomato fruits as influenced by nutritional treatments (%)

Treatments	% Crude Fiber
T1	0.73 ± 0.004^{j}
T2	1.02 ± 0.030^{f}
T3	0.90 ± 0.008^{i}
T4	1.01 ± 0.005^{fg}
T5	1.35 ± 0.005^{b}
T6	1.13 ± 0.006^{c}
T7	1.45 ± 0.002^{a}
T8	1.07 ± 0.003^{d}
T9	1.01 ± 0.003^{fh}
T10	1.04 ± 0.001^{e}

Results are in Means ± SD. Means ± SD along columns showing different superscripts are significantly different at P=0.005.

The result of Crude protein assay revealed that the highest value of 2.08±0.005 was obtained from the tomato fruits of the plants treated with organic and inorganic fertilizers in combination with Nacl and Bicarbonate. This was followed by a mean value of 1.97±0.030 obtained from the fruits of the plants fed with inorganic fertilizer in combination with Nacl and Bicarbonate. The Control plants gave fruits with the least Crude protein value of 0.09±0.00. Differences among the Crude protein values were significant especially with respect to the Control plants. (Table 6)

Table 6: Percentage Crude Protein Composition of tomato fruits as influenced by nutritional treatments (%)

Treatments	% Crude Protein Composition
T1	0.09 ± 0.003^{j}
T2	1.02 ± 0.003^{hi}
T3	1.04 ± 0.040^{h}
T4	1.15 ± 0.044^{g}
T5	1.88 ± 0.044^{c}
T6	1.97 ± 0.030^{b}
T7	2.08 ± 0.005^{a}
T8	1.53 ± 0.036^{d}
T9	1.48 ± 0.036^{de}
T10	1.41 ± 0.004^{f}

Results are in Means ± SD. Means ± SD along columns showing different superscripts are significantly different at P=0.005.

DISCUSSION

The finding that the Ash content of tomato fruits is increased by organic and inorganic manure treatment in combination with salinity and bicarbonate is in line with the report of [7], who stated that organic material in combination with NPK and organomineral significantly increased ash content compared to organic material. Also, organic material in combination with NPK increased nutritive value. The high ash content is possible because more minerals were incorporated into the soil. The result of this research is however not in agreement with that reported by [21], who reported that the ash content was higher in the plant treated with organic fertilizer. This is also consistent with that reported by [8,9] who observed that ash content of the Amaranth planted with organic fertilizer was significantly higher. However, these researchers did not use salinity and Bicarbonate fertilization. Although the mineral supply into the soil influences plants development, allocation of photosynthates is a different process. It has been reported by some researchers [21, 25] that salinity and bicarbonate fertilization positively influenced priority allocation of substances to the fruit.The result on the crude protein assay was obtained because of the mixture of more than one fertilizer in the soil which released more nitrogen and other minerals were incorporated into the soil. This result is in agreement with [21], who stated that the best result on mean crude protein was obtained when three mixed fertilizers was used. According to [18], plant food is a good source of protein, where 12% or more of its caloric value are provided by protein. The principal functions of proteins are for growth and development [23]. Besides, protein is part of a determining factor of the human weight. Proteins build up and maintain the body form structure of the body, regulate body process and used as a source of energy [17,19]. The absence of fertilizer and other mineral treatments to the Control plants resulted in the fruits of the Control giving the least result. (Table 6). The result from the Crude fiber showed that there was an increase in the fiber content as a result of the treatment given. This was because from the treats more nitrogen and other minerals were incorporated which was clearly absent from the Control (non-fertilized) (Table 5). Crude fiber (Dietary fiber) cellulose and hemicellulose are polysaccharides embedded in the cell wall of plants and they are integral constituents of sclerenchyma tissues, hence contribute to the support, tensile strength and density of plants [7]. Besides, the hygroscopic nature of fibers enables them to absorb and retain water [19]. This implies that the higher the amount of fiber in a vegetable, the more volume of water it will retain or the more resistance the fruit will stand against skin crack. Dietary fiber is important in the system as it helps to lower cholesterol level and reduces the risk of heart diseases and diabetes [23]. Fiber aids digestion, softens stool, prevents constipation and enhances bowel movement [21]. Therefore treatments that will encourage increased fiber composition of a tomato fruit should be encouraged. The results of total carbohydrate and fat revealed that the highest mean value was recorded in the tomato plant fed with organic and inorganic fertilizers in combination with Nacl and bicarbonate and from inorganic fertilizer respectively. The least contents was found in the fruits of the Control plants. Carbohydrates are plant products which are synthesized as the by-products of photosynthetic processes. They are consumed by man and animals as the major source of energy. Carbohydrates are hydrolyzed in the body to yield glucose which can be utilized immediately or stored as glycogen in the muscles and liver for future use [7]. Total Carbohydrate is the amount of the main components of structural materials in the plants. Salinity and bicarbonate treatment have been used in to influence allocation of materials. Combined application of organic and inorganic fertilizers brings significant change in soil fertility by bringing positive effect on the soil pH, inorganic carbon content, total nitrogen, available K and available P. The minimum food value in the Control plants indicated an improvement in the soil fertility status of the treated plants due to integrated nutrient management [14]. Crop cultivation with the use of different manures gives differences in nutritional output of crops. This is because the nutrient released by these manures from animal wastes depends largely on the type of feeds and the type of nutrients contained in such feed [19]. When carbohydrates are consumed in excess of the body requirement, the excess is converted to fat and stored in the adipose tissue under the skin. Carbohydrate provide source of energy for the cell and tissues, this is the major source of fuel for the body [23]. Fats are secondary plant products that yield more energy per gram than carbohydrates. Dietary fats are important not only because of their high energy value but the fat soluble vitamins and essential fatty acids contained in the fat of natural foods. Fat is one of the main determining factor of body weight in an individual [24]. Salinity and bicarbonate fertilization may have influenced extra allocation of substances as carbohydrates and fats.

The result of the moisture content revealed that the highest moisture was found in the sample treated with organic fertilizer. This was followed by the plant treated with inorganic fertilizer. The least moisture content was observed in the plant treated with organic and inorganic fertilizers in combination with Nacl and bicarbonate (Table 2). Plants are sensitive to availability of water [25]. They have adaptive and sensing mechanisms that ensure their survival and competitive success. Water influences functionality and growth of plants. It is also a determining factor of body weight in an individual [12]. The moisture content of food reflects the water activity [20] and it is used to measure food stability to contamination of organisms [18]. Water is used to control body temperature, lubricates joints and transport nutrients and wastes [17]. However, excessive accumulation of water may influence skin crack in fruits.

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