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Physicochemical and Sensory Evaluation of Selected Tomato (*Solanum Lycopersicum*) Varieties from Minna, Niger State Nigeria

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ABSTRACT

Tomato is a highly sort after crop among different groups of people globally because of its versatile usability in different cuisines as well as its nutrient content. It is also a highly available, low priced, tasty with very important health benefits. This study evaluated five different tomato varieties (Beefsteak, Heirloom, Cherry, Paisano and Campari) for their nutrient, physicochemical and organoleptic properties. Standard procedures were employed to determine the parameters. The result obtained showed that the ash content was significantly higher ($p<0.05$) in Campari tomatoes (0.60±0.57%) compared to other varieties. Crude protein and carbohydrate contents (0.94±0.15and 4.12±1.43 % respectively) were significantly ($p<0.05$) higher in Beefsteak tomatoes. Totals Soluble Solid (TSS) (5.87±0.12 ^{o} Brix), titratable acidity (7.12±0.11 %) and pH (4.60±0.00) were significantly higher in Cherry tomatoes. The lycopene content was found to be significantly ($p<0.05$) higher in Beefsteak tomatoes (0.67±0.1mg/100g), while Heirloom had the significantly higher β-carotene content (2.92±1.85 mg/100mg). There was significantly ($p<0.05$) higher colour and texture score (7.30±0.48) for Beefsteak tomatoes and overall acceptance score significantly higher for Cherry tomatoes (7.20±0. 63). There was no significant difference in the taste for the sampled varieties. The tomato varieties especially Beefsteak and Cherry, contained appreciable amount of nutrients and had good acceptability index.

Keywords: Tomato, Organoleptic score, Nutrient, Physicochemical, Lycopene, β-carotene

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INTRODUCTION

Tomato (*Solanum lycopersicum*) is a very important crop as it is consumed worldwide and forms part of the staple diet in different parts of the world. In the last five years, global production of tomatoes has increased from 165,295,864 tons in 2013 to 182,301,395 tons in 2017 (FAOSTAT 2019). It is the second most important source of nourishment worldwide and the development of its processed products which include juices, sauces and purees has led to increased consumption. Tomatoes are in high demand for fresh consumption and cooking purposes (FAOSTAT, 2014). Tomato is highly demanded among various categories of people due to its availability, low price, taste and unique health benefits (Salehi *et al*., 2019).

Among carotenoids found in tomatoes which include β-carotene, neurosporene, phyloene, and lutein, lycopene is the most important compound resulting from its high antioxidant activity, hence its beneficial health effects (Yazdani *et al*., 2019). Therefore, the consumption of tomatoes helps in providing protection against cardiovascular diseases, inflammation and cancers and normalizing cholesterol levels (Navarro *et al*., 2018; Mohri *et al*., 2018; Alam *et al*., 2019). Genetic and environmental factors affect the quality of tomatoes as such different varieties possess different organoleptic properties due to their different genotypes and cultivation in different geographic regions. These influences many properties and the aroma and flavour (Carli *et al*., 2011).

The chemical as well as the physical makeup of plant may be influenced by their geography. The soil and climatic conditions of the location where certain plants are cultivated can to a degree determine the nutrient composition, physicochemical and organoleptic properties such plant. There is also dearth of information on the properties of local varieties of tomatoes cultivated in Minna, Niger State, Nigeria and this study therefore aims to assess some physicochemical, nutritional and organoleptic properties of five varieties of tomatoes from Minna Niger State.

MATERIALS AND METHODS

Materials

Five (5) different varieties of tomatoes (Beefsteak, Heirloom, Cherry, Paisano and Campari) were collected from Masoyi farms along Bida expressway in Minna, and some other local farms within Bosso and Chanchaga local government areas of Niger State, Nigeria (Figure 1). These samples were identified at the department of Plant Biology, Federal University of Technology, Minna Niger State, Nigeria.

Methods

Sample preparation

The samples were washed with tap water and rinsed with distilled water. The samples were then stored in labelled black polythene bags and packed in a 2 L plastic bucket. This study was carried out at the Biochemistry department laboratory of Federal University of Technology Minna (FUT MINNA), Niger State, Nigeria.

Determination of the proximate composition of the five tomato varieties

The nutrient composition of the five varieties of tomato (moisture, total ash, crude fiber, and fat) were measured in triplicate using the Association of Analytical Chemists (2005) techniques. The nitrogen content was measured using the micro Kjeldah technique, and the nitrogen content was multiplied by a factor of 6.25 to convert it to protein. The total carbohydrate content was calculated using the 'difference' method. Percentages were used to report all the determined proximate analysis.

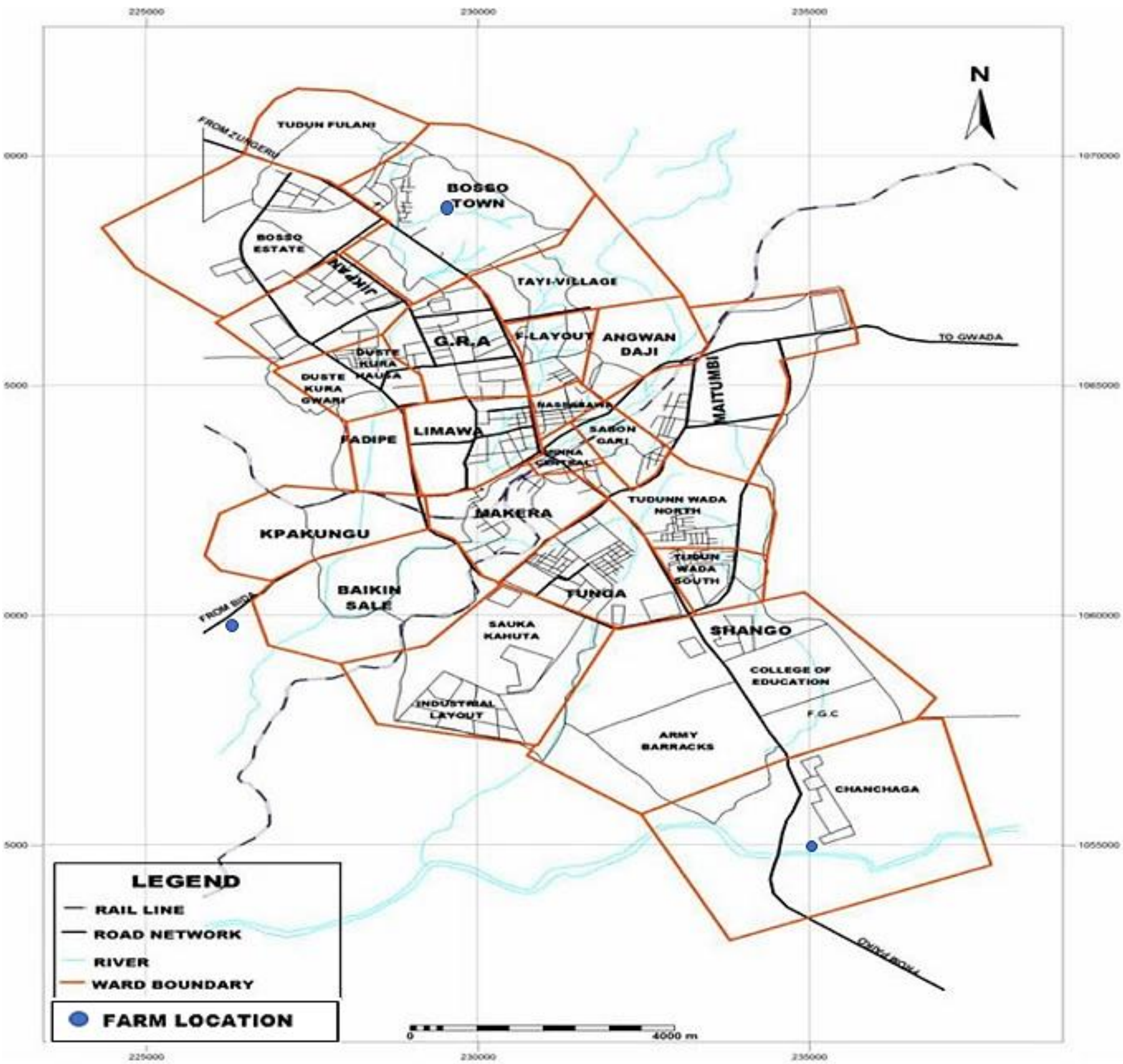

Figure 1: Sample collection Points in Minna, Niger State Nigeria (Salihu *et al*., 2017)

Determination of physicochemical properties of the tomatoes

The physicochemical properties determined in this study include total soluble solid, total solids, pH and titratable acidity. The determination of the total soluble solids (**TSS**) was carried out using a portable refractometer (SperScientific). The values were expressed in ^{o}Brix. The titratable acidity (**TA**) was determined by adding 10 g of the filtered tomato juice to 50 cm^3 of distilled water and titrated with 0.1 M NaOH using phenolphthalein as indicator (Gharezi *et al*., 2012). The **pH** was determined using a pH meter (CrisonBasic20) according to the instructions supplied by the manufacturer. The total solids (**TS**) content was determined by drying 3 g of homogenized sample in an oven at 70 ^{o}C, until the complete elimination of water. The content was calculated as:

$$\textbf{TS} = \frac{\text{Percentage of total solid weight}}{\text{Sample fresh weight}}$$

Determination of β-carotene

The method of Srivastava and Kumar (2004) with slight modification was used to determine the β-carotene content (mg/100g) of tomato samples. Five grams (5 g) of sample was extracted with 15 ml acetone, few crystals of anhydrous sodium sulphide were added and the residue re-extracted until colourless. The solution was transferred into a separating funnel and washed with 15 ml petroleum ether, thoroughly mixed and allowed to separate into two phases. The upper layer (organic phase) was collected and made up to 100 ml with petroleum ether. The absorbance of the mixture was then measured at 452 nm using petroleum ether as blank. The β-carotene was calculated using the equation:

$$\beta\text{-carotene (mg/100g)} = (\Delta A/€L) \times MW \times D \times (V/G)$$

Where: **ΔA** is the absorbance, **€** is the β -carotene molar extinction coefficient (2590), **L** is the cell path length (1 cm), **MW** is the molecular weight of β -carotene (536.8), **D** is a dilution factor, **V** is the final volume (mL), **G** is the sample weight (g).

Determination of lycopene

Lycopene content was determined using the method reported by Hussain *et al*. (2017). Twenty grams (20 g) of tomato was macerated for 24 hours in 100 cm^3 of 96 % ethanol, filtered and evaporated to dryness. A 10 cm^3 of mixture of acetone-hexane (ratio 4:6) was used to dissolve the extract and filtered using filter paper. Obtained extract was diluted ten times and the absorption (A) at wavelengths of 453, 505, 645 and 663 nm was measured using UV spectrophotometer. The amount of lycopene (mg lycopene/100 mL extract) was calculated as:

$$\text{Lycopene (mg/100 mL)} = -0.0458 \times A_{663} + 0.204 \times A_{645} + 0.372 \times A_{505} - 0.0806 \times A_{453}$$

Determination of the organoleptic properties

The tomato varieties were blended and boiled and their organoleptic property analysed to identify the taste, colour, texture and over all acceptance. The score was based on the hedonic scale engaged for the sensory evaluation of the tomato varieties by a panel of ten women.

Statistical analysis

Data collected was subjected to one-way Analysis of Variance (ANOVA) package and means separated using Duncan's Multiple Range Test of the same computer package.

RESULTS

Table 1 shows the proximate composition of the sampled tomato varieties which revealed that the five tomato varieties had over 93 % moisture content although Paisano tomato had significantly (P<0.05) higher in moisture content (96.00±0.50 %) than that of Beefsteak and Campari tomatoes. The ash content of the sampled tomato varieties was significantly (P<0.05) higher in Campari tomatoes (0.60±0.57 %) compared to the other varieties. The fibre and crude protein content were significantly (P<0.05) higher in Cherry tomatoes (0.75±2.31 %) and Beefsteak (0.94±0.15 %) respectively. The Beefsteak tomatoes was significantly (P<0.05) higher in carbohydrate content (4.12±1.43 %) than the other varieties. Table 2 revealed the result of the physicochemical analysis of the sampled tomato varieties in which the total solid content of Beefsteak tomato (43.67±1.15 %) and cherry (43.33±1.15 %) were significantly (P<0.05) higher than the other varieties. The TSS, TA and pH were significantly (P<0.05) higher in Cherry tomatoes (5.87±0.12 ^{o}Brix, 7.12±0.11 % and 4.60±0.00 respectively) compared to the other tomato varieties. Figure 1 shows the graphical representation of the level of lycopene and β-carotene contents in the tomato varieties. The lycopene and β-carotene contents were significantly (P<0.05) higher in Beefsteak tomatoes (0.67±0.1

mg/100g) and Heirloom Tomatoes (2.92±1.85 mg/100g) compared to other varieties. The organoleptic score is presented in Table 2. Colour and texture scores were significantly ($P<0.05$) higher in Beefsteak (7.30±0.48) compared to other varieties. Cherry tomatoes had the highest overall acceptability (7.20±0.63), although it was still comparable to others except Heirloom.

Table 1: Proximate Composition (%) of the Tomato Varieties

Samples	Moisture	Ash	Fibre	Protein	Fat	Carbohydrate
Beefsteak	94.13±1.0a	0.39±0.16a	0.56±4.51a	0.94±0.15c	0.27±0.01a	4.12 ±1.43c
Heirloom	95.10±0.90ab	0.58±0.41b	0.73±4.73b	0.58±0.21a	0.23±0.02a	3.35±2.18b
Cherry	95.53±1.00ab	0.55±0.12b	0.75±2.31b	0.56±0.30a	0.21±0.05a	2.40±1.46a
Paisano	96.00±0.50b	0.46±0.15a	0.57±3.06a	0.71±0.52b	0.21±0.05a	2.05±0.87a
Campari	93.87±0.84a	0.60±0.07c	0.54±2.65a	0.68±0.11b	0.32±0.01a	3.47±0.42b

Values are Mean ± Standard Deviation of triplicate determination. Value with different superscript on same column are $p<0.05$ (significantly different).

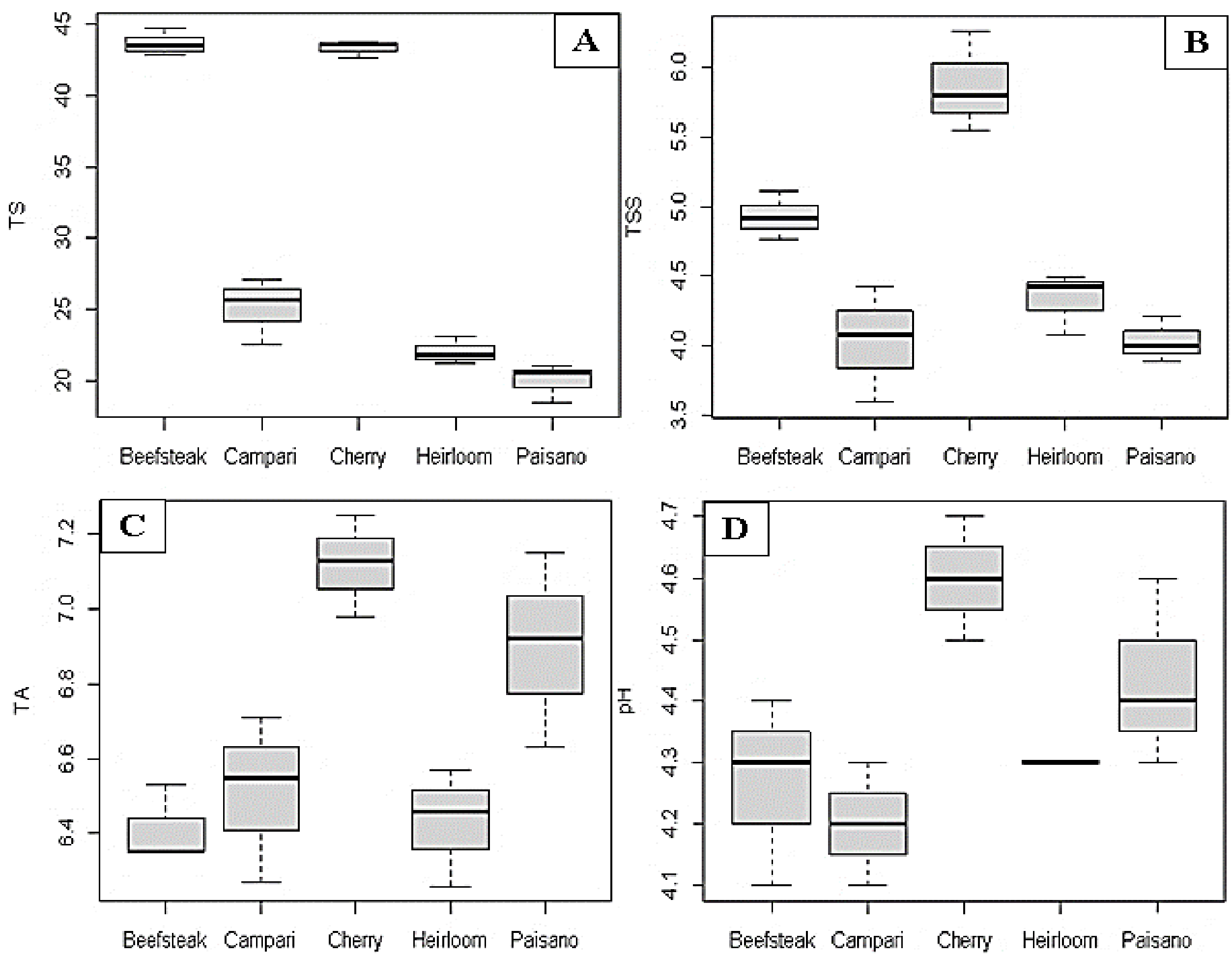

Figure 2: Physicochemical Properties of the Five Tomato Varieties

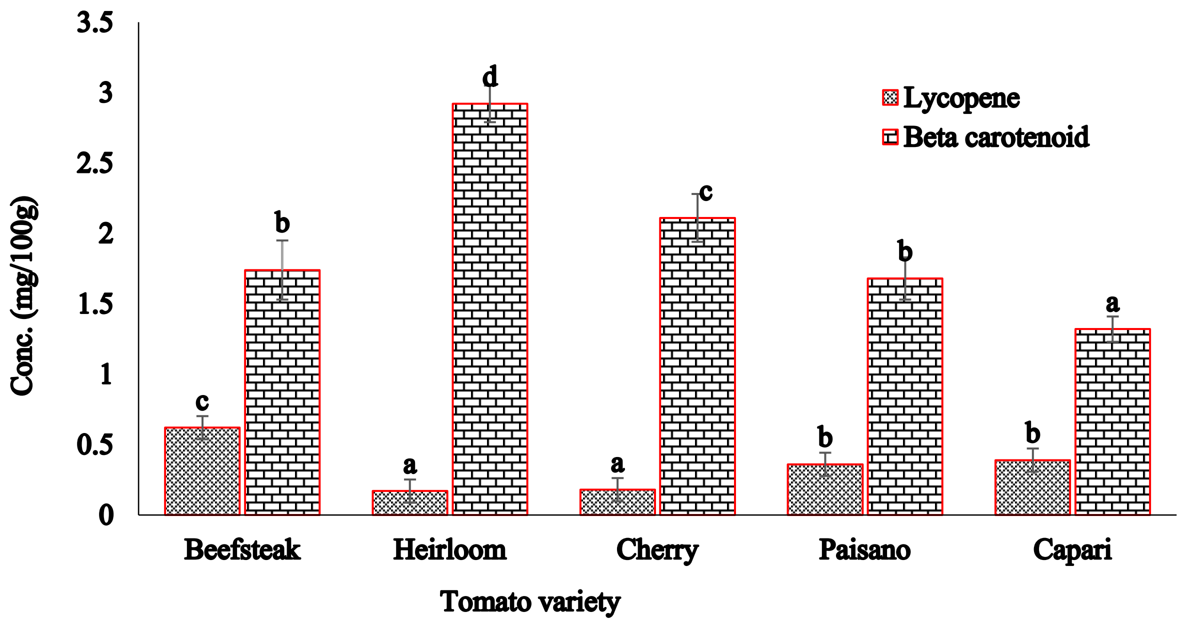

Figure 3: Lycopene and β-carotene Content in the Five Tomato Varieties

Table 2: Organoleptic Scores of the Five Tomato Varieties

Samples	Colour	Texture	Taste	Overall acceptance
Beefsteak	7.30±0.48c	7.30±0.82c	5.00±1.56a	6.70±1.16ab
Heirloom	5.70±1.34a	4.80±1.45a	4.90±0.88a	5.90±1.52a
Cherry	6.70±0.95abc	7.30±0.67c	5.80±1.23a	7.20±0.63b
Paisano	6.10±1.37ab	6.40±0.97bc	5.40±1.07a	6.60±1.17ab
Campari	7.00±0.94bc	6.10±0.20b	5.50±1.08a	6.90±0.20ab

Values are Mean ± Standard Deviation of ten determinations. Values with different superscripts on the same column are $P<0.05$ (significantly different). **Key**: 9 = like extremely, 8= like very much, 7 = like moderately, 6=like slightly, 5=Neither like or dislike, 4=Dislike slightly, 3=Dislike moderately, 2=Dislike very much, 1=Dislike extremely.

DISCUSSION

The five tomato varieties investigated in this research were found to have very high moisture content which agrees with previous studies (Adubofuor *et al*., 2010; Hossain *et al*., 2010; Ossamulu *et al.*, 2023) but was found higher than that (78.56 %) reported by Adebooye *et al*. (2006). Moisture content influences the biochemical and physiological changes in living systems. During food storage, the stability and quality of food is affected by the moisture content, and this may be the reason for the short shelf-life characteristic of tomatoes. However, this high moisture content in tomatoes could also be used as a potential source of water as water plays an indispensable role in the biochemical metabolism in the human body. Water does not only hydrate the body but also serves as a thermoregulator and maintains fluid balance (Garuba *et al*., 2018). The low ash content of the tomato varieties obtained from this research were in consonance with the results of Adubofuor *et al*. (2010) and Suleiman *et al*. (2011) in which the values ranged from 0.2 – 0.8 %. A similar result, of 0.65 % ash content was also reported by Mohammed *et al*. (2017). The ash content of any food sample is an indication of their mineral content (Harris and Marshall, 2017; Ali *et al*., 2022). This may imply that tomatoes are not be a rich reserve for minerals and may therefore require being supplemented with other foods for the required mineral acquisition. The fat composition of the five samples were revealed to be very low. However, the values were similar to those reported by Mohammed *et al*. (2017) and USDA (2019), which ranged from 0.1-0.6 %. This may consequently be responsible for the low energy reserve of the fruit. The low amount of crude fibre of the tomatoes were similar to the research reported by USDA (2019) and the research by Olaniyi *et al*. (2010), who obtained 0.62 % as the value for crude fibre. The presence of low amounts of lignin, cellulose and pentosane in the sampled tomato varieties, is indicated by the low crude fibre content. Fibre facilitates easy bowel movement in the body (Ossamulu *et al.,* 2014). The composition of the crude protein of the tomato varieties in this study agrees with the work of Garuba *et al*. (2018) whose values ranged from 0.26-2.60 %. The carbohydrate content in the result was in consonance with the result reported by Mohammed *et al*. (2017) who obtained 4.96 % which implied that the low carbohydrate content in the tomatoes gives it a less ability to generate energy for metabolic activities in human.

The total solid content in the tomatoes obtained from the research were similar to the research carried out by Gbarakoro *et al*. (2020) was within the range of 19.52-50.00 %. The total soluble solid content is the proportion of dissolvable solid in a given sample (Hossain *et al*., 2010). Total soluble solid content of the sampled tomato varieties was in consonance with the research reported by Onifade *et al*. (2013). This parameter is one of the most important quality parameters in processing. Tomato cultivars having higher TSS content as observed for Cherry tomato in this present study, suggest that they may be better suited for the preparation of processed products like tomato powder, canned products, ketchup, sauce and chutney (Srivall *et al*., 2016). High TSS is desirable to yield higher recovery of processed products.

Titratable acidity and pH are two interrelated concepts in food analysis that deal with acidity. The results low titratable acidity of the tomato varieties presented in this study were in consonance with the report by Mohammed *et al*. (2017) who obtained 6.5 % which indicated a low acidic concentration of the samples. Titratable acidity is a better predictor than pH of how organic acids in the food impact flavor and it measures the total acid concentration in a food (Tyl and Sadler, 2017). Titratable acidity value greater than 0.35 has been suggested as desirable for processing tomato (Aboagye-Nuamah *et al*., 2018). The pH value of the tomato varieties depicts that they were weakly acidic and this was also reported by Tigist *et al*. (2011). The pH of a plant positively correlates with its titratable acidity as observed in the result of this findings. The report of Castro *et al*. (2005) confirmed this by stating that there was a positive correlation between pH, sugar levels and TTA of a plant. Ripening, respiration rate and storage time may be influencers of the level of TTA of fruits (Tyl and Sadler, 2017).

The pH on the other hand helps to determine the degree of acidity and alkalinity of the sampled tomato varieties. The degree of maturity may influence the pH of the varieties of tomato. pH of ripe tomatoes may exceed 4.6, tomato products are generally classified as acidic foods (pH <4.6). pH below 4.5 is a desirable trait, because it halts proliferation of microorganisms (Tigist *et al*., 2011; Srivall *et al*., 2016). It is suggested that the appropriate pH value for industrial tomato should be between 4.18 and 4.4 (Campos *et al*., 2006). Therefore, the higher pH value of Cherry tomato variety may present it a more vulnerable variety to microbial proliferation.
The lycopene content revealed in this research was low in all the sampled tomato varieties compared to the beta-carotene content. These results was in similitude to the research reported by Astuti *et al*. (2018) and Palozza *et*

al., (2016), who determined that the lycopene content in tomatoes and were within the range of 0.2-5.0 mg/100g.The lycopene content present in tomatoes and other food samples inhibit cell invasion, angiogenesis, and metastasis and can have an anti-inflammatory and hypocholesterolaemia effect (Przybylska, 2020). The consumption of this tomatoes may enhance radio-protective effects, protection against degenerative diseases including cardiovascular diseases and age-related macular degeneration (Dobrin *et al*., 2019).

The β-carotene content of the sampled tomato varieties was observed to be very low compared to the values in the research reported by Alam *et al*. (2019). β-carotene is an important source of vitamin A which is necessary for proper vision in humans and it is also responsible for the colouring of tomatoes and other red and orange fruits as such making it industrially significant for the production of skin care products. More so, the sensory evaluation of the tomato varieties was in agreement with the observation reported by Patil *et al*. (2020). The patronage and desire to go for a particular variety of the fruit hinges on the overall acceptability by the consumers. The difference in acceptability could be due to the texture and taste which would are all important aspect of quality that determine the acceptance or the rejection of tomatoes with the consumers (Christine *et al*., 2021). The high acceptability observed for cherry tomato in this study agrees with the above statement (that is, its high acceptance might have been influenced by its texture and taste). Although the present study did not consider different gender test panelist, different perceptions for the colour, texture and taste of fruits between tasters depends on the gender at fruit tasting sessions.

It has been hypothesized that women probably have a finer perception of taste and eye for colour compared to men (Felföldi *et al*., 2021). The taste, flavor and colour of plants are dependent on the constituting chemical compounds especially organic acids, oils, volatile compounds, sugar amongst others. Fruit texture depends on the structural composition of the outer coats (for instance, pectin in tomatoes) as well as the dry matter. All the mentioned criteria that may be responsible for the aroma, flavor, colour or texture are all summed as genetic differences. Tomato is an almost ubiquitous vegetable as it is used for different delicacies in almost every home, some consumers seem not to care of the type of variety they use.

CONCLUSION

The tomato varieties showed appreciable amount of nutrients as well as desirable physicochemical properties. The tomato varieties also had low lycopene content and high amount of beta carotenoid which depicts the antioxidant potential of tomato fruits. Cherry and Beefsteak tomatoes varieties showed more desirable organoleptic properties and thus their high acceptability score. Generally, appreciable nutrient, physicochemical and sensory features of these varieties may therefore present them as important for both human consumption and industrial application.

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