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EVALUATION OF NUTRITIONAL COMPOSITION, PHYSICAL AND CHEMICAL CHARACTERISTICS OF SELECTED RAW AND PROCESSED TOMATO BRAND

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ABSTRACT

Tomato (Lycopersicon esculentum) belonging to the solanaceae family of plants. It is one of the most preferred beneficial vegetable consumed in the world. The aim of this study was to evaluate the nutritional, physical and chemical characteristics of selected local and processed tomatoes sold in Minna, Niger State. Three species of fresh local tomatoes and ten brands of processed tomatoes were sampled in triplicates across markets in Minna city. The proximate, vitamins, phenolic composition physical and chemical parameters were carried out using standard techniques. Proportionate application of HNO_3, H_2O_2 and de-ionised water aided the digestion of the samples. Colorimetric techniques were used to analyze for Phosphorus while FES and FAAS analyse other elements. Statistical Analysis of Variance (ANOVA) was carried out with IBM SPSS statistic version 21. The proximate values (%) are in ranges of: Fat (0.29 –11.31); Protein (6.65 – 20.15); Fibre (0.92 – 15.70) ash (0.08 –3.18); Carbohydrate (53.07 – 80.53). The physiochemical parameters values are in ranges: pH (2.25–4.83); Conductivity (3.73 –12.97), Titratable acidity (0.11 –1.07); Total soluble solids (15.23–40.70). The minerals values (mg/100g) are in ranges of: K (650.10 –2187.50); Na (21.55–2912.49); Ca (117.26 – 4297.75); Fe (2.09 –15.15); Mn (0.30 –1.24); Zn (8.15–20.01); P (24.45 – 42.17). The vitamins and phenolic values are in ranges: Vitamin A (0.47 –8.20); vitamin C (1.31–18.49); Phenolic (0.041– 0.360). Prominent values of fat and protein were found in raw samples. High values of physicochemical properties are observed among processed tomatoes relative to raw ones. The raw tomatoes have more prominent content of vitamin C, Mn and K. These unique contents, especially the moderate physical and chemical properties, make raw tomatoes to be more relevant in management of malnutrition.

Key words: *Raw tomato and processed tomato brands proximate, physicochemical, FES, FAAS*

INTRODUCTION

Tomato (*Lycopers icon esculentum)* belonging to the *solanaceae* family of plants (Eke-Ejiofor, 2015). It is one of the most preferred beneficial vegetable consumed in the world. Tomatoes are cultivated widely in home gardens and large farms for fresh consumption and commercial processing (Aditi *et al*., 2011). It is typically over 90% water and, once they are harvested, begins to undergo higher rates of respiration, resulting in moisture loss, quality deterioration and potential microbial spoilage (Abdullahi *et al*., 2016).

Tomato has many nutrients with secondary metabolites that are important for human health such as mineral matter, vitamins, antioxidants, phenolic compounds (Demirbas, 2010) besides other components such as dietary fiber and protein content (Katırcı *et al*., 2018). Its consumption reduces the risk of certain types of cancer, cardiovascular, osteoporosis and chronic degenerative diseases (Chang *et al*., 2006; Hernández *et al*., 2008; Bhowmik *et al*., 2012).

Minerals are involved in many important functions in the body, such as enzymatic reactions, bone mineralization, as well as the protection of cells and lipids in biological membranes. Low intake of minerals leads to deficiencies which could cause impairment of body functions (Melø *et al*., 2008). They detoxify free radicals which are produced during normal metabolism that affect DNA. Major and minor element contents of tomatoes depend on cultivar, cultivation method, region of cultivation, sampling period and growing

conditions (Demirbas, 2010; Hernández *et al*., 2008).
The major quality parameters of tomato both raw and processed perceived by consumers are colour and flavour but less emphasis is laid on the nutritional and health benefits (Eke-Ejiofor, 2015). Therefore, this study was to evaluate the nutritional and physiochemical characteristics of selected raw and processed tomatoes.

MATERIALS AND METHODS

Sample Collection

Three species of raw tomatoes which include Kano-India species, Minna-Gwari species and Zaria U.T.C. species and ten brands of processed tomatoes designated as Brand1 to Brand10 were sampled in triplicates across markets in Minna city.

Sample Preparation

The raw tomato was cleaned and weighed and then divided into two parts and their hardness and pH was determined using durometer and potentiometer respectively. The one part was blended into a paste and moisture was determined while the other part on which elemental and vitamins analysis were to be carried out was then sliced using a sharp knife which was then dry. After drying, the dried tomato was crushed into a powder using a clean mortar and pestle. The powdered sample was then stored at room temperature for the duration of the analysis. For the processed tomato, the tomato paste was also divided into two parts; one part was used for moisture determination while the other pat was dried for elemental and vitamin determination. The dried samples were stored at room temperature for the analysis.

METHODS

Proximate Analysis

Proximate analysis for crude fat, crude protein, crude fiber, carbohydrate and ash content were carried according to the method described by Abdullahi *et al*. (2016) and Joel *et al*. (2020).

Analysis of Phenolics and Vitamins

The phenolic content was determined by Folin-Ciocalteu method as described by Katırcı *et al*. (2018) while Vitamin A and C were determined according to the method described by Abdulahi *et al*. (2016).

Physical and Chemical Analysis

The pH and titratable acidity determinations were done using the method described by Joel *et al*. (2020), Total solid was obtained by difference (100- moisture content) as described by (Eke-Ejiofor, 2015), Moisture content was determined by the difference between the accurately weighed samples before and after drying in an oven at 105 °C as described by Abdullahi *et al*. (2016) while Determination of Tomato Electrical Conductivity was carried out with Conductivity meter.

Mineral Analysis

Atomic absorption spectrophotometer (AAS) was used to analyse the potassium, sodium, calcium, iron, manganese, zinc while Colorimetric techniques was used to analyzed for the content of Phosphorus.

Data Analysis

The statistical package of social sciences (SPSS) software version 21.0 was used. The results were evaluated using analysis of variance (ANOVA) and were presented as the mean value ± SD (standard deviation of mean) for the samples. Differences among the means were assessed using the Duncan's Multiple Range Test to determine which mean values were significantly different at $p<0.05$.

RESULTS AND DISCUSSION

The nutritional, physical and chemical parameters of three species of raw and ten brands of processed tomatoes differed significantly ($p<0.05$) due to different varieties and brands.

Table 1 shows the Physical and chemical parameter (%). The physiochemical parameters values are in ranges. pH (2.25–4.83) with brand 4 having the least and brand10 the highest. The pH (2.25–4.83) indicated the hygienic qualities of raw and processed tomato brands (CAC, 2011). Conductivity (3.73–12.97) with Kano-India species having the least and brand 5 the highest. The highest electrical conductivity was found with processed brands. This could be as a result of processing mechanism. Titratable acids (0.11–1.07) with brand 9 having the least and brand 7 the highest Titratable acidity (0.11–1.07) did not exceed the maximum acidity (7 %) recommended by CAC (2012). Total soluble solids (15.23–40.70) with brand 6 having the least and brand 7 the highest. The total soluble solid (15.23–40.70) of the samples were higher than the standard level of 20 to 22 % required by CAC (2011). The higher total soluble solid might be due to lower moisture content as reported by Eke-Ejiofor (2015).

Table 1; Physiochemical parameters

S/N	Sample	pH	Conductivity	Titratable Acids (%)	Total Soluble Solids
1	KI	4.79±0.01^{e}	3.73±0.01^{a}	0.41±0.01^{a}	28.42±0.01^{k}
2	MG	4.85±0.01^{h}	5.72±0.01^{d}	0.77±0.01^{b}	18.17±0.02^{h}
3	ZU	4.79±0.00^{f}	6.48±0.00^{f}	0.41±0.01^{a}	15.81±0.01^{d}
4	B1	4.78±0.01^{e}	8.87±0.01^{i}	0.18±0.00^{a}	17.53±0.01^{g}
5	B2	4.68±0.00^{c}	6.72±0.00^{g}	0.31±0.01^{a}	18.65±0.01^{i}
6	B3	4.86±0.01^{h}	8.34±0.00^{h}	1.02±0.01^{b}	15.21±0.01^{b}
7	B4	2.25±0.00^{a}	9.87±0.00^{k}	1.02±0.01^{b}	17.27±0.01^{e}
8	B5	4.72±0.00^{d}	12.97±0.00^{m}	1.04±0.00^{b}	15.23±0.03^{a}
9	B6	4.56±0.00^{b}	6.36±0.00^{e}	1.04±0.00^{b}	15.61±0.01^{c}
10	B7	4.86±0.01^{h}	5.25±0.00^{c}	1.07±0.00^{b}	40.61±0.01^{l}
11	B8	4.73±0.01^{d}	9.03±0.01^{j}	1.02±0.01^{b}	18.15±0.05^{h}
12	B9	4.88±0.01^{i}	9.92±0.00^{l}	0.11±0.01^{a}	19.01±0.01^{j}
13	B10	4.83±0.00^{g}	3.93±0.00^{b}	0.44±0.03^{a}	17.41±0.01^{f}

Values are reported as mean ± standard error of means. Values with the same letter on the column are not significant while values on the same column with different alphabetic superscript are significant at $p \leq 0.05$ DMRT test.

Key: KI = Kano-India variety, MG = Minna-Gwari variety, ZU= Zaria UTC variety, B1–B10 are processed tomato brands 1-10

Table 2 showed proximate composition (%). The proximate values are in ranges: Moisture (0.74–11.84) with brand 7 having the least and brand 6 the highest. The moisture contents values (0.74 – 11.84) with brand 5 having highest moisture. These were low compared to the values (69.00 – 84.85 %) reported by Eke-Ejiofor (2015). These decreases in moisture of the processed tomatoes increase the shelf life, hence beneficial to the consumers (Joel *et al*., 2020). Crude fat (0.29–11.31) with brand 3 having the least fat and Minna-Gwari species the highest (11.31 %). The fat content of the fresh tomato (Minna-Gwari species) is higher than all the processed brands and as well as its raw counterparts. The reason might be due to different geographical location and different in processing methods. Crude protein (6.66–20.15) with brand1 having the least and Minna-Gwari species the highest. The crude protein was higher in some of the raw than all the processed brands. The difference in crude protein contents could be attributed to species differences as well as differences in the processing conditions of the pastes. The higher protein content of the raw tomato in this study is variance with the reported as by Abdullahi *et al.* (2016) who reported higher protein only in processed tomato. Crude fibre (0.92–15.70) with brand10 having the least and brand 8 the highest; Ash (0.08–3.18) with brand10 having the least and brand5 the highest. The ash content in both raw and processed brands differed significantly, however, one of the processed tomatoes have higher ash than others. This might be as a result of addition of salt to the processed and high-water content of the raw. The crude fibre content of raw tomato is significantly lower than the processed brands tomato. This could be as a result of high-water content of the raw tomato. Abdullahi *et al*. (2016) reported similar observation. Carbohydrate (53.07–80.53) with Kano-India species having the least and brand 3 the highest. Carbohydrate percentage content in the raw tomato is lower than the processed brands. This might be as result of high-water contents in raw tomatoes.

Table 2: Proximate Composition (%)

Samples	Moisture	Crude Fat	Crude Protein	Crude Fibre	Ash	Carbohydrate
KI	4.77±0.01^{b}	9.08±0.00^{f}	19.26±0.01^{k}	11.57±0.01^{i}	2.28±0.00^{j}	53.07±0.00^{a}
MG	5.68±0.01^{d}	11.31±0.00^{m}	20.15±0.01^{l}	3.91±0.01^{e}	2.26±0.05^{j}	56.68±0.00^{c}
ZU	5.78±0.01^{e}	9.81±0.00^{l}	13.35±0.05^{i}	1.03±0.01^{b}	1.43±0.00^{f}	68.58±0.00^{i}
B1	7.93±0.01^{j}	9.11±0.00^{g}	6.66±0.01^{a}	2.92±0.01^{d}	2.01±0.00^{i}	71.39±0.00^{k}
B2	8.18±0.01^{k}	9.67±0.00^{i}	11.39±0.01^{g}	11.68±0.01^{j}	1.54±0.00^{g}	68.96±0.00^{j}
B3	5.47±0.01^{c}	0.29±0.00^{a}	10.07±0.01^{d}	2.60±0.00^{c}	1.07±0.00^{d}	80.53±0.00^{m}
B4	7.03±0.01^{h}	8.57±0.00^{d}	9.19±0.01^{c}	6.75±0.01^{h}	1.46±0.00^{f}	66.91±0.00^{h}
B5	8.37±0.01^{l}	9.73±0.00^{k}	10.07±0.01^{d}	11.94±0.01^{k}	3.18±0.00^{k}	56.73±0.00^{d}
B6	11.84±0.01^{m}	6.82±0.00^{b}	8.32±0.01^{b}	11.94±0.01^{k}	0.86±0.00^{c}	60.25±0.00^{e}
B7	0.74±0.01^{a}	8.58±0.00^{e}	10.51±0.01^{e}	3.94±0.01^{f}	0.52±0.00^{b}	75.74±0.01^{l}
B8	7.52±0.01^{i}	9.73±0.00^{j}	10.94±0.01^{f}	15.61±0.01^{l}	1.69±0.00^{h}	54.45±0.00^{b}
B9	5.99±0.01^{f}	9.19±0.00^{h}	12.26±0.01^{h}	4.23±0.01^{g}	1.39±0.01^{e}	66.98±0.00^{g}
B10	6.52±0.01^{g}	7.76±0.00^{c}	17.93±0.01^{j}	0.92±0.01^{a}	0.08±0.00^{a}	66.79±0.01^{f}

Values are reported as mean ± standard error of means. Values with the same letter on the column are not significant while values on the same column with different alphabetic superscript are significant at $p \leq 0.05$ DMRT test

Key: Kano = **Kano-India variety**, Minna = **Minna-Gwari variety**, Zaria= **Zaria UTC variety**

Phenolic and vitamins (antioxidants) are shown in Table 3.

The highest value of vitamin A, C and Phenolic were found in Brand 9, Kano-India species and Brand 7 respectively. Vitamins A, C and Phenolic are important quality parameters used in assessing tomato paste. They act as antioxidant, preventing the oxidation of some fatty acid component and play some important vital role in the body metabolism.

Table 3: Antioxidants Analysis (mg/100 g)

Samples	Vitamin A	Vitamin C	Phenolic content
KI	0.47±0.00[a]	18.49±0.01[j]	0.25±0.01[f]
MG	1.28±0.02[d]	10.60±0.10[h]	0.11±0.00[d]
ZU	1.93±0.00[g]	15.89±0.01[i]	0.16±0.00[c]
B1	1.89±0.00[f]	2.61±0.01[b]	0.20±0.00[d]
B2	3.57±0.00[i]	1.31±0.01[a]	0.46±0.00[j]
B3	1.06±0.00[c]	7.81±0.01[f]	0.04±0.00[a]
B4	4.28±0.00[j]	7.91±0.01[f]	0.24±0.00[f]
B5	5.62±0.00[k]	8.51±0.01[g]	0.12±0.00[b]
B6	0.76±0.00[b]	5.31±0.01[e]	0.22±0.02[e]
B7	1.81±0.00[e]	4.62±0.02[d]	0.36±0.00[i]
B8	6.55±0.00[l]	5.35±0.05[e]	0.32±0.00[g]
B9	8.20±0.00[m]	3.81±0.00[c]	0.34±0.00[h]
B10	2.32±0.00[h]	2.65±0.05[b]	0.32±0.00[g]

Values are reported as mean ± standard error of means. Values with the same letter on the column are not significant while values on the same column with different alphabetic superscript are significant at p≤0.05 DMRT test.

Key: KI = Kano-India variety, MG = Minna-Gwari variety, ZU= Zaria UTC variety, zB1–B10 are processed tomato brands 1-10

Table 3 showed the Mineral composition (%). The minerals values are in range: Potassium (650.10–2187.50) brand 9 having the least and Kano-India species the highest. Potassium (K) which has numerous functions in the biochemical and physiochemical functions of the body according to report of Abdullahi *et al*., (2016). They found the raw kano variety to have the highest value of K. The concentrations of sodium were higher in processed brands. This was attributable to the addition of table salt during the course of processing to improve preservation. This makes it inimical to hypertensive patients if recommend. With regard to Iron concentration, the processed brands tomato was found to be highest. Such a difference might arise due to possible deposition of iron from the iron plates used in drying of the tomato samples and differences in geographical location (Abdullahi *et al*., 2016). Calcium, Zinc and Phosphorus were significantly different in respect to the fresh species and processed tomato brands; however, their peak values were found with the brand 2, the processed tomato. Both are required in our dietary intake, as calcium and zinc support bone mineral density (Goodson, 2018) and phosphorus help to maintain a regular heartbeat and facilitate nerve conduction among others (Madell, 2020). There was also an assertion that foods that high in calcium are also high in phosphorous (Madell, 2020). Manganese (0.30–1.24) brand1 having the least and Minna-Gwari the highest; Manganese (0.30–1.24) is considered an essential nutrient and can be found especially, in vegetables. The highest value is found in fresh tomato (Minna-Gwari species). Manganese may play a positive role in bone health by working in concert with other vitamins and minerals to improve bone mineral density (Goodson, 2018

Table 4: Mineral compositions

Samples	K (mg/100g x10^{3})	Na (mg/100g x10^{3})	Ca (mg/100g x10^{3})	Fe (mg/100g)	Mn (mg/100g)	Zn (mg/100g)	Phosphorus (P) (mg/100g)
KI	2.19±0.01^{k}	0.05±0.03^{c}	2.76±0.22^{l}	2.39±0.00^{b}	0.80±0.00^{j}	15.43±0.00^{j}	37.47±0.00^{i}
MG	1.31±0.01^{f}	0.04±0.01^{b}	1.29±0.050^{h}	3.93±0.00^{e}	1.24±0.01^{l}	16.30±0.00^{k}	36.65±0.00^{h}
ZU	1.76±0.01^{i}	0.02±0.05^{a}	1.03±0.05^{g}	3.06±0.00^{c}	0.72±0.00^{i}	9.56±0.01^{e}	39.47±0.00^{j}
B1	0.76±0.01^{c}	1.14±0.11^{k}	1.66±0.10^{j}	2.09±0.01^{a}	0.21±0.00^{a}	8.53±0.00^{c}	40.87±0.00^{l}
B2	1.56±0.00^{g}	0.25±0.45^{e}	4.21±0.26^{m}	3.65±0.00^{d}	0.51±0.00^{e}	20.06±0.01^{m}	42.17±0.00^{m}
B3	1.56±0.01^{g}	0.61±0.01^{i}	1.56±0.01^{i}	7.87±0.00^{i}	0.56±0.00^{f}	14.01±0.01^{h}	24.76±0.00^{b}
B4	0.76±0.05^{c}	0.71±0.05^{j}	0.17±0.01^{b}	4.73±0.24^{g}	0.43±0.00^{c}	8.55±0.00^{d}	32.97±0.00^{e}
B5	1.93±0.01^{j}	2.91±0.01^{m}	0.44±0.01^{c}	7.18±0.00^{h}	1.02±0.00^{k}	13.65±0.01^{g}	39.76±0.00^{k}
B6	0.93±0.05^{d}	0.59±0.05^{h}	0.12±0.01^{a}	8.89±0.00^{k}	0.47±0.00^{d}	8.31±0.01^{b}	33.93±0.00^{g}
B7	1.21±0.01^{e}	0.22±0.01^{d}	0.59±0.02^{e}	15.15±0.00^{m}	0.69±0.00^{h}	14.33±0.01^{i}	32.02±0.00^{d}
B8	1.59±0.05^{h}	2.84±0.02^{l}	0.51±0.05^{f}	8.21±0.00^{j}	0.61±0.00^{g}	10.41±0.00^{f}	28.28±0.00^{c}
B9	0.65±0.10^{a}	0.27±0.05^{g}	0.46±0.04^{d}	4.44±0.00^{f}	0.42±0.00^{b}	8.15±0.00^{a}	24.45±0.00^{a}
B10	0.68±0.01^{b}	0.26±0.01^{f}	1.78±0.02^{k}	14.34±0.00^{l}	0.69±0.00^{h}	17.51±0.01^{l}	33.81±0.00^{f}

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Key: KI = Kano-India variety, MG = Minna-Gwari variety, ZU= Zaria UTC variety, B1–B10 are processed tomato brands 1-10

CONCLUSION

From the study, both raw tomatoes and processed brands were source of nutrients. Carefully taking according to the body requirement will benefit humanities. The processed tomatoes were found to have significant concentration in some of essential nutrients than the raw species in some cases. However, prominent values of fat and protein were found in raw samples. High values of physicochemical properties are observed among processed tomatoes relative to local ones. The raw tomatoes have more prominent content of vitamin C, Mn and K. These unique contents, especially the moderate physical and chemical properties, make raw tomatoes to be more relevant in management of malnutrition.

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