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Comparative Proximate Analysis of Tomato (*Solanum lycopersicum* L.) Fruits Sold in Markets in Benin City, Nigeria

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ABSTRACT: This study examined and compared the nutritional proximate composition analysis of fresh tomato fruits sold at three different markets located in Benin-City, Edo State Nigeria. The markets were Oba market, Evbuotubu market and Ikpoba market. The fruits were randomly obtained from three distinct vendors at each market. Standard analytical methods of food analysis were employed in carrying out the proximate analysis. Results obtained across the markets indicated that The moisture composition was at its peak and ranged from 92.73±0.42 to 93.50±1.14, the carbohydrate composition ranged from 2.72±0.45 to 3.62±0.94, the crude fibre composition ranged from 1.24±0.24 to 1.69±0.35, the protein content ranged from 0.91±0.21 to 1.00±0.14, the fat composition ranged from 0.91±0.08 to 0.94±0.05 and the ash content ranged from 0.23±0.07 to 0.26±0.05. Results from the analysis of variance test used in comparing the obtained data results revealed that the nutritional proximate composition analysis of tomato fruits sold in 3 different markets located in Benin City, Nigeria, showed no significant differences (p > 0.05).

Keywords: Tomato fruit, Benin-city, vegetable, proximate analytical composition, nutritional composition, level of significance.

INTRODUCTION

Tomato fruit is a nutrient-rich vegetable that benefits bodily systems and organs. It is currently among the most widely cultivated and consumed vegetable on earth. Usually red when ripe, tomatoes can also be found in a range of colours, such as orange, yellow, purple, and green. They may also come in diverse shapes and flavours. The tomato plant is a short-duration crop that produces a high fruit yield. It is known to adapt to a diverse range of soils and is largely grown in tropical, sub-tropical and temperate climates (Dorais *et al*., 2008). They are available in various fresh and processed forms, such as puree, juice, sauce, powder, and canned products (Vinzuda and Kumar 2023). The nutritional proximate factors associated with tomato fruits such as carbohydrate, protein, crude fibre, moisture, vitamin C and lycopene contents vary with cultivars, social and handling practices (Aoun *et al*., 2013).

Studies have shown that tomatoes offer numerous health benefits. They serve as an excellent source of antioxidants such as vitamin C, beta-carotene and lycopene. These antioxidants help in fighting free radicals formed around the body which are the major precursors of tumors and cancer cells (Megan, 2017; Kachhot and Patel 2024). Additionally, they have been demonstrated to safeguard the eyes and inhibit the development of cataracts. Also, the availability of fibre and potassium in tomatoes has proven to support healthy heart and prevent cardiovascular diseases (Megan, 2017; Chang *et al*., 2019). When tomatoes are thermally processed, their lycopene concentration increases and they do not lose their antioxidant properties (Thrumbo, 2005). In summary, tomato fruits have minerals, vitamins and beneficial trace elements that are easily absorbed by the body, helping to prevent infections and the body to strengthen its immunity (Ali *et al*., 2021).

This worked is aimed at (1) ascertaining the nutrient composition of tomato fruits consumed at various locations in Benin City, Edo State, Nigeria and (2) obtaining information on possible variations in their nutritional composition.

MATERIALS AND METHODS

Sample Collection. Ripe and freshly harvested red tomato (*Solanum lycopersicum* L.) fruits were randomly bought from three different vendors at Oba Market, Evbuotubu Market, and Ikpoba Market in

Benin City, Nigeria. After washing, the tomatoes were air-dried and cut into slices approximately 3-4 cm thick using a clean knife (Onuguh *et al*., 2022).

Assessment of Percentage Moisture content. A 5 g sample was weighed into a crucible and placed in an oven at 105°C for 2 hours. The weights of the sample and crucible were recorded and monitored regularly until a constant weight was reached. The percentage moisture content was subsequently calculated using the formula presented in equation 2 below (Moronkola *et al*., 2011).

$$\% \text{ Moisture} = \frac{\text{Loss in weight due to sample dryness}}{\text{Weight of sample collected}} \times 100 \quad (1)$$

$$= \frac{Wt_2 - Wt_3}{Wt_2 - Wt_1} \times 100 \quad (2)$$

Where; Wt_1 = weight of empty crucible,
Wt_2 = sample before drying + weight of crucible and
Wt_3 = sample after attaining constant weight on drying + weight of crucible

Assessment of Ash Content Percentage. A covered porcelain crucible was heated in a hot Bunsen burner flame, allowed to cool in a desiccator, and then weighed. A 5 g sample was precisely weighed into a crucible and carefully placed in a muffle furnace at 600°C for 4 hours. The crucible was then transferred to the desiccator to cool. Once cooled, the ashed sample within the crucible was weighed. The ash content was determined using the formula provided in equation 3 below (Moronkola *et al.*, 2011).

$$\text{Ash content } \% = \frac{Wt_3 - Wt_1}{Wt_2 - Wt_1} \times 100 \quad (3)$$

Where, Wt_1 = Weight of empty crucible,
Wt_2 = sample before ashing + weight of crucible (W_1) and
Wt_3 = sample after ashing + weight of crucible (W_1)

Assessment of Crude Protein Content Percentage. Five (5) grams of dried material were weighed on ashless filter paper provided. The paper containing the sample was then folded and placed into the digestion vessel or flask. Twenty (20) ml of sulfuric acid (H_2SO_4) and four pieces of granulated zinc were added. The mixture was gently heated inside a fume cupboard for six hours and then allowed to cool. After cooling, the solution was diluted with deionized water and moved to an 800 ml Kjeldahl flask. Next, 100 ml of 40% NaOH was combined and the mixture was distilled. The distillate was then titrated against a boric acid (0.05%) solution with an indicator, methyl red. The protein content was determined based on the nitrogen content found in the sample using equations 4 and 5 (AOAC, 1990; Onuguh *et al*., 2022).

$$\% \text{ Nitrogen} = \frac{0.014 \times C \times V \times 100 \times DF}{\text{Weight of sample}} \times 100 \quad (4)$$

$$\text{Crude Protein } \% = \% \text{ Nitrogen} \times 6.25 \quad (5)$$

Where C = the molarity of acid, V = the volume of acid used, and DF = the volume ratio of solution.

Assessment of Crude Fat Percentage. Two (2) grams of the sample was placed in a beaker and weighed, with the weight recorded as "Wt". Next, ten (10) milliliters of water was introduced, and the solid was dispersed through agitation. The solid particles dissolved and the slurry turned brown after the addition of ten (10) milliliters of concentrated HCl, followed by placement in a boiling water bath. After cooling, 10 milliliters of ethanol were added, followed by vigorous shaking. A flask "Wt1" was subsequently weighed and recorded. The ether layer was transferred into the flask and placed in a boiling water bath to evaporate the ether. The extraction was repeated using 50 mL of diethyl ether to ensure the ether evaporated, leaving the fat residue behind. The flask containing the fat was weighed and labeled "Wt2". The fat content was subsequently calculated as a percentage using the formula provided in equation 6 below (Moronkola *et al.*, 2011; Onuguh *et al*., 2022).

$$\% \text{ Fat} = \frac{Wt_2 - Wt_1}{Wt} \times 100 \quad (6)$$

Where, Wt = weight of the sample,
Wt_1 = weight of dried flask and
Wt_2 = weight of dried flask fat residue.

Assessment of Crude Fibre. In a beaker, 5 grams of the sample was heated with 200 milliliters of 1.25% H_2SO_4 for 30 minutes and then filtered. The residue was rendered acid-free after being rinsed with distilled water. It was then boiled for 30 minutes with 200 milliliters of 1.25% NaOH, filtered, and rinsed with distilled water until it was free of alkalinity. It was washed once with 10% HCl, twice with ethanol, and three times with petroleum ether. The residue was placed in a crucible and dried overnight in an oven at 105°C. It was placed in a muffle furnace and heated to 550°C for 90 minutes after being cooled in a desiccator, in order to determine the ash weight (AOAC, 1990).

Assessment of Carbohydrate Content. The crude carbohydrate content of the sample was determined by summing the percentages of other components and subtracting this total from 100 percent (Moronkola *et al.*, 2011; Onuguh *et al*., 2022).

Percentage Carbohydrate = 100 – (% moisture + % protein + % ash + % lipid + % crude fiber). (7)

Statistical Data Analysis. The statistical analysis was conducted using SPSS data analytic software, version 25. One-way ANOVA (analysis of variance) was used to analyze data. Differences were regarded significant at $p < 0.05$.

H_0: The nutritional proximate analysis of tomato fruits sold in 3 different markets in Benin City, Nigeria, showed no significant differences.

RESULTS AND DISCUSSION

Table 1 shows the results of the proximate nutritional composition analysis of tomato fruits purchased from 3 different markets within Benin City, Nigeria. It indicated that the moisture composition was the highest

and varied from 92.73±0.42 to 93.50±1.14, the carbohydrate content was second and varied from 2.72±0.45 to 3.62±0.94, the crude fibre content varied from 1.24±0.24 to 1.69±0.35, the protein content varied from 0.91±0.21 to 1.00±0.14, the fat content varied from 0.91±0.08 to 0.94±0.05 and the ash content ranged from 0.23±0.07 to 0.26±0.05. The result obtain in Kwara State Nigeria (Garuba *et al*., 2018), indicated that the moisture, carbohydrate, crude fibre, protein, fat and ash contents were 94.22%, 5.72%, 0.14%, 0.10%, 0.13%, and 0.17% respectively. The moisture composition was comparable with the result in Table 1 but other nutrient contents varied noticeably.

Results displayed in Table 2 shows that the p-values associated with each of the ANOVA statistics were all greater than the level of significance of 0.05, thus, the null hypothesis is hereby accepted. Hence, the nutritional proximate analysis of tomato fruits sold in 3 different markets in Benin City, Nigeria, showed no significant differences ($p > 0.05$).

Table 1: Proximate Nutritional Composition Analysis of Tomato Fruits Sold in 3 Markets in Benin City, Nigeria.

	%Moisture	% Fat	% Ash	% Fibre	% Protein	% Carbohydrate	TN
Oba Market	92.73±0.42	0.91±0.08	0.24±0.03	1.50±0.20	1.00±0.14	3.62±0.94	7.27
Evbuotubu Market	93.50±1.14	0.94±0.05	0.23±0.07	1.69±0.35	0.92±0.18	2.72±0.45	6.50
Ikpoba Market	93.11±0.85	0.93±0.04	0.26±0.05	1.24±0.24	0.91±0.21	3.55±0.34	6.89
Nutrient Range	0.77±1.21	0.03±0.94	0.03±0.86	0.45±0.42	0.09±0.25	0.90±1.04	

Mean ± Standard deviation of three replications ; TN = % Total Nutrient contribution in the absence of moisture

Table 2: Analysis of Variance Result Showing Differences in the Proximate Analysis of Tomato Fruits Marketed in 3 Different Markets in Benin City, Nigeria.

		Sum of Squares	df	Mean Square	F	Sig.
% Moisture	Between Subjects	310.722	2	655.219	0.917	.207
	Within Subjects	833.812	21	41.337		
	Total	1144.534	23			
% Fat	Between Subjects	621.777	2	882.119	0.112	.351
	Within Subjects	975.531	21	44.353		
	Total	1597.308	23			
% Ash	Between Subjects	287.337	2	876.766	1.001	.491
	Within Subjects	179.451	21	47.539		
	Total		23			
% Fibre	Between Subjects	671.690	2	156.146	0.743	.110
	Within Subjects	265.811	21	35.785		
	Total	466.788	23			
% Protein	Between Subjects	702.319	2	746.199	1.042	.553
	Within Subjects	310.591	21	37.013		
	Total	1012.91	23			
% Carbohydrate	Between Subjects	421.920	2	915.046	0.141	.371
	Within Subjects	492.512	21	41.250		
	Total	914.432	23			
% TN	Between Subjects	561.737	2	307.412	1.093	.221
	Within Subjects	419.550	21	59.071		
	Total	981.287	23			

Results: % Moisture: $F(2, 12) = 0.917$, $p>0.05$; % Fat: $F(2, 12) = 0.112$, $p>0.05$; % Ash: $F(2, 12) = 1.001$, $p>0.05$; % Fibre: $F(2, 12) = 0.743$, $p>0.05$; % Protein: $F(2, 12) = 1.042$, $p>0.05$; % Carbohydrate: $F(2, 12) = 0.141$, $p>0.05$; % TN: $F(2, 12) = 1.093$, $p>0.05$

Table 3: % Contribution of Other Nutrients in the Non-existance of Moisture.

	Fat%	Ash%	Fibre%	Protein%	Carbohydrate%	Total%
Oba Market	12.52	3.30	20.63	13.76	49.79	100
Evbuotubu Market	14.46	3.54	26.00	14.15	41.85	100
Ikpoba Market	13.50	3.77	18.00	13.21	51.52	100
% Average Nutrient Contribution	13.49	3.54	21.54	13.71	47.72	100

$$\text{\% contribution of a nutrient in the non-existance of moisture} = \frac{\text{contribution of a nutrient \%}}{\text{TN}} \times 100$$

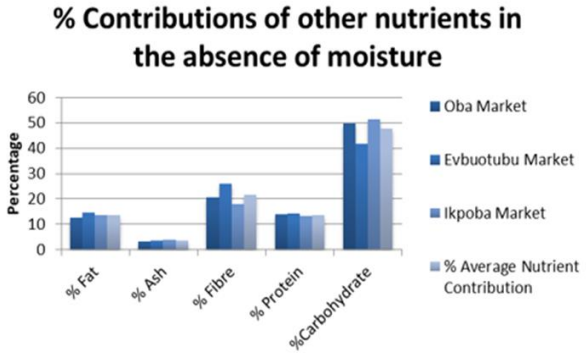

Fig. 1. Contribution of Nutrients in the Nonexistence of Moisture.

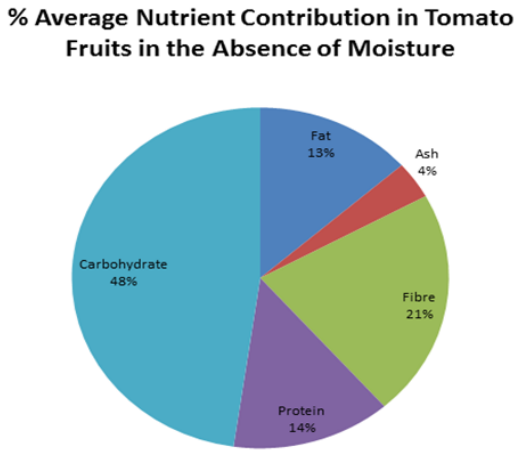

Fig. 2. Percentage Average Nutrient Contribution in Tomato Fruits in the Absence of Moisture.

As shown in Table 3, the availability of other nutrients became more pronounced when the moisture content was entirely disregarded. The average nutrient concentration in the absence of moisture decreased in the following order: carbohydrate > fibre > protein > fat > ash.

High average carbohydrate content (47.72%), fibre content (21.54%) and protein content (13.71%) were recorded. Carbohydrates serve as the primary energy source for all cells in the body, including those of the central nervous system, while proteins contribute to the structure of bones, muscles, and skin (Samson and Isaac 2019). Dietary fiber aids in lowering body cholesterol levels, subsequently reducing the risk of cardiovascular diseases (Oboh *et al*., 2006).

CONCLUSIONS

This research work determined and compared the proximate nutritional composition analysis of freshly harvested red tomato fruits marketed in Benin City, Nigeria. A high moisture content that ranged from 92.73±0.42 to 93.50±1.14 was indicated. The average nutrient composition in the absence of moisture was determined to decrease in the following order: carbohydrate > fibre > protein > fat > ash. These tomato fruits were discovered to be rich in carbohydrates, fibre and protein if the moisture content is eliminated. Carbohydrates serve as the primary energy source for all cells in the body, including those of the central nervous system, while proteins contribute to the structure of bones, muscles, and skin. Dietary fiber aids in lowering body cholesterol levels, subsequently reducing the risk of cardiovascular diseases. This work also investigated significant variations in the proximate nutritional composition of tomatoes sold in different markets within the city. Results from the ANOVA test used in comparing the results revealed the nutritional proximate analysis of tomato fruits sold in 3 different markets in Benin City, Nigeria, showed no significant differences ($p > 0.05$).

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