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Determination of Proximate Composition and Elemental Analysis of Tomato *(Lycopersicum solanum)* consumed in Kano State, Nigeria

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Abstract: *Tomato (Lycopersicum solanum) is a major agricultural crop cultivated in Nigeria, especially in the northern parts, it is widely consumed vegetable grown worldwide with an annual production of more than 120 million tons in the world. Every human being requires a good nutrition as a basic need for proper development and well-being. Many forms of tomatoes are today available in the market. They range from dried, canned juiced and some other forms. These are to ensure non-stop supply of the fruit throughout the year and to prevent contamination or spoilage. However, in many cases; when a food item is subjected to the preservation techniques, they tend to lose some nutrients compared to the fresh food item. The current study was aimed to compare the nutritional contents of canned and fresh tomato obtained from the market. Proximate composition, mineral and vitamin analyses carried out on canned tomato paste (Gino) and fresh tomato (Tf) show that, the fresh tomato possesses high contents of moisture (23.63 ± 0.24^a), ash (3.54 ± 0.04^a) and carbohydrate (77.37 ± 0.20^a) than the canned tomato. However, the least percentage composition of crude fat (1.19 ± 0.18^a), crude fiber (7.52 ± 0.00^b) and protein (10.38 ± 0.08^a) compared to canned tomato ($p<0.05$). When Mineral analysis was carried out, it shows that sodium, magnesium, potassium, calcium and iron concentrations are significantly higher in canned tomato ($p<0.05$) compared to fresh tomato. Thus, proximate and minerals are needed for proper composition of body fluids, tissues, bones, teeth, muscles and nerves for regulation of the cardiovascular system activities.*

Keywords: *Tomato; Proximate composition; Mineral analysis; Canned paste.*

1.0 INTRODUCTION

Tomato (*Lycopersicum solanum*) is one of the most popular and widely grown vegetable crops in the world. It has its origin from South America specifically Peru, Bolivia, Ecuador and Columbia (Davidson *et al.*, 1975) before it was spread around the world following the Spanish colonization of the Americans and its many varieties are now widely grown all over the world (Joy *et al.*, 2007). Tomato is one of the most popular and widely consumed vegetables grown worldwide with an annual production of more than 120 million tons in the world (Andrew, 2000). Tomato is a major agricultural crop cultivated in Nigeria, especially in the northern parts, it has been reported that over six million tons of tomatoes are produced annually, with about 50% lost between rural production and town consumption in the tropical areas (Adenike, 2012).

Tomato is a fleshy berry regarded as very popular perishable fruit as well as vegetable grown throughout the tropical and temperate regions of the world (Joy *et al.*, 2007). It is typically over 90% water and once they are harvested, they begin to undergo higher rates of respiration, resulting in moisture loss, quality deterioration and potential microbial spoilage. Harvesting itself separates the fruit or vegetable from its source of nutrients. In many cases, fresh tomato has a shelf life of only days before they are unsafe or undesirable for consumption. Post-harvest activities greatly influence the level of losses and the quality of produce. These are grading, packaging, pre-cooling, storage and transportation (Spooner *et al.*, 2005; Kunzek *et al.*, 1999). An efficient marketing system is essential for sustained agricultural development. It affects both producers' income and consumers' welfare. There are several factors which influence the efficiency of tomato marketing including perishes ability, seasonality, quality, prices and location of the products (Ismail *et al.*, 2016). Storage and processing technologies have been utilized for centuries to transform perishable fruits and vegetables including tomato into safe, delicious and stable products. In some cases, processed food including tomato are said to have same or even higher nutrient content (Ismail *et al.*, 2016).

Tomatoes are not only a good source of Vitamin A and C but they are also a good source of other vitamins and minerals. Tomatoes contain higher levels of minerals, Phosphorus and Potassium; they also contain folate and high levels of the antioxidants beta-carotene and lycopene. One medium tomato have 552mcg of beta carotene and 3,165mcg of lycopene which can help boost the immune system by fighting the damaging effects of substances called free radicals (McSweeney *et al.*, 2005).

Lycopene which is the red colored pigment found in tomatoes is a hydrocarbon with extended conjugated double bond as the

carotenoids (Rodriguez and Kimura, 2004). As a fat soluble compound, lycopene has a similar absorption property as dietary fat. In the stomach and duodenum, lycopene will separate from the food matrix and subsequently dissolve in the lipid phase (Krinsky and Yeun, 2005). Food processing is one of the factors that affect the bioavailability of lycopene and thus increase absorption. For instance heat induces isomerization of all trans-lycopene to cis-isomers which would increase its bioavailability (Unlu *et al.*, 2007). Dietary supplementation or adequate intake of lycopene and vitamin A rich foods is beneficial in asthmatic and rheumatoid arthritis patients and has been reported to be safe when used as food additive (Thrumbo, 2005).

In recent times, the Roma VF, Ronita and UTC cultivars have become very popular among farmers in Kano State and this study has been designed to ascertain the proximate composition and elemental analysis of some key factors that can determine their use for both domestic and industrial purposes. Tomato is low in saturated fat, cholesterol and sodium. Tomatoes can be eaten raw, with salad or mixed with meat, pulse and vegetable dishes. Slices of red tomatoes are used for garnishing. Cooking or processing of tomato (e.g. tomato paste, ketchup, tomato soup, and tomato sauce) maintains its lycopene content. Test also shows that eating tomatoes has more benefits (with all of its other ingredients) than taking lycopene alone (USDA, 2005; McDonald *et al.*, 1998).

Tomato has a limited shelf life at ambient conditions and is highly perishable this makes its preservation inevitable. Sun drying is one of the most common methods of preservation in Nigeria due to its vest availability all the year round. A large percentage of the tomatoes produced in the northern part of Nigeria are usually sun dried on the bear ground to avoid wastages which results in an unattractive dried tomato chips (Adenike, 2012). Preservation and storage of tomato is difficult especially in Nigeria because of the prevailing situation of poor transportation networks coupled with high temperatures that enhances decay during storage (Ibironke, 2013). There is the need to find ways of improving the shelf life of tomato in a safe and low cost manner.

Proximate analysis refers to the determination of the major nutritional constituents of tomato and it is used to assess if tomato is within its normal compositional parameters or somehow been adulterated. As plants form main portion of our diet; so their nutritive value is imperative (Jimoh and Oladiji, 2005). Besides these biochemical; the moisture, fiber, ash contents and the energy values of individual vegetable species have also been reported to be important to the human health as well as for soil quality (McSweeney *et al.*, 2005).This method partitioned nutrients in tomato into six (6) components; moisture content, crude fat, crude protein, crude carbohydrate, crude fibre and ash content.

Elemental analysis is a process where a sample of some material (e.g., soil, waste or drinking water, bodily fluids, minerals, chemical compounds) is analysed for its elemental and sometimes isotopic composition. Elemental analysis can either be qualitative or quantitative. Qualitative: determining what elements are present or the presence of a particular element. Quantitative: determining how much of a particular or each element is present.

The purpose of elemental analysis is to determine the quantity of a particular element within a molecule or material (McSweeney *et al.*, 2005; Abdullahi *et al.*, 2016).The Flame Atomic Absorption Spectrometry (FAAS) is a spectroscopic method of analysis it depends on the principle of spectroscopy which bases on beer-lamberts law. The technique utilizes the absorption spectrometry in assessing the concentration of analyte in the sample, that is, it uses the absorption of light to measure the concentration of gas-phase atoms. The light source is usually a hollow-cathode lamp or flame of the element that is being measured. Lasers are also used in the research instruments (Abdullahi *et al.*, 2016).

Major element functions are numerous and varied, and are vitally important in body health. Key major elements include sodium, magnesium, potassium, calcium, and iron. These minerals play roles in body fluid osmotic pressure, bone and teeth integrity. These elements are important in numerous body functions, but in relatively small amounts; less than 100mg/day (Ismail *et al.*, 2016).

Every human being requires a good nutrition as a basic need for proper development and wellbeing. In local community where resources are sometimes scarce, one of the ways of achieving good nutrition is through the exploitation of available local resources, knowledge of the proximate composition and some of its elemental analysis of these local plant resources is therefore very necessary in order to encourage increase cultivation and consumption of these plant sources. Many forms of tomatoes are today available in the market. They range from dried, canned juiced and some other forms. These are to ensure non-stop supply of the fruit throughout the year and to prevent contamination or spoilage. However, in many cases; when a food item is subjected to the preservation techniques, they tend to lose some nutrients compared to the fresh food item. Thus, the current study was aimed to compare the nutritional contents of canned and fresh tomato obtained from the market.

2.0 MATERIALS AND METHODS

A fresh sample of tomato and a canned tomato designated as “Cf and Gino” were obtained from ‘Yankaba market in Kano State, Nigeria.

2.1 Preparation of Samples

The fresh tomato was cleaned and divided into two parts. One part, on which moisture is to be determined, was blended into

a paste. While the other part on which proximate, elemental and vitamins analysis is to be carried out was sliced using a sharp knife and was then put under the sun to 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 research. For the canned tomato; the tomato paste was also divided into two parts, one part was used for moisture determination while the other pat was dried under sun to dry for proximate elemental and vitamin determination. The dried sample was stored at room temperature for the duration of the research.

Fig. 1: A Tomato variety in Nigeria

2.2 Quantitative Determination of Proximate Composition

The dried powdered samples of each extract were brought to uniform size by sieving. Both samples were analyzed for moisture, protein, ash, fibre and carbohydrate by the methods of Association of Official Analytical Chemists (AOAC) 2003 (Abdullahi *et al.*, 2026).

2.2.1 Determination of Moisture Content (Oven drying method)

1.5 g of well-mixed dried powdered sample of each extract was accurately weighed in clean, dried crucible (W_1). The crucible was heated in an oven at 100-105^{o}C for 6-12 h until a constant weight is obtained. The crucible was be placed in the desiccators for 30 min to cool. After cooling it was weighed again, and the percent moisture was calculated by the following formula:

$$\% \text{ Moisture} = \frac{W_1\text{-}W_2 \times 100}{\text{Wt. of Sample}}$$

Where;
W_1 = Initial weight of crucible Sample
W_2 = Final weight of crucible + Sample

2.2.2 Determination of Ash-content

A crucible, which has been dried for at least 2 hours at 100^{0}C from oven to desiccators, cooled and its weight was recorded (W1). 5g of sample was weighed in to the crucible (W2). The samples were ashed in furnace at 600^{0}Cfor 2 hours. Crucible was removed from furnace and allowed to cool in a desiccator and weighed (W3).

Calculation;

$$\% \, Ash \, (dry \, basis) = \frac{W3 - W1}{W2 - W1} \; X \; 100\%$$

$$Where: W1 = weight \; of \; empty \; crucible,$$

$$W2 = weight \; of \; crucible + sample \; before \; ashing,$$

$$W3 = weight \; crucible + \; ash \; all \; in \; grams.$$

2.2.3 Determination of Crude Protein

Accurately 0.2g of sample was weighed out into digestion tube. 15cm^3 of H_2SO_4 acid was added. The tube was swirled gently until the sample and the acid were thoroughly mixed.5g of Kjeldahl catalyst mixture was added. The solution was heated curiously until it was clear. The temperature was raised and the solution was heated to boil for 2 hours after the solution was cleared. The solution was allowed to cool and it was transferred into 100cm^3 volumetric flask and diluted to volume to volume with distilled water and mixed thoroughly. This ends the digestion process. For the distillation, 10cm^3 of 2%boric acid was measured into a 100cm^3 Erlenmeyer flask then 1-2 drops of mixed indicator was added. 10cm^3 aliquot of the digest was transferred into a distillation apparatus. 15cm^3 of 40% NAOH was added into the mixture. The nitrogen distilled into boric acid/indicator flask for at least 10-15minutes.the condenser tip was then rinsed with distilled water. The distillate was then titrated with 0.025N H_2S0_4 to a pink end point and the burette reading was taken.

Calculation;

$$\%N = \frac{\frac{0.014MeN}{100g}X\text{titre of the TV X digest volume}(100ml)X\text{ normality of acid }(0.025)}{\text{Weight of sample }(0.2g)X\text{ Volume of aliquot used }(10ml)} X\ 100\%$$

$$\text{Therefore, total crude protein} = \%N \text{ X } 6.25$$

2.2.4 Determination of Crude Lipid

Filter paper was folded into a thimble shape and weighed and its weight was zeroed. 2g of sample was placed into the thimble. The thimble was slipped into a thimble holder. 250cm^3 of petroleum ether was added using glass funnel from the top of the condenser.

$$NFE = 100 - (\text{crude protein} + \text{crude fibre} + \text{moisture} + \text{ash} + \text{crude fat})$$

The heater switch, main power switch and the condenser water were turned on, followed by extraction for minimum of 4 hours on a high setting (condensation rate of 5-6 drops per second). After the extraction, the heater and water tap were turned off, and the ether (with the fat extract) was transferred into a beaker of known weight (W1) the thimble was rinsed with more petroleum ether. The beaker was taken into an oven at 70^{0}C for about 30 minutes. It was then allowed to cool and the ether was drained out. The weight of the beaker and the fat it contains was weighed (W2).

Calculation;

$$\%\ Crude\ fat = \frac{W2 - W1}{\text{Weight of sample }(2g)}\ X\ 100\%$$

Where:

$$W1 = weight\ of\ beaker$$

$$W2 = \text{weight of beaker}(g) + \text{fat extract}(g)$$

2.2.5 Determination of Crude Fibre

2 g sample (W_0) was weighed and transferred to a porous crucible. The crucible was placed into Dosi-fiber unit and kept the valve in "Off" position. 150 mL of preheated H_2SO_4 solution and some drops of foam-suppresser were added to each column. Then the cooling circuit was opened and the heating elements turned on (power at 90 %). When boiling starts, the power was reduced to 30 % and allowed for 30 min. Valves was opened for drainage of acid and rinsed with distilled water thrice to completely ensure the removal of acid from sample. The same procedure was used for alkali digestion by using KOH instead of H_2SO_4. The samples was dried in an oven at 150 ^{o}C for 1 h and allowed to cool in a desiccator and weigh (W_1). The samples crucibles were kept in muffle furnace at 55 ^{o}C for 3 - 4 h. The samples were cooled in desiccators and weighed again (W_2). Calculation was done using the following formula:

$$\%\ \text{Crude Fibre} = \frac{W_1 - W_2 \text{ x } 100}{W_0}$$

2.2.6 Determination of Carbohydrate

The carbohydrate content would be determined by subtracting the sum up percentage of compositions of moisture, protein, fibre, and ash contents from 100.

%Carbohydrate = 100 – (%moisture + crude protein + %crude lipid + %crude fibre + %ash)

2.3 Determination of Mineral Element

The ash residues was digested using 5cm^3 of concentrated Nitric acid and then filtered using a filter paper in to 100cm^3 volumetric flask and was diluted to the mark with distilled water. It was then transferred in to sampling bottle, ready for analyses. The procedure was repeated for all other samples. ***Atomic absorption spectrophotometer (aas)*** **was used in this respect.** This is equipment for the determination of mineral content of a sample.

5cm^3 of 1N Nitric acid (HNO_3) solution was added to the ash contained in the crucible. Evaporation to dryness on a hot plate at a low heat under ventilation was then followed. The sample was then returned to furnace and heated at 400^{0}C for 10 minutes and a perfectly white ash was obtained. The sample was again cooled on top of asbestos's sheet before the addition of 10cm^3 of 1N HCL and then the solution was filtered into 50cm^3 volumetric flask. The crucible and the filter paper were washed with additional 10mlportion of 0.1N HCL three times and the volume was made up to 100cm^3 with distilled water. The filtrate was then stored the determination of Sodium, Potassium, Calcium, Magnesium and Iron by flame photometry.

3.0 RESULTS AND DISCUSSION

3.1 Results

Table 1: Results of Proximate Analysis of Tomatoes (%)

Parameters	Fresh (Cf)	Canned (Gino)
Moisture content	23.63±0.24^a	20.63±0.15^b
Ash content	3.54±0.04^a	1.96±0.05^b
Crude Fabre	7.52±0.00^b	11.38±0.36^a
Crude Fat	1.19±0.18^a	1.81±0.04^a

Crude Protein	10.38±0.08[a]	10.67±0.17[a]
Carbohydrate	77.37±0.20[a]	74.18±0.58[b]

Values are Mean + standard deviation; Where n=number of samples used; Values having similar superscript differ significantly

Values are expressed as mean ± standard deviation of triplicate (n=3) determination and value with different superscript on the same row are significantly different ($p<0.05$) and does with the same superscript are not significantly different ($p>0.05$). One-way ANOVA was used to analyze the results and mean differences were sorted out based on Turkey-Kramer's Multiple Comparisons Test.

Table 2: Results of Elemental Analysis of Tomatoes (mg/Kg)

Parameter	Fresh (Cf)	Canned (Gino)
Sodium	3.74±0.31[b]	8.66±0.22[a]
Magnesium	3.29±0.22[a]	3.34±0.08[a]
Potassium	51.06±5.21[b]	60.01±1.50[a]
Calcium	64.27±6.24[b]	75.01±1.80[a]
Iron	6.13±0.63[b]	7.21±0.18[a]

Values having similar superscript differ significantly

Values are expressed as mean ± standard deviation of triplicate (n=3) determination and value with different superscript on the same row are significantly different ($p<0.05$) and does with the same superscript are not significantly different ($p>0.05$). One-way ANOVA was used to analyze the results and mean differences were sorted out based on Turkey-Kramer's Multiple Comparisons Test.

3.1 Discussion

Industrially produced canned tomatoes are important product and subject to regular market analysis as well as trade considerations (Andress, 2006). A 1997 study found that canned fruits and vegetables provide as much dietary fibre and vitamins as the same corresponding fresh or frozen foods, and in some cases, even more (Potter, *et al.,* 1999). In general, canning has no major effect on the carbohydrate, protein, or fat content of foods.

From Table 1 comparing the canned tomato and fresh one, indicates that the fresh tomato has much higher moisture content than the canned tomato (*$p<0.05$)*. Several factors could account for such a difference. This difference may be as a result of vaporization in the course of heating. Since the main reason behind canning is to preserves the tomatoes product so as to stay for a longer time without getting spoilt, then reducing the water content of the tomatoes decreases the risks or chances of microbial growth Also, to increase the solid content so that consumers can buy more solid matter. Geographical differences could be another factor. The moisture content of the fresh tomato is in conformity with the finding of (Romain, 2001; Harry, 1994).

The ash content of the raw tomato was found to have higher ash content than the canned tomato, the implication is that fresh tomato contains soluble vitamins which on heating can easily be lost or evaporated as such it is very important to prepared and used raw tomato while fresh not rotten when it has lost his essential minerals. This result was contrary to (Ismail *et al.,* 2016) who opined that the ash content of fresh tomato was found to have the lowest ash content with significant difference compared to the canned tomatoes ($p \leq 0.05$). The crude fibre contents of fresh and canned tomato are found to be in trace amounts, as such there is no much different in crude fibre content between the two tomatoes. Looking at the percentage value of fat for fresh tomato, it can be seen that it has the lowest fat content than the canned tomato. The fresh tomato has significantly lower fat content than the canned tomato *($p<0.05$)*. Several factors might result to such difference. The difference of processing mechanism involved in the processes of preservation might have a different effect on the fat content. Also geographical differences may also be a contributing factor for the difference. Looking at the percentage composition of crude protein, the fresh tomato was found to be in trace with the canned tomato as such there in no more difference in crude protein content between the two tomatoes.

The canned tomatoes were found to have low percentage of carbohydrate compared to the fresh tomato. This is due to preservatives added to the canned tomato. The results of these findings showed higher carbohydrate contents of fresh tomato than that reported by (Saywell and Robertson, 1932). However, it was reported lower than that reported by (Romain, 2000; Harry, 1994). The carbohydrate content of canned tomato was found much higher than that reported by (Mike, 2009; Martín-Belloso and lanos-Barriobero, 2001).

On the mineral composition in Table 2, with regards to canned tomato the fresh tomato has the lowest concentration of sodium. This could be as a result of addition of salt (table salt) during the course of canning to improve preservation. The result made the canned tomato not recommendable, especially for hypertensive patients as higher sodium content might increase blood pressure. The magnesium concentration of fresh tomato was found to be significantly the same when compared with canned tomato. Therefore, there is no much difference between fresh and canned tomato in terms of concentration of magnesium.

The fresh tomato has the lowest potassium concentration when compared with the canned tomato; this difference might result to the fact that nutritional content might be affected by soil nutrient. The results of the findings showed a lower concentration of fresh tomato as stated by (Harry, 1994; Romain, 2001; Missio *et al.,* 2025).

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

People often regard canned foods as less nutritious than fresh food; this research reveals that this is not always true for tomato. In general, while canning often lowers the content of water-soluble and thermally labile nutrients, the fresh tomato contain less nutrient concentration due to high water content which in addition makes it more liable for microbial attack. This is the reason why the canned tomatoes was found to contained higher concentration of elements; sodium, magnesium, potassium, calcium and iron. In terms of proximate analysis, the canned tomatoes were higher in crude fiber, crude lipid and crude protein while fresh tomatoes are higher in moisture content, ash and carbohydrate.

4.2 Recommendations

Due to the high nutritional composition of canned tomatoes, one may recommend it for consumption, because it is rich in some mineral elements such as potassium, magnesium, sodium etc. even more than the raw tomatoes. However, consumption of canned tomatoes would not be recommended since synthetic and canned products are not advocated for practical natural nutrients, due to their side effects.

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AUTHOR CONTRIBUTIONS

All authors contributed toward data analysis, drafting and critical revision of the paper and agreed to be accountable for all aspects of the research study.

CONFLICT OF INTEREST

The authors declared no competing interests exist.

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