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Comparative Nutritional Composition of Raw and Canned Tomatoes *Solanum lycopersicum (Lycopersicon esculentum*) Dutse Market Jigawa State, Nigeria

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Abstract
*This work was carried out to determine and compare the nutritional composition of both raw and canned tomatoes which today flood our market. The canning is carried out to ensure an adequate supply of tomatoes throughout the year and to prevent spoilage. Proximate, vitamin and mineral analysis conducted on samples of canned tomatoes (A) and raw tomatoes (B) shows that, the raw tomatoes has high percentage composition of moisture (92.33%±0.58), ash (1.67%±0.29) and carbohydrate (93.28%±0.68) and it has least percentage composition of crude protein (4.05%±0.1), crude lipid (1.0%±0.29) and energy (348.5%±1.45) compared to the canned tomatoes with values of percentage composition of moisture(*65.17%±0.38*), ash* **(**1.17%±0.29*) and carbohydrate (*85.01%±0.92*) and it has high percentage composition of crude protein (*10.82%±0.13*), crude lipid(*3.00%±0.5*) and energy (*355.00±1.55*)kcal.The mineral analysis indicates that sodium, potassium, magnesium and phosphorus concentration are higher in canned tomatoes while calcium is found to be high in raw tomatoes. The vitamin analysis reveals that vitamin C is high in the canned tomatoes than in the raw tomatoes. Lycopene content was found to be high in the raw tomatoes (0.646%±0.05) compared to the canned tomatoes (0.177%±0.02).*

Keywords: Nutritional composition, raw tomatoes, canned tomatoes, lycopene content, Solanum lycopersicum

INTRODUCTION
Fruits and vegetables are generally defined as the edible plant structure of a mature ovary of a flowering or herbaceous plant that is eaten whole or in parts raw or cooked. Fruits developed from the ovary in the base of the flower and contain the seeds of the plant (Calbom and Keane, 1992). Vegetables may be defined as the fresh edible part of plants such as the root, stem or leaf which is either raw, cooked, canned or processed in some other way, provide suitable human nutrition (Calbom and Keane, 1992). Fruits and vegetables usually have considerable amounts of vitamins and minerals and generally they contain little protein or fat and have low calorie content (Pamplona-Roger, 2003).Fruits and vegetables have high fiber content and they also contain natural colour pigments and as such are used as food colourants which improve the sensory quality of foods (Tombak,2000).Phytochemicals such as flavonoids, limonoids (prominent in orange) and lycopene (prominent in tomatoes), which are powerful antioxidants

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and also prominent in most fruits and vegetables (Negri, 1991), help in the prevention of arteriosclerosis, cardiovascular diseases and prostate cancer (Trout, 1991: Simon and Sobulu 1974).

In Nigeria, mainly grown vegetables include tomatoes, okra, sweet pepper, spinach and carrot. Among these okra, tomato and sweet pepper are commonly and daily eaten by all classes of soups. They are equally good sources of vitamins where fruits are not ecologically viable (Olaosegba, 1986).Vegetable are the fresh and edible portions of herbaceous plants. They are important classes of food substances and highly beneficial for the maintenance of health and prevention of diseases. They contain valuable food ingredients, which can be successfully utilized to build up and repair the body. They are valued mainly for their high carbohydrate, vitamins and mineral contents. There are different kinds of vegetables; they may be edible roots, stems, leaves, fruits or seeds. Each group contributes to diet in its own way (Robinson, 1990).

The health of an individual depends on the qualities and quantities of food consumed. A substance that provides nourishment essential for the maintenance of life and growth is called nutrient. Fish is a good source of many important nutrient, including proteins, mineral elements, vitamins (Alfred and Patrick, 1985). Fruits and vegetables provide essential components of a balanced diet and are ranked as nutrient dense foods. The term "nutrient-dense" means food that is high in nutrients but relatively low in calories. Nutrient-dense foods contain vitamins, minerals, complex carbohydrates, lean protein and healthy fats facilitates maintaining a healthy weight (USDA, 2010 and Denton and Swarup,1983). A higher consumption of Fruits and Vegetables can be associated with a lower risk of some chronic diseases (EFSA, 2008), especially cardiovascular diseases, including heart attack and stroke. Some Fruits and Vegetables may have a protective effect against certain types of cancer (USDA, 2010). The effect cannot be easily explained on the basis of their nutrient content. Intakes of Fruits and Vegetables are low in many EU countries (EFSA,2008). Tomatoes, *Solanum lycopersicum* (*Lycopersicom esculentum)* is a tender warm season crop. It is characterized by glandular hairs (trichomes) that emit strong aroma when broken. Tomato plants are typically vinyl, prostrate, and are either determinate, semi determinate or indeterminate based on whether the apical stems terminate in an inflorescence. Most shoots form in the axils of leaves. It has got a deep tap root which may extend to three meters with extensive secondary roots (Peirce, 1987, Purseglove, 1988). The fruits are mostly red but there are some other colours such as yellow. There is a lot of variation between cultivars in the size and shape of the fruits, in the thickness of the fleshy mesocarp and in the development of the placenta (Prashanth, 2003: Veershetty, 2000).

Tomato, *Solanum lycopersicum (Lycopersicon esculentum)*is one of the most widely cultivated vegetable cropin Africa and in the world as a whole (Peirce, 1987: Opena and Kyomo, 1990). Tomatoes and tomato products are rich in health-related food components as they are a good source of carotenoids (lycopene and ß-carotene), ascorbic acid (Vitamin C), vitamin A, Vitamin E, folate, flavonoids, minerals, proteins and dietary fiber (Beecher, 1998; Davies and Hobson 1981). Regular consumption of healthy tomatoes has been correlated with a reduce risk of various types of cancer and heart diseases. These positive effects are believed to be attributable to the anti- oxidant particularly the carotenoid, flavonoids, ascorbic acid and phenolic compounds. (Giovanelli *et al.*, 1999, laveli *et al.,* 2000; Ruprich *et al,* 2000). Lycopene the principal pigments found in tomatoes represent the most abundant carotenoids in it and it is able to function as an antioxidant by quenching singlet oxygen which has been implicated in cancer

and other serious diseases (Kramer, 1982andQuinn 1980). It is the intention of this research to investigate the comparative composition of raw and canned tomatoes, *Solanum lycopersicum (Lycopersicon esculentum)* commonly found in Jigawa State in the North-western Nigeria. This study focuses on the comparative proximate composition and mineral content of raw and canned tomatoes and their lycopene content.

MATERIALS AND METHODS

Collection and Identification of Plant Materials

The tomatoes fruits were collected from Dutse market Jigawa State, Nigeria on 15th July, 2018 and transported to the Herbarium Unit where it was identified by a botanist, Department of Biological Sciences, Faculty of Science, Federal University Dutse, Jigawa State for identification.

Drying and Preservation of Plant Material

The raw tomatoes were dried at room temperature for a week and repeated until a constant weight was obtained, while canned tomatoes were also dried at room temperature. The samples were oven dried at 55^{o}C for 24hours and ground into powdered using mortar and pestle. The powder sample was stored in an air-tight plastic container used for further analysis except for the moisture content determination, which was based on fresh weight.

Determination of Moisture Content

A clean, dried dish was weighed (W1). 5g of grounded sample was weighed as(W2). The dish was shaken gently to ensure uniform distribution of sample. The dish containing sample was placed in the oven at 100^{o}C for 2hour then, the dish was move to a desiccator and allowed to cool. The dish containing the dried sample was weighed (W3), (Ademoroti, 1996 : AOAC, 1990 : Sadiq and Hassan,2008).

Determination of Ash Content

A crucible, which has been dried for at least 2 hours at 100^{0}C from oven to desiccator, cooled and its weight 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 as 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.

Crude Fibre Determination

2g of the sample was weighed into one-liter conical flask as (W1) and made up to 100cm^3 with distilled water. Then 20cm^3 of 10% H_2SO_4 acid was added to the sample and allowed to boiled gently for 30 minutes using cooling finger to maintain a constant volume. The sample was filtered through a Muslim cloth and rinsed with distilled water, the residue was scrapped back into the flask with spatula and made up to 100cm^3 with distilled water. Then 20cm^3 of 10 % NaOH was added to the sample and allowed to boiled for another 30minutes as repeated above

to maintain a constant volume. The residue was washed thoroughly with distilled water and allow to drain. The residue was scapped back into an empty crucible and dried in an oven at 105^0C for 24 hours and cooled in desiccator. The sample was weighed as (W2) and the ashed in the furnace at 540^0C for 1hour was cooled in desiccators and weighed again as (W3). Calculation:

$$\%\ Crude\ fibre\ =\ \frac{W2-W3}{W1}\ X\ 100\%$$

Crude Protein Determination

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 with distilled water and mix thoroughly. The flask was mounted on the distillation rack and 20cm^3 of 2%boric acid was measured and mixed 250cm^3Erlenmeyer flask and placed under the still set such that the delivery tube was just touching the surface of the solution. Also, the cooling water tap was opened.20$cm^3$of 40% NaOH was added from the side arm to the kjeldahl flask as the distillation was done after thorough mixing of the content in the flask. The 40g of the distillate was collected and titrated with standard acid solution, and the titre values were recorded. The nitrogen distilled into boric acid/indicator flask for 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 taken.

Calculation

% Total crude Protein = % Nx6.25

Determination of crude fat: 250cm^3extraction flask was dried in the oven at 105^0C and allowed to cooled in the desiccator. The empty extraction flask was weighed and covered with cleaned white cotton wool.200cm^3ofpetroleum ether was added into each dried 250cm^3extraction flask. The covered porous thimble was placed into the condenser and the apparatus assembled. The sample was extracted for six hours, the porous thimble was removed and the petroleum ether was removed from the water bath when it was almost free of petroleum ether. After the extraction, the flask containing the oil was dried at 105^0C for one hour and cooled in desiccator and the extraction flask containing the oil was weighed as (W2).

Determination of Carbohydrate

Carbohydrate as nitrogen free extract (NFE) was calculated by difference or available carbohydrate was calculated as difference between 100% DM and sum of the percentages of crude protein, crude lipid, crude fibre and ash(AOAC, 1990).The sample calorific value was estimated according to the formula:

NFE=100 – crude protein + crude fibre + ash +crude fat

Energy (inkcal)=(2.44xgprotein)+(8.37xg lipid)+(3.57xgavailable carbohydrate)
(Asibey-Berko andTayie,1999).

Mineral Element Determination

Sample Digestion

One gram of the powdered sample was digested with 25.0cm^{3}concentrated HN03 using Tecator digestion block until evolution of brown fume stopped. One-centimeter cube of perchloric acid was added to the mixture and the content was further heated to a clear solution. After heating, 30cm^3 of hot distilled water was added to the digest and heated to boiling. The solution was then filtered hot into a clean 50cm^3 volumetric flask, cooled and made up to the mark with distilled water (Asibey-Berko and Tayie,1999). Two more duplicate digest solutions and a blank were prepared.

Mineral Quantification

K and Na were analyzed by flame spectrometry (with Corning 400spectrophotometer). K, Cl and NaCl were used to prepare the standards. Phosphorus was determined colorimetrically with Jenway 6100 spectrophotometer using phosphovanado-molybdate method with KH_2P0_4 as the standard. Calcium and Magnesium were analyzed by titrating the sample solutions against EDTA solution using Calcon and Erichrome Black indicators (AOAC,1990)

Vitamin C Determination

Method as described by (Ngaski, 2006). 3g of each sample was dissolved in 2cm^3 of 10% glacial acetic acid and blended for 10minutes and filtered. The residue was further washed with 5cm^3 portion of 10% glacial acetic acid. 60cm^{3}of 0.3M H_2 SO_4 was added and followed by the additional of 2g solid potassium iodide and 25cm^3 of 0.01M potassium iodate with 25cm^3 of the filtrate was titrated with 0.07M sodium Thiosulphate solution.

Determination Of Lycopene

Lycopene was extracted using hexane: ethanol: acetone (2:1:1) mixture following the method of Gordon and Diane, 2007; Toanalyzed lycopene accumulated in fruit samples; the following five steps in analysis were followed:

1. Fresh fruit samples (0.001 g) were dissolved in 1cm^3 of distilled water and vortexed in a water bath at 30^{o}C. for 1 hour, then 8.0 cm^3 of hexane: ethanol: acetone (2:1:1) added.
2. The samples were capped and vortexed immediately, then incubated out of bright light for one hour.
3. After at least 10 minutes, or as long as many hours later, 1.0 0 cm^{3}water was added to each sample and vortexed again.
4. Samples were allowed to stand for 10 minutes to allow phases to separate and all air bubbles to disappear, and finally absorbance of samples determined at 503 nm by spectrophotometry.
5. the lycopene levels in the hexane extracts were calculated according to Lycopene (mg/g) = Abs503nm ×537×8×0.55/ 0.10×172 or, Abs 503nm × 137.4

Statistical Analysis

Triplicate results were subjected to SPSS, version 4.

RESULTS AND DISCUSSION

Results

The results for the Comparative nutritional composition of raw and canned tomatoes, *Solanum lycopersicum* (*Lycopersicon esculentum*) are shown in Tables 1, 2 and 3.

Table 1 Proximate composition of *Solanum lycopersicum* **(*Lycopersicon esculentum*)**

Parameters (g/100)	Canned Tomatoes	Raw Tomatoes
Moisture content(FW)	65.17±0.38	92.33±0.58
Crude protein	10.82±0.13	4.05±0.10
Crude lipid	3.00±0.50	1.00±0.29
Crude Fibre	Trace	Trace
Ash content	1.17±0.29	1.67±0.29
Carbohydrate	85.01±0.92	93.28±0.68
Energy (kJ/100g)	355.00±1.55	348.50±1.45
Vitamin C(mg/100g)	0.40±0.00	0.20±0.00

Mean ± Standard deviation (SD) of triplicate determination, FW= Fresh weight.

Table 2 Mineral composition of *Solanum lycopersicum* **(*Lycopersicon esculentum*)**

Elements	Canned Tomatoes (mg/100g)	Raw Tomatoes (mg/100g)
Na	169.37±1.64	75.83±3.82
K	1283.0±57.73	783.33±28.87
Ca	0.52±0.03	0.62±0.06
Mg	0.78±0.08	0.66±0.05
P	3.73±0.01	2.84±1.69

Mean ± Standard deviation (SD) of triplicate determination.

Table 3: Lycopene Content of *Solanum lycopersicum* **(*Lycopersicon esculentum*)**

Lycopene(mg/kg)	Raw tomatoes	Canned Tomatoes
1	0.63	0.18
2	0.61	0.16
3	0.70	0.19
Mean	0.65	0.18
STD	0.05	0.02
Mean ± SD	0.65±0.05	0.18±0.02

Mean ± Standard deviation (SD) of triplicate determination.

Table 4 Dietary Recommendation for Mineral Elements (mg/100g)

Elements	Children (7-10yrs)			Pregnant and breastfeeding mothers
		Male	Female	
Na	400	500	400	500
Ca	800	800	800	1,200
Mg	170	350	280	355
P	800	800	800	1,200
K	1,600	2,000	2,000	2000

Source: food and nutrition board (FNB, 2001).

Discussion

From Table 1, comparing the moisture content of canned tomatoes and the raw one,this indicates that the raw tomatoes has much higher moisture content of 92.33±0.58 against moisture content of 65.17±0.58,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.
Considering the percentage composition of crude protein, the canned tomatoes was found to have higher crude protein compared to the raw tomatoes because of the reduction of water in the canned tomatoes in the process of canning.

With regard to the percentage composition of crude lipid, the canned tomatoes have higher content of crude lipid than the raw tomatoes with a significant difference as a result of low moisture content.

The crude fibre contents of both canned and raw tomatoes are found to be in trace amounts, as such there is no much different in crude fibre content between the raw and canned tomatoes.
The ash content of the raw tomatoes was found to have higher ash content than the canned tomatoes, the implication is that fresh or raw tomatoes contains soluble vitamins which on heating can easily be lost or evaporated as such it is very important to prepared and used raw tomatoes while fresh not rotten when it has lost his essential minerals.

With regard to carbohydrate, the canned tomatoes were found to have low percentage of carbohydrate compared to the raw tomatoes. This is due to preservatives added to the canned tomatoes.
In terms of energy, the raw tomatoes were found to be lower in energy. This could be as a result of higher water content in the raw tomatoes.

Considering the vitamin C content, canned tomatoes was found to have higher content of vitamin C than the raw tomatoes, even though both the canned and raw tomatoes were found to have very low vitamin C content. The reason for this may be attributed to addition of preservative added in the process of canning.

Table 2 shows that the mineral composition of tomatoes revealed that canned tomatoes have the higher concentration of sodium. This could be due to the addition of salt (common salt) in the process of canning. However, is very expedient for the common man to always endeavor to consumed raw tomatoes as fresh as possible since the human body does not require excess salt intake in the form of bicarbonates. In the event of scarcity then he should think otherwise considering the health implications.

With regard to the concentration of potassium, the canned tomatoes were found to have higher concentration of potassium than the raw tomatoes. This is because the nutritional composition of the two tomatoes sample can be affected by the soil nutrient. Considering the concentration of calcium, the raw tomatoes have higher concentration of calcium than the canned one. The magnesium concentration in canned tomatoes was found to be a little higher than that of raw tomatoes. Therefore, there is no much difference between raw and canned tomatoes in terms of concentration of magnesium. The results of minerals composition were compared with standard requirements.

With regard to the concentration of phosphorus, the canned tomatoes were found to have higher concentration of phosphorus than the raw tomatoes. This is because phosphorus is a component of the essential insoluble vitamins required by the body for proper functioning.

Table 3 shows the lycopene content of tomatoes, the lycopene content was found to be higher in the raw tomatoes than the canned one. Lycopene serves as anti-oxidants by eliminating free radicals in our bodies and also help to boost the male sex fertility when consumed fresh. This present research was favorably compared with standard literature.

CONCLUSION

Canned foods are often regarded as less nutritious than the raw or fresh foods. This research carried out on tomatoes reveals that this is not always true for tomatoes. Generally, while canning often lowers the content of water soluble and thermally labile nutrients, the raw tomatoes contains less nutrient concentration due to the fact that it has high water content which makes it liable for microbial attack. This is the reason why the canned tomatoes was found to contained higher concentration of potassium, magnesium, sodium, phosphorus etc. In terms of proximate analysis, the canned tomatoes were higher in crude protein, crude lipid and energy while raw tomatoes is higher in moisture content, ash and carbohydrate. Canned tomatoes have high content of vitamin C and raw tomatoes has higher content of lycopene. One of the disadvantages of canning products is in terms of the composition of preservatives added in the process of canning. Most at times these preservatives are not even safe for human consumption and yet they are used for food products preservation or as additives.

RECOMMENDATION

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. But however, I would not recommend the consumption of Canned tomatoes since Synthetic and canned products are not advocated for practical natural nutrients, due to their side effects.

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