BIOSCIENCES BIOTECHNOLOGY RESEARCH ASIA, June 2016. Vol. **13**(2), 1163-1169

Proximate, Mineral and Vitamin Analysis of Fresh and Canned Tomato

Ismail Ismail Abdullahi[1], Nasiru Abdullahi[2], Abdullahi Muhammad Abdu[3] and Abdullahi Salisu Ibrahim[4]

Department of Biotechnology, Faculty of Science and Humanities, SRM University, India.

http://dx.doi.org/10.13005/bbra/2147

(Received: 10 March 2016; accepted: 21 April 2016)

Many forms of preserved tomato are today available in the market. They range from dried, canned juiced and some other forms. These are to ensure nonstop supply of the fruit throughout the year and to prevent 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 aimed at comparing the nutritional contents of canned and fresh tomato obtained from the market. Proximate, mineral and vitamin analysis conducted on three samples of canned tomato paste (C1, C2 and C3) and fresh tomato (Cf) show that, the fresh tomato has high percentage composition of moisture (93.8±3.00) and fat (0.62±0.08) than the three canned tomato. However, it has the least percentage composition of carbohydrate (2.52±0.01), protein (1.00±0.49), crude fibre (1.21±0.99) and ash (0.85±0.01) compared to canned tomato ($p<0.05$). When Mineral analysis was conducted, it indicate that sodium, potassium, and calcium concentrations are significantly higher in canned tomato ($p<0.05$), while the iron was found to be significantly higher in fresh tomato ($p<0.05$). Vitamin A content of fresh tomato is higher while that of vitamin C is higher in canned tomato.

Keywords: Tomato, Proximate, mineral, Canned, Vitamins.

Fruits and vegetables provide colour, flavour and nutrients to our diets. They are more often most attractive and health-promoting when used as fresh. However, majority of people are not capable of keeping gardens that could supply the daily servings year round[1]. 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[2]. It is typically over 90% water and, once they are harvested, 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.

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.

Food preservation is the process of treating and handling food to stop or slow down spoilage (loss of quantity, edibility or nutritional value) and thus, allow for longer storage time[3]. Among the oldest methods of preservation are drying, refrigeration and fermentation. Modern method include canning, pasteurization, freezing,

* To whom all correspondence should be addressed.
E-mail: ismailbangis.iia@gmail.com

irradiation and the addition of chemicals. Advances in packaging materials have played an important role in modern food preservation[4].

Canning is a method of preserving food in which the food contents are processed and sealed in an air tight container. Thus, under specific conditions freeze-dried canned products can last for up to 30 years in edible state[5].

Plum tomatoes such as Roma or San Marzano are the most common choice for canning, since they have a greater solid-to-liquid ratio than other tomatoes and make a more substantial canned product. Commercial canners use a processing tomato, which has a firmer outer peel and pectin layer. Industrially produced canned tomatoes are important product and subject to regular market analysis as well as trade considerations[6]. However, safety measures need to be taken since improperly canned tomatoes can cause botulism poisoning, whether produced industrially or at home[7]. The peelability of processing tomato is significantly affected by the presence of various tomato defects particularly yellow eye and blossom end rot[8].

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[5].

A significant loss of nutrients, especially heat-labile vitamins, may occur during the canning process. In general, canning has no major effect on the carbohydrate, protein, or fat content of foods. Vitamins A and D and beta-carotene are resistant to the effects of heat. However, vitamin B_1 is sensitive to thermal treatment and the pH of the food[9]. Although the anaerobic conditions of canned foods have a protective effect on the stability of vitamin C, it is destroyed during long heat treatments[10].

The research project is aimed at comparing the physicochemical assessment of canned tomato and fresh tomato.

MATERIALS AND METHODS

A fresh sample of tomato designated as Cf and three canned tomato of different company products designated C1,C2 and C3 were obtained from Tarauni market in Kano State, Nigeria.

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.

Determination of moisture content[11]

A clear, dried aluminum dish was weighed (W1). 5g of grounded sample was weighed in to each of the dish (W2). The dish was shaked gently to ensure uniform distribution of sample.

The dish containing sample was placed in the oven at 100°c for 2hour then, the dish was move to desiccator and allowed to cool. The dish containing a dried sample was weighed (W3).

Calculation

The percentage moisture was calculated as follows;

$$\%\ moisture\ = \frac{W2 - W3}{W2 - W1}\ x\ 100$$

Where,

$W1$ = *initial weight of empty aluminum dish*

$W2$ = *Weight of aluminum dish + sample before drying,*

$W3$ = *final weight of dish + sample after drying.*

Determination of ash content[11]

A crucible, which have been dried for at least 2 hours at 100°C from oven to desiccator, 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°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,*

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

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

Crude fibre determination[11]

2g of sample was weighted (W1) and transferred into filter paper, supported on a filter cone in a 60^0 funnel. It was then extracted with three 25cm^3 portions of ether and vacuum was applied until sample was dried. The extracted sample was transferred quantitatively by brushing into a 600cm^3 beaker of the fibre digestion apparatus. 200cm^3 of 1.25% sulfuric acid (H_2SO_4) solution was added. A beaker was then placed on digestion apparatus with pre-adjusted heater and boiled exactly 30minutes. The beaker was rotated periodically to keep solids from adhering to sides. The beaker was removed and the content was filtered through California Buckner funnel. The beaker was rinsed with 50-75cm^3 of boiling water and washed through funnel. This was repeated with tree 50cm^3 portions of water and sucked dry. The residue was returned to beaker by blowing through funnel. 200cm^3 of boiling 1.25% sodium hydroxide (NAOH) solution was added. It was then returned to heart and boiled for 30minutes. The beaker was removed and filtered and removed as mentioned earlier. It was then washed with 25cm^3 of boiling 1.25% sulfuric acid solution followed by 50cm^3 portion of water and 25cm^3 of alcohol respectively. The fibre mat and residue was dried at 130^0C for 2hours. It was then cooled in a desicator and weighed (W2). It was then ignited at 600^0C to constant weight for about 30minutes. It was then cooled in desicator and weighed (W3).

Calculation

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

Crude protein determination[11]

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

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

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

Determination of crude fat[11]

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. 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 70^0C 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:

$W1 = weight\ of\ beaker$

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

Determination of carbohydrate[11]

Carbohydrate as nitrogen free extract (NFE) was calculated by difference as:

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

Mineral element determination

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 absorbtion spectrophotometer (aas)

This is equipment for the determination of mineral content of a sample.

The device consist of an atomizer (usually a flame), a source of radiation (usually a hallow cathode lamp) a device for dispersing radiation (example, a mono-chromator) and an electronic processing unit (photo multiplier, amplifier, etc).

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 an 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.

Vitamin c determination[12]

Accurately 5g of ground sample was dissolved in 500cm^3 of volumetric flask and made up of to the mark and filtered 50cm^3 of this was then pipette into a 100cm^3 volumetric flask. 25cm^3 of 20% metaphosphoric acid was then added and made of distilled water. 10cm^3 of the solution was then pipetted into a flask and 2.5cm^3 of acetone was then added. This was titrated with indophenol solution until a faint pink colour persisted for 15 seconds.

Calculation

$$\text{Vitamin C (mg/100cm3)} = \frac{\textit{Sample titre } (T)}{\text{Standard titre } (S)} \; x \text{ conc. of standard}$$

Vitamin A determination

Into a conical flask containing 25cm^3 of 95% of ethanol, 5g of macerated sample *(AmarantinusCandatus/Habicus sabdariffa*) was placed and maintained at a temperature of about 60-80^{0}C in a water bath for about 20 minutes with periodic shaking.

The extract was decanted, allowed to cool and its volume was measured by means of measuring cylinder and recorded as initial volume (V1)

The ethanol concentration of the sample was brought to 85% by adding 7.5cm^3 of distilled water. It was further cooled into a container of ice water for about 5minutes.

Into a separating funnel, 12.5cm^3 of petroleum ether (pet ether) were poured and cooled; ethanol extract was added to it. The funnel was swirled gently to obtain a homogenous mixture and latter allowed standing until separate layer were obtained. The bottom layer was run into a beaker while the top layer was collected in 250cm^3 conical flask. The bottom layer was returned to the separating funnel and re-extracted with some of the pet-ether for five to six times until the ethanol extract become fairly yellow. The entire pet-ether extract was collected into 250cm^3 conical flask and returned into the separating funnel for re-extraction with 25cm^3 of 85%ethanol. The final extract (the clear layer) was measured and poured into sample bottle for further analysis[11].

The absorbance of the extracts was measured using spectrophotometer (spectronic20). The spectrophotometer was set up to a wavelength of 436nm and cuvette- containing pet-ether (blank) was used to calibrate to zero point. Sample of each extract was placed in a cuvette and readings were taken when the figure become steady. The operation was repeated five to six times for each sample and average values were recorded.

After the concentration of â-carotene was calculated, the vitamin A (Retinol) was calculated by using the following:

6µg of â-carotene is equivalent to 1µg of retinol equivalent.

RESULT AND DISCUSSION

Industrially produced canned tomatoes are important product and subject to regular market analysis as well as trade considerations[6]. 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[5]. In general, canning has no major effect on the carbohydrate, protein, or fat content of foods. Vitamins A and D and beta-

Table 1. Proximate Composition (%)

N=2	Moisture	Crudeprotein	Crudefibre	Etherextract	Chabohyd rate	Ash
C1	72.00 ± 1.30^{a}	$4.20\pm0.49^{d,g}$	6.16 ± 0.99^{i}	0.14 ± 0.01^{l}	13.70 ± 1.33^{o}	3.83 ± 0.00^{r}
C2	71.80 ± 2.8^{b}	$4.16\pm0.78^{e,h}$	5.64 ± 0.57^{j}	0.28 ± 0.03^{m}	14.92 ± 0.90^{p}	3.20 ± 0.01^{s}
C3	72.40 ± 0.15^{c}	$4.83\pm0.42^{f,g,h}$	4.97 ± 0.21^{k}	0.14 ± 0.00^{n}	15.18 ± 0.60^{q}	2.48 ± 0.04^{t}
Cf	$93.80\pm3.00^{a,b,c}$	$1.00\pm0.49^{d,e,f}$	$1.21\pm0.99^{i,j,k}$	$0.62\pm0.08^{l,m,n}$	$2.52\pm0.01^{o,p,q}$	$0.85\pm0.01^{r,s,t}$

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

Table 2. Mineral Composition (mg/kg)

n=2	Sodium(Na)	Magnesium(Mg)	Potassium(K)	Calcium(Ca)	Iron (Fe)
C1	127.25^{a}	81.80^{d}	72.37	$2.29^{g,k}$	$18.07^{l,p}$
C2	163.29^{b}	66.50^{e}	71.82	$2.21^{h,j}$	$10.89^{m,n}$
C3	163.29^{c}	132.72^{f}	89.09	$2.78^{i,j,k}$	$27.43^{n,p}$
Cf	$21.52^{a,b,c}$	$76.87^{d,e,f}$	61.90	$1.60^{g,h,i}$	$34.45^{l,m}$

Values having similar superscript differ significantly.

Table 3. Vitamins composition of canned (mg/100g)

N=2	Vitamin A	Vitamin C
C1	0.005^{a}	10.00^{a}
C2	0.004^{b}	9.77^{b}
C3	0.004^{b}	9.77^{c}
Cf	$0.010^{a,b,c}$	$5.71^{a,b,c}$

Values having similar superscript differ significantly.

carotene are resistant to the effects of heat[9].

From table 1, comparing the canned tomatoes and fresh one, indicates that the fresh tomato was has much higher moisture content (93.8±3.00) than the canned tomatoes (C1: 72.00±1.30, C2:71.80±2.80, C3:72.4±0.15) ($p<0.05$). Several factors could account for such a difference. Since the main purpose of canning is to preserve the quality content, then reducing the water reduces the risk 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) and Harry (1994)[13,14].

With regard to ash content, the fresh tomato was found to have the lowest ash content with significant difference compared to the canned tomatoes ($p<0.05$).

This might result because, as marked on the cans, salt has been added to the canned tomatoes and might increase to ash content.The high water content might also contribute to the low level of ash.

Looking at percentage composition of crude protein, the canned tomato C3 was found to have the highest crude protein and differ significantly with the other two canned tomatoes. The fresh tomato differ significantly with the three canned tomatoes. The high water content of fresh tomato might result in low level of protein.

The crude fibre content of fresh tomato is significantly lower than the canned tomato. This could be because the high water content of the fresh tomato contributes to the low dry matter which contains the crude fibre.

With regard to fat content, the canned tomato C2 has the highest value of fat within the canned samples with a significant difference. This might be that, C2 producing company uses tomato with higher fat content than those producing C1 and C3. Looking at the percentage value of fat for

fresh tomato, it can be seen that it has the highest fat content than the canned tomatoes. The fresh tomato has significantly higher 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.

With regards to carbohydrate, the canned tomato C3 has the highest percentage of carbohydrate followed by C2 and C1respectively. It was found that there is no significant within the canned tomatoes. The carbohydrate content of fresh tomatoes was found to be the least and significantly lower than the other three samples (canned tomato). This might be as a result of high water content of the fresh tomato. The result of this finding show a higher carbohydrate content of fresh tomato than that reported by Saywell and Robertson[15]. However it is lower than that reported by Romain and Harry [14,13]. The carbohydrate content of canned tomato was found to be much higher than that reported by Mike[16].

On the mineral composition, sodium content of C3 was found to be highest followed by C2 and C1 respectively. The fresh tomato has the lowest concentration. This could be as a result of addition of salt (table salt) during the course of canning to improve preservation. The result made the cannedtomato not recommendable, especially for hypertensive patients as higher sodium content might increase blood pressure. the concentration of sodium in C1was found to be in conformity with that stated by Mike and Harry[16,14]. An important role in signal transduction, acid base balances etc. the concentration of Na in C1was found to be in conformity with that stated by Mike (2009) and Harry[16,14].

The concentration of potassium (K) in C1 and C2 are closely similar while that of C3 was found to be higher than the first stated two. The fresh tomato has the lowest K concentration. This difference might result due to the fact that nutritional content might be affected by soil nutrient. However, since all the four samples analyzed do not have much difference, tomato neither canned nor fresh processed could be recommended as a source of K which have numerous functions in the biochemical and physiochemical functions of the body. The result of the findings shows a lower concentration with regard to fresh tomato as stated by Harry and Romain[14,13].

Looking at Calcium, C1and C2 were found to have almost similar concentrations while C3 has a higher concentration than the other two tomatoes. The fresh tomato has the least concentration of calcium.

With regard to Iron concentration, the fresh processed tomato was found to be highest in fresh locally processed tomato followed by C3, C1 and C2 respectively. Such a difference might arise due to possible deposition of iron from the iron plates used in drying of the tomato samples. The canned tomato might have protective effect of Iron deposition than the fresh tomato. Also, as a result of coating of the cans which can protect iron deposition from the can.

However the concentration of iron from this finding is higher than that observed by Harry (1994), Romain (2001) and Martin-Balloso and Lianos-Barribero (2001)[14,13,17]. This might possibly result due to geographical differences. For aneamic patients (i.e Iron deficiency anaemia), the canned and fresh tomato dried on iron plates could be recommended.

The Vitamin A contents of the canned tomatoes was found to be closely related with a difference not exceeding 0.001mg/1000g. However, the Vitamin A content of fresh tomato was found to almost double that of canned tomato. This could be due to the high fat content of the fresh tomato which makes it stabilize the Vitamin A and make it more available than the canned tomato with the lower fat content.

Vitamin C content of the canned tomatoes were found to have almost similar concentrations of vitamin C which is higher than that of the fresh tomato. Both the canned and fresh tomatoes were found to have very low Vitamin C in comparison with fresh tomatoes as reported by Harry and Romain[14,13]. This difference might arise as a result of possible Vitamin C loss during the processing procedure.

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. It can be seen that the proximate contents of the canned tomatoes were significantly higher than the fresh tomato with the exception of crude fat. The same is also applied to most of the minerals analyzed. Only magnesium appeared to indicate no significant difference while iron was higher in fresh tomato. The Vitamin A content was found to be almost similar in canned tomato and higher in fresh tomato. Due to high content of Vitamin C in canned tomato, it can serve as good supplement of the antioxidant. Never the less fresh tomato can also serve the same function even though it has lower vitamin C content.

ACKNOWLEDGEMENT

Our gratitude goes to Department of Biochemistry, Bayero University Kano Nigeria where the research was conducted.

REFERENCES

1. Joy C R., Diane M B. and Christine M B. Nutritional comparison of fresh, frozen and canned fruits and vegetables. Part 1. Vitamins C and B and phenolic compounds. *Sci Food Agric,* 2007; **87**: 930–944.
2. Robinson, R.W. *Tomato Encyclopaedia of Food Agriculture and Nutrition*. Fourth edition. McGrow Hill Inc.New York. 1976; 650-652.
3. Ananou, S., Maqueda, M., Martinez-bueno, M. and Valdivia, E. Biopreservation, an ecological approach to improve the safety of shelf-life of food In A.mandez-vilas (E.d) Communicating current research and educational tropics and trend in applied microbiology, formatex. 2007.
4. Alzamora, S.M. Tapia, M.S. and Lopez-Malo A. *Minimally processed Fruits and vegetables: fundamental aspect and applications*. Springer.2000; **266**.
5. Potter, N.N. and Hotchkiss, J.H. *Food Science*. 5th Edition. Springer 1999; pp 22-27.
6. Andress, E. L. Sorting out Tomato canning direction. National Center for Home Food Preservation. 2006; pp 02-21.
7. Redlinger, P. Canning and freezing tomatoes. *PM 638*. Iowa State University Extension. 2001; pp 2-21.
8. Garcia, E. and Barret, M. D. Evaluation of processing tomato from two consecutive growing season: quality attributes pellability and yield. *Jounal of Food Processing and Presavation. 2006;* **30**(1):20-36.
9. Ovesen, L., Jackson, J., Leth, T. and Reinholdt, J. The effect microwave heating on vitamin B1 and E, and linoleic and immunoglobulins in human milk. *Int J Food SciNutr:* 1996*;* **47**(5):427-36.
10. EncyclopaediaBrittanica, Food preservation. 2011. Retrived from *http:www.brittanica.com/EBchcked/topic/212684/food preservation.*
11. A.O.A.C. Official Methods of Analysis 12th Edition. (W. Hortuntzed). *Association of Official Analytical Chemists, Washington, D.C. 1975.*
12. Pearson, D. The Chemical Analysis of Foods. Eight edition. J and N Churchin. London. 1970; Pp 499.
13. Romain, H.R. *Crop production in Tropical Africa*. CIP Royal liberary Albert I, Brussseis. 2001; pp 467-475.
14. Harry, W.J.*Encyclopaedia of Agricultural Science*, volume V S-W. Index. 1994; pp 337-349.
15. Saywell, L.G. and Robertson, D.P. Carbohydrate content of tomato. *Plant Physiol.* 1932; **7**(4):705-710.
16. Mikes Calorie and Fat gram chart for 1000 foods sorted by Carbohydrate content *Health advantage* 2009.
17. Martín-Belloso, O. and Llanos-Barriobero, E. Proximate composition, minerals and vitamins in selected canned vegetables. *Eur Food Res Technol.* 2001; **212**:182–187.