African Journal of Food Science Vol. 6(3), pp. 52-57, 15 February, 2012
Available online at http://www.academicjournals.org/AJFS
DOI: 10.5897/AJFS11.164
ISSN 1996-0794 ©2012 Academic Journals

*Full Length Research Paper*

# Variations in physico-chemical and sensory qualities of canned unpeeled halved tomatoes as influenced by cultivar, soak treatment and brine composition

**Makanjuola, Solomon Akinremi[1], Akanbi, Charles Taiwo[1] and Enujiugha, Victor Ndigwe[2]***

[1]Department of Food Science and Technology, Obafemi Awolowo University, Ile-Ife, Nigeria.
[2]Department of Food Science and Technology, Federal University of Technology, Akure, Nigeria.

Accepted 2 February, 2012

**The composition of two commonly consumed tomato cultivars (Ibadan-Local and Roma-VF) and their physico-chemical and sensory qualities after thermal processing under various conditions were evaluated. Fresh Ibadan-Local had higher titratable acidity (0.66 and 100 g) while Roma-VF had higher ascorbic acid (23.22 mg/100 g). Soluble solids, pH, total solids and lycopene were not significantly different (P>0.05). The drained weight and pH of canned Roma VF halves were 91.71 and 4.82%, respectively, while corresponding values for canned Ibadan halves were 79.25 and 4.94%. The tomato halves canned in 0.1%NaCl brine had lower drained weight (77.67%), total solids (4.94 and 100 g), titratable acidity (0.26 and 100 g) and ascorbic acid values (5.36 mg/100 g) than the corresponding values (91.8%, 5.25 g/100, 0.31 and 100 g and 8.93 mg/100 g, respectively) obtained from tomato halves processed in combined brine solution of 0.1% NaCl and 1% $CaCl_2$ brine.**

**Key words:** Unpeeled tomatoes, halved, calcium chloride, soak treatment, brine composition.

## INTRODUCTION

The nutritional value of tomato (*Lycopersicon esculentum*) is due to the beneficial effects of some health promoting constituents (vitamins, fibre and carotenoids), which in general inhibit oxidative processes and in particular, help prevent some types of cancer and cardiovascular diseases (Muratore et al., 2005). Tomatoes are good dietary sources of lycopene, β-carotene, ascorbic acid and polyphenols (Nguyen and Schwartz, 1999; Ruiz et al., 2001; Sahlin et al., 2004) thus they could help in alleviating the scourge of micro-nutrient deficiency in the world, which is put at more than two billion (Kennedy et al., 2003). The processing of tomatoes is of great importance because of their perishable nature and prevalent huge post-harvest losses (Enujiugha and Akanbi, 2005). The world production of tomatoes exceeds 24 million metric tons (Rao and Barringer, 2005). Tomato production in Nigeria has more than doubled in the last ten years and the production in 2001 alone was about 879,000 metric tons Food and Agriculture Organization (FAO, 2002).

The three most commonly available tomato cultivars in Nigeria markets are: Ibadan Local, Roma-VF and Ife-1 (Akanbi and Oludemi, 2004). Canned tomatoes are usually peeled (FAO, 1981; Rao and Barringer, 2005, 2006; Adedeji et al., 2006). The removal of peels from tomatoes leads to substantial losses of carotenoids and ascorbic acid because they are present in large amount in the peels when compared to the tomato pulp or juice (Ihekoronye and Ngoddy, 1985; Sharma and Le Maguer, 1996; Makanjoula et al., 2010). The canning of unpeeled tomatoes should thereby be encouraged rather than peeled tomatoes. Such a product offers a good avenue

*Corresponding author. E-mail: venujiugha@yahoo.com

**Table 1.** Means for compositional and physical characteristics of raw Ibadan and Roma vf Tomato[1].

| Tomato characteristics | Physical measurements | |
|---|---|---|
| | Ibadan | Roma |
| Longitudinal diameter (cm) | 3.46 [b] ±0.32 | 5.98 [a] ±0.29 |
| Cross sectional diameter (cm) | 5.12 [a] ±0.57 | 3.92 [b] ±0.25 |
| Size index | 0.68 [b] ±0.04 | 1.22 [a] ±0.03 |

[1]Means within a row followed by different letters are significantly different ($p<0.05$).

for preserving tomatoes especially in Nigeria where tomatoes are usually consumed unpeeled. The objective of this research was to compare the characteristics of raw and processed Ibadan-Local and Roma-VF tomatoes when thermally processed by different methods which involved alterations in soak and brine treatments.

## MATERIALS AND METHODS

Mature, ripe and fresh tomato fruits (Ibadan Local and Roma-VF) were purchased from a local market in Ile-Ife, Nigeria. Tin plated steel cans were used for the study.

### Raw tomato characteristics

Twenty whole tomatoes were randomly picked from each cultivar. The tomatoes from each cultivar were divided into four portions (a portion contains five whole tomatoes). Each of the portions was subjected to analysis to determine the characteristics of the raw tomato. The fruit sizes were determined with a vernier caliper. The longitudinal diameter {stem to blossom end} and cross-sectional diameter [transverse diameter} were measured. Size index was determined by dividing the longitudinal diameter by cross-sectional diameter (Shawakfeh and Ereifej, 2005).

### Processing

The unpeeled tomatoes were sorted for size and redness, washed under running tap water and halved with a stainless steel knife. Approximately 1.5 kg of each tomato cultivar was soaked in either 1% calcium chloride solution or water for ten min, immediately after the soak the tomatoes were hand filled into cans. Approximately 110 g of the halved tomatoes were filled into 300 x 208 cans. This was followed by filling the cans with brine. Three different brine compositions were used: 0.1% sodium chloride, 0.1% sodium chloride plus 1% calcium chloride, 0.1% sodium chloride plus 1.5% calcium chloride. One of the three brine solutions was added to each can at 90°C to cover the tomatoes, leaving about half inch headspace. The halved tomatoes were covered with 70 ml of one of the three brine solutions. The combination of two cultivars, two soak treatment and three brine conditions resulted in 12 treatments. The filled cans were processed for 12 min at 121°C and then allowed to cool under ambient temperature. The cans were stored at room temperature (28°C) for 60 days prior to evaluation. The canned tomatoes were evaluated for drained weight, titratable acidity, lycopene, ascorbic acid, total solids and pH; and the brine for soluble solids, turbidity, volume and pH. Aroma, appearance, color and overall acceptability of the canned tomatoes were assessed by sensory evaluation.

### Physico-chemical analysis

The tomatoes were homogenized in a laboratory blender at high speed for 1 min and then subjected to analysis. Drained weight, titratable acidity (as % citric acid) and ascorbic acid were determined by Association of Official Analytical Chemists AOAC (1990) methods. Total solids and lycopene content were determined as described by Sharma and Le Maguer (1996). The homogenates were filtered and the $^{o}$Brix was determined by placing 2 to 3 drops of the undiluted juice (or brine) in the refractometer. An HI 8314 membrane pH meter (Hanna Instruments, Portugal) was used to read the pH, while the brine volume was measured using a measuring cylinder. Brine turbidity was determined as transmittance at 660 mm (McCurdy et al., 1983) of 10 ml brine diluted to 100 ml.

### Sensory evaluation

A 12 member sensory panel did sensory evaluation. The processed tomatoes were rated for aroma, appearance, colour and overall acceptability. Appearance was rated visually as tomato integrity whether the fruit is whole or disintegrated. A 9-point hedonic scale was used (Enujiugha, 2006), with 9 being extremely acceptable, 5 being moderately acceptable and 1 being not acceptable.

### Statistical analysis

The experiment was designed as a three-way factorial. Analysis of variance was calculated for sensory and objective data as described by Lipson and Sheth (1973), and least square differences tests (LSD) as described by Akindele (1996) at 95% confidence interval. Correlation coefficients were calculated using SPSS version 11.

## RESULTS AND DISCUSSION

### Raw tomato characteristics

Means of physical characteristics of raw Roma VF and Ibadan local tomato are presented in Table 1. The means for the compositional characteristics (pH, titratable acidity, lycopene, ascorbic acid, total solids) of the raw tomatoes have been discussed by Makanjuola et al. (2010). Roma VF had higher longitudinal (stem-blossom

**Table 2.** Quality attributes of canned halved tomato[1].

| Main effects | Drained weight (%) | pH | Total solid (g/100 g) | Titratable acidity (g/100 g) | Ascorbic acid (mg/100 g) | Lycopene (mg/100 g) |
|---|---|---|---|---|---|---|
| | | | **Cultivar** | | | |
| Ibadan | 79.25[b]±7.50 | 4.90[a]±0.12 | 5.46[a]±0.39 | 0.28[b]±0.03 | 7.74[a]±1.46 | 6.55[b]±1.95 |
| Roma | 91.71[a]±4.57 | 4.82[b]±0.09 | 4.88[a]±0.49 | 0.30[a]±0.03 | 7.74[a]±1.68 | 9.67[a]±1.26 |
| | | | **Soak treatment** | | | |
| $CaCl_2$ | 90.14[a]±4.14 | 4.86[a]±0.09 | 5.04[a]±0.49 | 0.30[a]±0.03 | 7.74[a]±1.68 | 8.88[a]±1.43 |
| $H_2O$ | 80.82[b]±3.10 | 4.90[a]±0.14 | 5.29[a]±0.47 | 0.29[a]±0.06 | 7.74 [a] ±1.60 | 7.33 [a] ±2.65 |
| | | | **Brine composition** | | | |
| NaCl | 77.67[bc]±3.10 | 5.02[a]±0.09 | 4.94[a]±0.60 | 0.26[a]±0.06 | 5.36[b]±0.01 | 8.20[a]±2.14 |
| 1% $CaCl_2$ | 91.89[a]±4.89 | 4.82[b]±0.07 | 5.25[b]±0.25 | 0.31[b]±0.03 | 8.93[a]±0.02 | 7.77[a]±2.64 |
| 1.5%$CaCl_2$ | 86.79[ab]±7.28 | 4.81[b]±0.04 | 5.31[b]±0.48 | 0.31[b]±0.03 | 8.90[a]±0.03 | 8.36[a]±1.9 |

[1] Means within a column and main effect heading followed by different letters are significantly different (p<0.05).

**Table 3.** Brine characteristics of canned halved tomato[1]

| Main effects | Brine volume (ml) | Brine pH | Brine soluble solids (%) | Brine turbidity (%T) |
|---|---|---|---|---|
| | | **Cultivar** | | |
| Ibadan | 82.69[a]±4.77 | 4.95[a]±0.12 | 5.43[a]±0.39 | 59.33[a]±9.44 |
| Roma | 71.42[b]±5.88 | 4.82[b]±0.11 | 5.03[a]±0.47 | 61.15[a]±4.28 |
| | | **Soak treatment** | | |
| $CaCl_2$ | 74.92[a]±6.82 | 4.85[b]±0.12 | 5.13[a]±0.51 | 64.88[a]±7.11 |
| Water | 79.19[a]±8.08 | 4.91[a]±0.14 | 5.33[a]±0.41 | 55.60[b]±3.91 |
| | | **Brine composition** | | |
| NaCl | 80.63[a]±2.38 | 5.04[a]±0.08 | 5.00[b]±0.01 | 54.55[a]±6.97 |
| 1%$CaCl_2$ | 72.16[a]±6.77 | 4.81[b]±0.09 | 5.00[b]±0.51 | 63.18[a]±5.95 |
| 1.5%$CaCl_2$ | 78.38[a]±9.56 | 4.80[b]±0.07 | 5.70[a]±0.30 | 63.00[a]±5.56 |

[1]Means within a column and main effects heading followed by different letters are significantly different (P<0.05).

end) diameter (5.98 cm) while Ibadan local had a higher cross sectional (transverse) diameter (5.12 cm). This agrees with the result of Adedeji et al. (2006). The size index was higher for Roma VF.

## Characteristics of processed halved tomatoes

Mean values for objective and sensory data observed for the main effects of cultivar, soak treatment and brine composition are presented in Tables 2, 3 and 4. A significance difference ($p<0.05$) was observed between the two cultivars for drained weight, pH and lycopene (Table 2). Roma VF had higher drained weight and lower brine volume than Ibadan Local but no cultivar difference was observed for brine soluble solids and brine turbidity (Table 3). Ibadan local had the highest loss of titratable acidity on inspection. The brine pH for both cultivars were in the acidic range, however, Roma VF brine had a lower pH than Ibadan Local (Table 3). The brine pH reduced from between 6.44 and 7.90 before processing to a range of 4.80 to 5.04 in the canned product on evaluation after the 60 days storage. Sensory data revealed that significant differences ($p<0.05$) existed between the two cultivars for aroma and overall acceptability and no difference was observed for color and appearance (Table 4). Roma VF had higher score for aroma and overall acceptability.

The Ibadan local had lower lycopene than Roma VF although there were no significant difference ($p>0.05$)

**Table 4.** Sensory score of canned halved tomato[1].

| Main effects | Aroma | Appearance | Colour | Overall acceptability |
|---|---|---|---|---|
| | | **Cultivar** | | |
| Ibadan | $3.58^{b}\pm0.50$ | $3.21^{a}\pm0.48$ | $3.58^{a}\pm0.67$ | $3.91^{b}\pm0.56$ |
| Roma | $4.54^{a}\pm0.8$ | $4.11^{a}\pm1.57$ | $4.34^{a}\pm1.02$ | $4.72^{a}\pm0.89$ |
| | | **Soak treatment** | | |
| $CaCl_2$ | $3.69^{b}\pm0.92$ | $3.27^{a}\pm0.71$ | $3.52^{a}\pm0.68$ | $3.92^{b}\pm0.64$ |
| Water | $4.44^{a}\pm0.49$ | $4.21^{a}\pm1.42$ | $4.40^{a}\pm0.96$ | $4.71^{a}\pm0.83$ |
| | | **Brine composition** | | |
| NaCl | $3.50^{a}\pm0.76$ | $3.00^{a}\pm0.76$ | $3.43^{a}\pm0.44$ | $3.72^{a}\pm0.67$ |
| 1%$CaCl_2$ | $4.28^{a}\pm0.56$ | $3.72^{a}\pm0.43$ | $4.00^{a}\pm0.52$ | $4.41^{a}\pm0.16$ |
| 1.5%$CaCl_2$ | $4.41^{a}\pm0.83$ | $4.25^{a}\pm1.84$ | $4.45^{a}\pm1.29$ | $4.83^{a}\pm1.01$ |

[1] Means within a column and main effect heading followed by different letters are significantly different ($p<0.05$).

between the two cultivars before canning. Akanbi and Oludemi (2004) reported that lycopene degradation was faster in Ibadan local juice/pulp than in Roma VF juice/pulp and this may explain the observation in this investigation. The soak treatment produced significant differences in drained weight (Table 2). The $CaCl_2$ soak produced tomatoes with higher drained weight than water soak. Treating of tomatoes with $CaCl_2$ has been reported to reduce drained weight loss in tomatoes (Rao and Barringer, 2005). The soak treatment produced no significant differences in pH, total solids, titratable acidity, ascorbic acid and lycopene values. The $CaCl_2$ soak was observed to produce lower brine pH and less turbidity (Table 3).

The lower brine turbidity produced by the $CaCl_2$ soak may be due to reduced loss of pectin into the brine. Nath and Ranganna (1983) observed that the viscosity of covering syrup for canned guavas increased due to pectin leaching from the fruit into the syrup and $CaCl_2$ soak was found to reduce the pectin leaching. No significant differences were observed for brine volume and brine soluble solids. Sensory data showed that the aroma of tomato from the water soak was preferred to $CaCl_2$ soak and this may be responsible for the better overall acceptability of the tomatoes from water soak rather than the $CaCl_2$ soak (Table 4).

There was no difference in color and appearance based on the soak treatment. Brine composition had a significant influence on drained weight, pH and ascorbic acid values of the tomato (Table 2). The 1% $CaCl_2$ brine had tomato of higher drained weight than NaCl. No significant difference existed in tomato drained weight between the 1.5% $CaCl_2$ brine and the other two brine composition. The NaCl brine had a higher pH than the other two brine treatments. The brine composition produced no difference in lycopene values (Table 2); however, more ascorbic acid was retained in tomatoes packed in the $CaCl_2$ brine than in the NaCl brine. The $CaCl_2$ brine had lower brine pH than NaCl brine and this same pattern was observed by Nath and Ranganna (1983) in the covering syrup of canned guavas not treated with calcium chloride). The brine composition had no significant influence on brine volume and brine turbidity. The 1.5% $CaCl_2$ brine produced more loss of soluble solids into the brine than the NaCl and 1% $CaCl_2$ brine. No significant difference was observed for all the sensory data evaluated when the influence of the brine composition was considered (Table 4).

## Correlation

The correlation matrix is shown in Table 5. It was observed that several dependent variables varied together as treatment was altered. A correlation coefficient that is less than $\pm0.80$ is not acceptable for concluding that the objective measurement reasonably corresponds with sensory data (Kramer and Twigg, 1970). Based on this comment, there is no correlation between the sensory data and the objective data in this investigation. The drained weight and brine volume were correlated. Tomatoes with higher drained weight recorded lower brine volume; however, tomato pH, brine pH, ascorbic acid and titratable acidity were highly correlated. The overall acceptability corresponds well with the aroma, appearance and color. This suggests that aroma, appearance and color are very critical in the quality assessment of tomatoes. Drained weight of halved tomatoes is highly correlated with brine pH and tomato pH. An increase in drained weight due to calcium chloride addition produces brine and halved tomatoes with lower pH.

**Table 5.** Correlation coefficients among sensory scores and objective data for canned halved tomatoes.

| Coefficients | Drained weight | Brine volume | Tomato pH | Brine pH | Total solids | Aroma | Appearance | Color |
|---|---|---|---|---|---|---|---|---|
| Overall acceptability | 0.309 | 0.343 | 0.521 | -0.548 | 0.086 | 0.770** | 0.878** | 0.872** |
| Color | 0.259 | -0.273 | -0.475 | -0.498 | 0.210 | 0.605* | 0.848** | |
| Brine turbidity | 0.638* | -0.352 | -0.615* | -0.697* | -0.313 | | | |
| Lycopene | 0.533 | -0.494 | -0.441 | -0.482 | -0.445 | | | |
| Ascorbic acid | 0.502 | -0.325 | -0.801** | -0.811** | 0.329 | | | |
| Titratable acidity | 0.402 | -0.441 | -0.605* | -0.226 | | | | |
| Brine pH | 0.782** | 0.693* | 0.944** | | | | | |
| Tomato pH | 0.811** | 0.563 | | | | | | |
| Brine volume | 0.712** | | | | | | | |

*Indicates significance at the 5% level. **Indicates significance at the 1% level.

**Table 6.** Comparison of the effect of processing variables on canned halves tomato characteristics.

| Properties | Cultivar | Soak treatment | Brine composition |
|---|---|---|---|
| Drained weight | + | + | + |
| Tomato pH | + | _ | + |
| Total solids | _ | _ | _ |
| Titratable acidity | _ | _ | _ |
| Ascorbic acid | _ | _ | + |
| Lycopene | + | _ | _ |
| Brine volume | + | _ | _ |
| Brine pH | + | + | + |
| Brine soluble solids | _ | _ | + |
| Brine turbidity | _ | + | _ |

The + signs denote processing variable producing significant difference in the measured property and - signs denote processing variable producing no significant difference.

## Comparison of the influence of processing factors

The influence of processing factors cultivars, soak treatment and brine composition on the objective data evaluated were compared in Table 6. Objective data measured for the canned halved tomato showed that the cultivar type and brine composition both had significant influence of five physico-chemical properties while the soak treatment had significant influence on three. This reveals that cultivar type and brine composition had the greatest effect on canned unpeeled tomato halves.

## Conclusion

The objective data reveal that variation in thermal processing condition of soak composition and brine composition produces differences in the canned unpeeled halved tomatoes. The cultivar type and brine composition produced the greatest differences in the canned characteristics of unpeeled halved tomatoes. Care should however be exercised in selecting the appropriate $CaCl_2$ concentration to prevent can corrosion.

## REFERENCES

Adedeji O, Taiwo KA, Akanbi CT, Ajani R (2006). Physicochemical properties of four tomato cultivars grown in Nigeria. J. Food Process. Preserv., 30: 79-86.

Akanbi CT, Oludemi FO (2004). Effect of processing and packaging on the lycopene content of tomato products. Int. J. Food Properties., 7: 139-152.

Akindele SO (1996). Basic Experimental Designs in Agric. Res., pp. 41-43, Montem Paperbacks, Akure, Nigeria.

AOAC (1990). Official Methods of Analysis. Association of Official Analytical Chemists, Virginia, USA.

Enujiugha VN (2006). Supplementation of ogi, a maize-based infant weaning food, with African oil bean seed (*Pentaclethra macrophylla* Benth). Int. J. Postharvest Technol. Inno., 1(2): 202-211.

Enujiugha VN, Akanbi CT (2005). Postharvest losses affect sustainable production of onions and tomatoes in the Nigerian savannah. Proceedings, International Conference on Postharvest

Technology and Quality Management in Arid Tropics, Sultan Qaboos University, Oman (January 30, 2005), pp. 95-98.
FAO (1981). Codex Standard for Canned Tomatoes. Food and Agriculture Organisation of United Nations, Rome, Italy (www.codexalimentarius.net /web/standard-list.do? lang=en).
FAO (2002). World Crop Production Statistics. Food and Agriculture Organisation of United Nations Statistical Database Online Service, Viale delle Terme di Caracalla, Rome, Italy. (www.appsl.fao.org/page/collection?subset = agriculture).
Ihekoronye AI, Ngoddy PO (1985). Integrated Food Sci. and Technol. for the Tropics, Macmillan Publishers Ltd, London. p.90,
Kennedy G, Nantel G, Shetty P (2003). The scourge of “hidden hunger”: global dimensions of micronutrient deficiencies. Food, Nutr. Agric., 32: 8-14.
Kramer A, Twigg BA (1970). Some General Principles In “Quality Control for the Food Industry”. 3rd Edition. Avi Publishing Company, Westport, Connecticut. pp. 10-18.
Lipson C, Sheth NJ (1973). Statistical Design and Anal. Eng. Experiments, McGraw-Hill Book Company. pp.197-219.
Makanjuola SA, Akanbi CT, Enujiugha VN (2010). Influence of cultivar, soak treatment and brine composition on the physico-chemical and sensory qualities of unpeeled whole canned tomatoes. Niger. Food J., 28(2): 72-81.
McCurdy SM, Drake SR, Swanson BG, Leung HK, Powers JR (1983). Influence of Cultivars, soak solution, blanch method, and brine composition on canned dry pea quality. J. Food Sci., 48: 394-399.
Muratore G, Licciardello E, Maccarone E (2005). Evaluation of the chemical quality of a new type of small – sized tomato cultivar, the plum tomato (Lycopersicon lycopersicum). Ital. J. Food Sci., 17: 75-81.
Nath N, Ranganna S (1983). Determination of a thermal process schedule for guava (*Psidium guajava* Linn). J. Food Technol., 18: 301-316.
Nguyen ML, Schwartz SJ (1999). Lycopene: Chemical and Biological Properties. Food Technol., 53: 38-45.
Rao SN, Barringer SA (2005). Timing of calcium treatment on resistance of raw and canned diced tomatoes to mechanical abuse. J. Food Process. Preserv. , 29: 1-7.
Rao SN, Barringer SA (2006). Calcification of diced tomatoes by liquid dipping versus electrostatic powder coating. J. Food Process. Preserv., 30: 71-78.
Ruiz RM, Mangut V, Gonzalez C, De LaTorre R, Lattorre A (2001). Carotenoid extraction from tomato by products. Acta Horticulturae (ISHS). 542: 83-90.
Sahlin E, Savage GP, Lister CE (2004). Investigation of the antioxidant properties of tomatoes after processing. J. Food Comp. Anal., 17: 635-647.
Sharma SK, Le Maguer M (1996). Lycopene in tomatoes and tomato pulp fractions. Ital. J. Food Sci., 8: 107-113.
Shawakfeh KQ, Ereifej KI (2005). Pod Characteristics of two *Cerantonia siliqua* L. varieties from Jordan. Ital. J. Food Sci., 27: 187-194.