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The effect of shelf life on vitamins, lycopene and sugar composition of some common Nigerian tomato varieties

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Abstract
Tomatoes are the second most-produced vegetable around the world, behind the potato crop and one of the most important crops in West Africa. Tomato is a very popular crop which over time has been a major ingredient in human food all over the world, in Africa and especially in Nigerian dishes, they are rich in minerals, vitamins, essential amino acids, sugars and dietary fibers, tomato contains much vitamin B and C, iron and phosphorus. The objective of this study is to investigate the effect of shelf life of the popular Nigerian tomato varieties on vitamin, lycopene and sugar content. The experiment was carried in Babcock University, Ilishan-Remo Ogun State, Nigeria. There were nine (9) different varieties of tomatoes selected for this study: Roma VF, U C 82-B, Rio Grande, TROPIMECH, Roma Savanah, Rio Fuego, Hausa Local (which are regulars in Nigerian markets), Beefsteak and Yellow Pear. Experiments were carried out to determine: Lycopene, Vitamin C, β-Carotene, Vitamin B3 and Sugar Content and the variation across shelf life. The varieties maintained a good texture and wholesomeness as at day 7; however, there was reduction in the texture and wholesomeness at day 14 with UC 82-B (<2) and Rio Fuego (<1) having a more significant deterioration. There was increase in the Lycopene with Yellow Pear recording the highest content (2.651mg/100g), Vitamin C with the highest in the Rio Fuego (14.23mg/100g), β-Carotene with the highest in the Rio Fuego variety (441.57µg/100g), Vitamin B3 with highest recorded by Beefsteak (0.63mg/100g) and Sugar Content with Yellow Pear with highest value (2.69%) of the varieties of tomatoes over the 14 days shelf life. It is concluded that a preservative practice of washing tomato fruits in a 2% salt solution after harvest helps preserve the physical appearance and the nutritional content of the fruits.

Keywords: tomato, shelf life, lycopene, vitamin, carotene

Introduction
Tomatoes are the second most-produced vegetable around the world, behind the potato crop and one of the most important crop in West Africa (FAOSTAT, 2012; Showemimo *et al.*, 2006) [1, 8]. Tomato is a very popular crop which over time has been a major ingredient in human food all over the world, in Africa and especially in Nigerian dishes (Showemimo *et al.*, 2006) [8]. In Nigeria, almost every soup from all the numerous tribes has tomato or tomato products in it. Tomato is not only used as cooking recipe ingredients, tomato fruits are consumed fresh in salads or cooked in sauces, soup and meat or fish dishes. Tomatoes could be grown in green houses and open fields.

According to Leonardi, *et al*, (2000) [5], tomatoes contribute to a healthy, well-balanced diet, he went on to say that they are rich in minerals, vitamins, essential amino acids, sugars and dietary fibers, tomato contains much vitamin B and C, iron and phosphorus. Tomato is a crop with high nutritional requirements and its production is influenced by the availability of nutrients with greater uptake of macronutrients like Nitrogen, Phosphorus and potassium (Ferreira *et al*., 2003; Toor *et al*, 2006; Zuba *et al*, 2011) [2, 10, 11]. Tomato sales in Nigeria are done in open market with the fruits displayed for easy sales accessibility, these fruits are kept until sales is complete without any preservatives exposing them to spoilage in a shorter time period. This situation has brought to attention a likely relationship in the deterioration of the tomato fruits and nutritional content of the fruits.

The objective of this study is to investigate the effect of shelf life of the popular Nigerian tomato varieties on vitamin, lycopene and sugar content.

Methodology
The experiment was carried in Babcock University, Ilishan-Remo Ogun State, Nigeria. Babcock University is located in the rain forest vegetation zone of Nigeria with an average annual rainfall of 1500mm and altitude of about 300 meters above sea level; while the mean annual temperature is about 27°C.

There were nine (9) different varieties of tomatoes selected for this study: Roma VF, U C 82-B, Rio Grande, TROPIMECH, Roma Savanah, Rio Fuego, Hausa Local (which are regulars in Nigerian markets), Beefsteak and Yellow Pear.

Shelf life experiment
Evaluation of shelf life was done by collection of the best

three (3) fruits from each of the nine (9) varieties of tomatoes planted. These samples were washed in a salt water solution and kept under the same conditions of humidity and temperature and they were left on open shelf in a dark and ventilated room. The fruits were checked at intervals of day 1, 7 and 14 for the following parameters: the fruit texture, being examined to test for its firmness and it was rated on a scale of 5 to 1, with 5 being very firm and 1 being very flaccid and Wholesomeness of the fruit was also measured in identifying decay in the fruits of each varieties and this was rated on a scale of 5 to 1, with 5 being no decay and 1 being very decayed. Data collected will be recorded.

Determination of lycopene

1g of fresh tomato was weighed into a 250ml beaker and crush with a glass rod.25ml of HPLC grade acetone was added and shaken for 10min.25ml of methanolic NaOH solution was added and a reflux condenser attached.

The mixture above was heated in boiling water bath for 1hr with frequent shaking. The mixture was cooled rapidly and 50ml of distilled water added. The hydrolysate obtained was transferred into a separatory funnel. The solution was extracted thrice with 50ml of HPLC acetone, 1g of K2SO4 added to remove any traces of water. The organic layer was carefully removed into a 250ml beaker and subsequently filtered into a 100ml Volumetric flask and made up to mark with HPLC acetone.

Standard solutions of lycopene of range 0-50ug/ml were prepared from100ppm stock lycopene solution. The different concentrations of lycopene standard solutions were treatedsimilarly like sample. The absorbances or optical density of sample extracts as well as standard solutions of lycopene were taken on a Spectronic 21D Spectrophotometer at a wavelength of 340nm.

Amount of lycopene in ug/g or mg/kg =

$$\frac{\text{Absorbance of sample X Gradient factor X Dilution factor}}{\text{Weight of sample taken.}}$$

Data collected was subjected to Analysis of variance (ANOVA), Treatment means if statistically different was separated by Duncan Multiple Range Test (DMRT) at 5% level of significance using the Statistical Package for Social Science (SPSS) version 21.

Determination of vitamin C

10g of the sample slurry was weighed into a 100ml volumetric flask and diluted to 100ml) with 3% metaphosphoric acid solution (0.0033M EDTA). The diluted samples were filtered using a Whatman Filter Paper No. 3.

10ml of the filtrate was pipetted into a small flask and titrated immediately with a standardized solution of 2.6 dichlorophenol-in-dephenol to a faint pink end point. The ascorbic acid content of the fruit was calculated from the relationship below.

$$\frac{V \times T}{W} \times 100 = \text{mg ascorbic acid per 100g sample.}$$

Where

V = --ml dye used for titration of aliquot of diluted sample.

T = ascorbic acid equivalent of dye solution expressed as mg per ml of dye.

W = gram of sample in aliquot titrated.

Determination of β-carotene

Stock solution of beta carotene was prepared by taking 10mg in 100ml n-hexane. The concentration of stock solution was equal to 100 ppm. The stock solution was diluted to different known concentration e.g. 20, 40 and 60ppm, dilutions were obtained in 5 ml of each n-hexane solutions. Each working standard solution was injected into HPLC system installed at the Laboratory of Department of Agricultural Chemistry, Peshawar and chromatographic condition was Perkin Elmer HPLC programme containing LC-1000 pump (Isocratic), having C18 column and connected with LC 250 UV/VIS detector was used. Peak identification and quantification was made by "CSW 32 software" for HPLC system. HPLC was calibrated by running mobile phase (Acetonitrile, dichloromethane and methanol by the ratio of 70:20:10, respectively) at the rate of 2ml per minute. Wave length was fixed at 452 nm. The pressure of the column was kept 1800-2000 PSI. Each standard solution (20µl) of beta carotene was injected when the injector was in load mode. The standard beta carotene peak was achieved at the retention time of 4.7 minutes (Rt = 4.7). The concentrations of the beta carotene standards were plotted against the peak area to obtain a straight line.

Determination of vitamin B3

5g of sample was blended and 100ml of distilled water added to dissolve all Nicotinic acid or Niacin present.

5ml of this solution was drawn into 100ml volumetric flask and make up to mark with distilled water.

10 – 50ppm of Niacin stock solution were also prepared.

The absorbances of the diluted stock solutions and sample extract were measured at a wavelength of 385nm on a Spectrophotometer. Different concentrations of standard stock solutions were read on the Spectrophotometer for absorbances at the specified wavelength to obtain the Gradient Factor. Amount of Niacin in sample was calculated using the formula:

$$\text{Mg/100g Niacin} = \text{Absorbance x Dilution x Gradient Factor Stock}$$

Determination of sugar content

Reagent 5ml distilled water was homogenized with a suitable quality of the fruit juice for 3 minutes. An extract of 100ml was made in the volumetric flask and centrifuged at

approximately 1,000rpm for 15 min. For sugar content analysis, 15ml of 1m hydrochloric acid was added and 10ml of distilled water. This was boiled gently for 3 minutes and cooled in a beaker of tap water and then diluted to 20ml with water. It was mixed well and the absorbance of each tube was measured in a spectronic 20, zeroing with tube 1. A calibration curve was prepared from the results obtained for tubes 2, 3, and 4 by plotting absorbance vertically against moles of glycose plus fructose in each tube as abscissa. The sugar content was obtained from the standard calibration curve (Anon. 2002).

Results and discussion

Texture

Findings showed until day 14, none of the tomatoes lost significant level of texture. The most flaccid variety at day 14 was the Rio Fuego, closely followed by UC 82-B, this low flaccidity rate might be attributed to the 2% salt solution in which the varieties were treated with at harvesting as salt serve as preservative and it is readily available to an average low socio-economic earner. This result showed that tomatoes can be preserved for less than 2 weeks (<14 days) with the salt solution and still retain its texture (Fig 1).

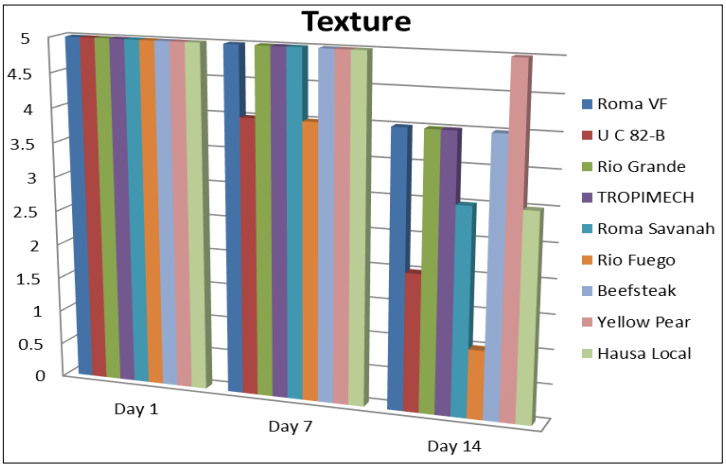

Fig 1: Texture of 9 tomato varieties

Wholesomeness

As at the day 7 of shelf life examination, the varieties showed no significant signs of decay, this could be due to the low room temperature (17^{o}C) which limits the multiplication of microorganisms. However, at day 14, Rio Fuego showed a significant deterioration in wholesomeness with a 100% decay feature. This result indicated that all the varieties perform well with little decay in under 14 days, however, Rio Fuego showed a low storage quality. This result shows also affirms that the Yellow Pear variety is the most economic variety to be cultivated for commercial purposes considering its durable shelf life(Fig 2).

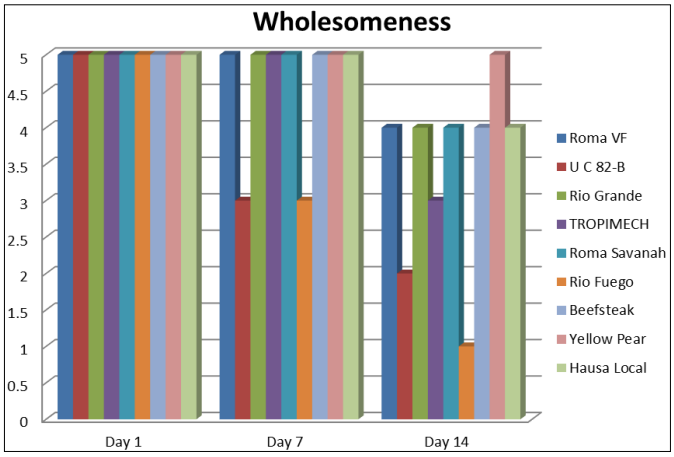

Fig 2: Wholesomeness of 9 tomato varieties

Vitamin C Content

The initial Vitamin C content of the tomato varieties ranged from 13.57mg/100g to 14.23mg/100g and was highest in the Rio Fuego variety (14.23mg/100g) while the Roma VF had the least Vitamin C content (13.57mg/100g). After 14 days on the shelf, there was a unanimous increase in the Vitamin C content of the tomato varieties except UC 82-B with a 2.03% decrease in Vitamin C content.

ß-Carotene content

The range of ß-Carotene in the varieties at the 1st day of harvest was from 441.57µg/100g to 438.25µg/100g, the nutrient was higher in the Rio Fuego variety (441.57µg/100g) while the Hausa Local had the least ß-Carotene content (438.25µg/100g). According to Meredith and Purcell (1966), the presence of ß-Carotene content increases during fruit ripening, a strong indication that Rio Fuego ripens quicker than the other varieties planted. At the 14th day however, UC 82-B, Rio Grande and TROPIMECH decreased in ß-Carotene content by 0.02%, 0.05% and 0.12% respectively, with tropimech recording the lowest ß-Carotene content at 14 days.

Lycopene content

Yellow Pear recorded the highest lycopene content at day 1 with 2.651mg/100g while the Beefsteak had the least Lycopene content (2.594mg/100g), with an average range of 2.651mg/100g and 2.594mg/100g, it is expected that the tomato varieties display red color, as opined by Martinez-Valverde *et al.* (2002) [6] that lycopene is a carotenoid pigment

that provides red colour and has antioxidant qualities. This content however increased across all varieties of tomatoes indicating an increase in colour pigmentation.

B3 content

Records showed a range of 0.63mg/100g to 0.76mg/100g with Beefsteak having a significantly higher value while Roma VF having the lowest recorded B3 content at day 1, the values however increased in all varieties except Roma Savanah with a reduction to 0.64 mg/100g at day 14 from 0.74 mg/100g at day 1.

Table 1: Nutrient content of nine varieties of tomatoes

Variety	Days	VIT.C (mg/100g)	ß-Carotene (µg/100g)	LYCOPENE (mg/100g)	B3 (mg/100g)	SUGAR %
Roma VF	1	13.57	438.26	2.634	0.63	2.54
	7	13.79	439.41	2.651	0.67	2.68
	14	14.02	439.96	2.666	0.71	2.83
U C 82-B	1	14.07	441.31	2.612	0.66	2.48
	7	13.93	441.26	2.659	0.69	2.66
	14	13.79	441.23	2.703	0.73	2.84
Rio Grande	1	13.78	439.79	2.641	0.71	2.61
	7	13.81	439.67	2.654	0.74	2.77
	14	13.85	439.56	2.662	0.75	2.94
Tropimech	1	13.64	438.84	2.637	0.69	2.52
	7	14.26	438.59	2.667	0.77	2.72
	14	14.88	438.34	2.698	0.86	2.92
Roma Savanah	1	13.82	439.86	2.646	0.74	2.66
	7	14.08	440.88	2.661	0.71	2.79
	14	14.33	441.91	2.674	0.67	2.93
Rio Fuego	1	14.23	441.57	2.603	0.65	2.59
	7	14.29	441.68	2.672	0.81	2.81
	14	14.35	441.79	2.739	0.97	3.04
Beefsteak	1	14.16	441.36	2.594	0.76	2.63
	7	14.31	441.79	2.676	0.84	2.84
	14	14.44	441.88	2.754	0.93	3.05
Yellow Pear	1	13.95	439.93	2.651	0.73	2.69
	7	13.98	440.65	2.663	0.79	2.75
	14	14.02	441.37	2.672	0.86	2.82
Hausa Local	1	13.93	438.25	2.621	0.69	2.61
	7	14.02	439.58	2.669	0.73	2.73
	14	14.11	440.32	2.687	0.76	2.92

Sugar content

There was a consistent increase in sugar content of all the varieties from day 1 to day 14 with a significantly higher value recorded by Beefsteak variety while the lowest significant value was recorded by UC 82-B. Flores *et al.* (2003) [3] revealed that increase in sugars and other organic acids are indicators of good fruit quality, showing that increase in the sugar content over the period of 14 days is an indication of good quality and expectedly should taste better as flavor is a function of sugars and acid (Stevens *et al*., 1977; Kader *et al*., 1978) [9, 4].

Conclusion

Important information has been generated on nutrition properties of the samples of different varieties of tomato as they change with storage time and system. It can be concluded that these qualities generally change with time. The study revealed that there were continuous increases in the quality parameters such as Lycopene, Vitamin C, β-Carotene, Vitamin B3 and sugar content. Importantly, the 2% salt solution post-harvest wash can be a better alternative especially in preservation of tomato for longer shelf life, nutrient protection and cutting down cost of storage as far as rural communities are concerned.

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