

Effect of thermal processing on lycopene, beta-carotene and Vitamin C content of tomato [Var.UC82B]

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Abstract: The available lycopene, beta-carotene and vitamin C content of raw, boiled and fried tomato (Var.UC82B) were evaluated. Ripe tomato was purchased from Ogbete main market Enugu- Nigeria and the variety was identified at the Crop Science department, University of Nigeria Nsukka. It was sorted, washed and pulped using a blender. The pulp was divided into seven portions and labeled (A-G) Portion A was raw sample that served as a control since it was neither boiled nor fried. Portions B, C, and D were boiled for 2, 15 and 30minutes respectively. Portions E, F and G were fried in refined bleached and deodourized groundnut oil for 2, 15 and 30 minutes respectively. The seven samples were separately packaged in vial glass tubes and analyzed within three days from the time they were produced. Result shows that the three response variables evaluated were significantly [$P < 0.05$] affected by either boiling or frying. The lycopene content significantly increased [$p < 0.05$] as the period of boiling or frying increased between 2 and 30minutes. Boiling the pulp or frying it for 30 minutes increased the lycopene content from 24.2 to 32.9 % respectively. However, both the beta-carotene and the Vitamin C content significantly [$p < 0.05$] decreased as boiling or frying period increased between 2 and 30 minutes. The beta-carotene content decreased by 61.4 %, while the Vitamin C content decreased by 49.4 % when the tomato pulp was boiled for 30 minutes. When the tomato pulp was fried for 30 minutes, the beta-carotene decreased by 63.6 %, while the vitamin C decreased by 50.0 % [$p < 0.05$]. It is therefore, advisable to boil or fry tomato before consumption for maximum absorption of its available lycopene. However, excessive heat treatment would have adverse effect on the beta carotene and vitamin C content of the tomato.

Keywords: Tomato, Boiled, Fried, Lycopene, Carotene

1. Introduction

Lycopene is a bioactive carotenoid found in many red fruits and vegetables such as tomatoes, watermelon, pink grapefruits, apricots and pink guava [1]. Animals including humans cannot synthesize lycopene. Therefore, they obtain lycopene exclusively from diets [2]. However, lycopene is synthesized in various isomeric forms by some plants and microorganisms [3]. Studies have shown that intake of lycopene-rich foods reduced risk of prostate cancer [4, 5, 6] Lycopene scavenges free radical which causes oxidative damage to cells [7]. Lycopene may improve male fertility because its consumption by men improved the morphology and mobility of sperm cells [8]. Lycopene is the most predominant carotenoid in human plasma compared to

beta-carotene and other dietary carotenoids in tomato consuming populations [9]. Light, thermal and chemical reactions during processing affect lycopene [10, 11]. Heat processing of fruits and vegetables rich in lycopene makes the availability of lycopene higher than in the raw products [12, 13].

Tomato matrix disruption by mechanical homogenization or heat treatment of tomato increases lycopene bioavailability [14, 15]. Oxidation and thermal degradation of lycopene occurred at high temperatures and processing times beyond 90 minutes [16, 17]. Similarly, it was reported that excessive heat treatment negatively affects the lycopene content of tomatoes [18]

Numerous studies have shown association between higher intakes of carotenoid - rich fruits and vegetables and

reduced risk of cancer [19]. β -Carotene is an organic compound, a red-orange pigmented terpenoid that abounds in plants and fruits. It is a precursor of vitamin A.

Vitamin C (ascorbic acid) is found in many fruits and vegetables. It plays the role of an antioxidant and acts to neutralize free radicals [20, 21, 22]

This present research aims at subjecting tomato pulp to frying or boiling and thereafter evaluating the effect of these treatments on the lycopene beta carotene and vitamin C contents of the samples.

2. Materials and Methods

2.1. Source of Raw Material

Ripe tomato [Var. UC82B] was purchased from Nsukka main market and identified at the Department of Crop Science University of Nigeria Nsukka. Refined, bleached and deodourized groundnut oil was also bought from the same market.

2.2. Sample Preparation

The samples were prepared at the Department of Biochemistry Caritas University Amorji, Enugu. The tomato was sorted, washed, manually sliced and pulped using a blender [Turner Corp. Shanga-Hai. Model No QBL-15L40] at 12000 rpm for 10 minutes. The pulp obtained was divided into seven portions weighing 200g each and labeled as samples A-G. Sample A served as the control sample, it did not receive thermal treatment. Samples B, C and D were separately boiled for 2, 15 and 30 minutes respectively. Samples E, F and G were separately deep fat-fried in refined groundnut oil for 2, 15 and 30 minutes respectively. The samples were separately packaged in glass bottles stored in a refrigerator and analyzed within three days from the time they were processed.

3. Analysis

The raw and processed samples were subjected to the following analysis within three days of sample preparation:

3.1. Lycopene Content Determination

A 1g of sample was weighed into a clean beaker and macerated with 20ml of 1% metaphosphoric acid solution and filtered. Also, 10ml of metaphosphoric acid solution was used to wash off the residue. The resultant residue was macerated with 20ml of acetone, then filtered and the absorbance of the filtrate read at 440nm against acetone as blank using a Spectrophotometer [Pye Unicam double beam spectrophotometer]. The analysis was replicated three times and the mean calculated. The concentration of lycopene was calculated [23]

$$\text{Lycopene [mg/100ml]} = \frac{\text{Mean absorbance} \times \text{dilution factor}}{\text{Slope}}$$

The slope (0.095) was calculated from the standard curve of lycopene plotted using concentration of lycopene against absorbance.

3.2. Beta-Carotene Content Determination

A 1g sample was weighed into a beaker and macerated with 10ml mixture of acetone and n-hexane (1:1) and filtered. 10ml of 50% $(\text{NH}_4)_2\text{SO}_4$ solution was added, vigorously shaken and allowed to settle. Then the upper layer was collected and the absorbance read in Pye Unicam double beam Spectrophotometer at 450nm against hexane as blank [24]

$$\text{Beta-carotene [mg/100ml]} = \frac{\text{Mean absorbance} \times \text{dilution}}{\text{Slope}}$$

The slope (1.249) was obtained from the standard curve of beta-carotene plotted using concentration of beta-carotene against absorbance.

3.3. Vitamin C Content Determination

A 1g samples was weighed into a beaker and macerated with 20ml of 0.4% oxalic acid solution and filtered. Then 1ml filtrate was pipetted into a test tube and 0.2ml of 0.01% methylene blue solution added. Also 1ml of acetate buffer pH 4.2 was added into the solution and made up to 5ml mark using distilled water. Absorbance of the solution was read using Spectrophotometer [Spectronic D2] vitamin C was calculated [25]

$$\text{Vitamin C [mg/100ml]} = \frac{\text{Mean absorbance} \times \text{dilution factor}}{\text{Slope}}$$

The slope (0.0693) was calculated from the standard curve of vitamin C against absorbance.

3.4. Statistical Analysis

Data obtained from the triplicate determinations of the three response variables were analyzed using SPSS version 16.0 through One-Way Analysis of Variance [ANOVA]. The means that differed significantly were separated using Duncan's multiple range (DMR) test and LSD. Significant difference between means of the samples was determined at $P < 0.05$

4. Results

The phyto-chemical composition (lycopene, beta-carotene and vitamin C content) of boiled and fried tomato pulp are presented in Table 1. Raw tomato pulp contained lycopene, beta-carotene and vitamin C in varied concentrations as 12.4 ± 0.01 , 15.7 ± 0.01 and 49.8 ± 0.014 mg/100ml respectively. Two minutes boiling increased lycopene from 12.4 ± 0.01 to 13.9 ± 0.01 mg/100ml and decreased beta carotene from 15.7 ± 0.01 to 12.2 ± 0.01 mg/100ml and also decreased vitamin C from 49.8 ± 0.014 to 42.2 ± 0.14 mg/100ml. Extending the boiling

time to 15 minutes further increased the lycopene to 14.8 ± 0.04 mg/100ml but decreased the beta carotene and vitamin C to 6.6 ± 0.00 and 33.7 ± 0.24 mg/100ml respectively. Boiling the paste for 30 minutes increased the lycopene to 16.4 ± 0.05 mg/100ml but reduced the beta carotene and vitamin C to 5.7 ± 0.140 and 25.2 ± 0.00 mg/100ml respectively. Similarly, frying the pulp for 2 minutes increased the lycopene to 14.0 ± 0.01 mg/100ml, but decreased the beta-carotene and vitamin C content to 15.2 ± 0.01 and 36.9 ± 0.00 mg/100ml respectively, while 15 minutes frying increased the lycopene to 14.9 ± 0.04 mg/100ml similar to boiling reduced the beta-carotene and vitamin C to 9.2 ± 0.00 and 22.8 ± 0.03 mg/100ml respectively and Again, 30 minutes frying increased the

lycopene to 18.50 ± 0.10 mg/100ml and reduced the beta-carotene and vitamin C to 6.1 ± 0.06 and 20.9 ± 0.07 mg/100ml respectively

5. Discussion

Table 1 Shows the Phyto-chemical composition of raw and thermally processed tomato [Var.UC82B] samples. The lycopene content of the tomato pulp significantly increased [$P < 0.05$] when boiled or fried. The available lycopene content progressively increased as boiling or frying period was increased from 2 to 30 min. Figure 1 exhibits the lycopene content of both boiled and fried tomato samples.

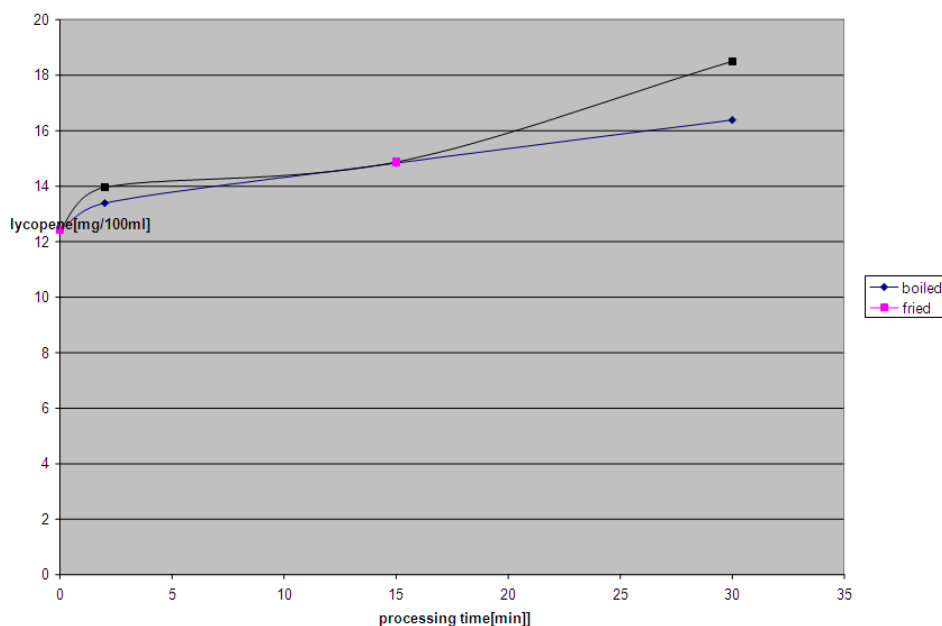


Fig. 1. Effect of Period of Processing on lycopene Content of Tomato

Table 1. Lycopene, beta carotene and vitamin C content of the samples

Type of treatment	Sample Code	Processing Time (min.)	Lycopene (mg/100ml)	Beta-carotene (mg/100ml)	Vitamin C (mg/100ml)
Raw	A	0	$12.4^a \pm 0.01$	$15.7^a \pm 0.01$	$49.8^a \pm 0.014$
	B	2	$13.9^b \pm 0.01$	$12.2^b \pm 0.01$	$42.2^b \pm 0.14$
Boiled	C	15	$14.8^c \pm 0.04$	$6.6^c \pm 0.00$	$33.7^c \pm 0.24$
	D	30	$16.4^d \pm 0.05$	$5.7^d \pm 0.140$	$25.2^d \pm 0.00$
Fried	E	2	$14.0^b \pm 0.01$	$15.2^c \pm 0.01$	$36.9^c \pm 0.00$
	F	15	$14.9^c \pm 0.04$	$9.2^d \pm 0.00$	$22.8^f \pm 0.03$
	G	30	$18.50^e \pm 0.10$	$6.1^e \pm 0.06$	$20.9^e \pm 0.07$

Values are means of triplicate determinations \pm SD. Values in the same column bearing different superscripts are significantly different [$P < 0.05$]

Boiling the pulp for 2min increased the available lycopene content by 10.9%, while 24.2% increase in lycopene content was observed by extending the boiling period to 30min.

Similarly, frying the tomato pulp for 2minutes significantly increased [$P < 0.05$] the available lycopene content by 11.1%, while frying it for 30 minutes increased the available lycopene content by 32.9%. The observed

increase in available lycopene content of tomato pulp as a result of boiling or frying is in agreement with earlier reports that lycopene in the natural trans form is poorly absorbed from raw tomato when consumed [15, 12]. Similarly, lycopene is less absorbed from fresh tomatoes than cooked tomatoes [13]. Therefore, thermally processed tomato products could be the best food sources of lycopene. Men seeking to avoid prostate enlargement may increase their intakes of raw tomato.

Figure 2 shows the curve of β -carotene of boiled and fried tomato samples at varied processing periods. The β -carotene content of tomato decreased with increase in period of boiling and frying. There was a significant

[$P < 0.05$] decrease in β -carotene content as a result of boiling tomato pulp for 2 minutes and further decrease occurred by extending the boiling time to 30 minutes. Similarly, frying tomato pulp for 2 minutes decreased its β -carotene content, while frying it for 30 min caused more decrease in its β -carotene content. This sharp decrease in β -carotene content of the samples as boiling or frying time increased suggests that β -carotene is a heat labile compound, and could be more available in raw tomato than the processed counterpart.

The Vitamin C content of tomato pulp decreased as both boiling and frying period increased as shown in Table 1 and Figure 3.

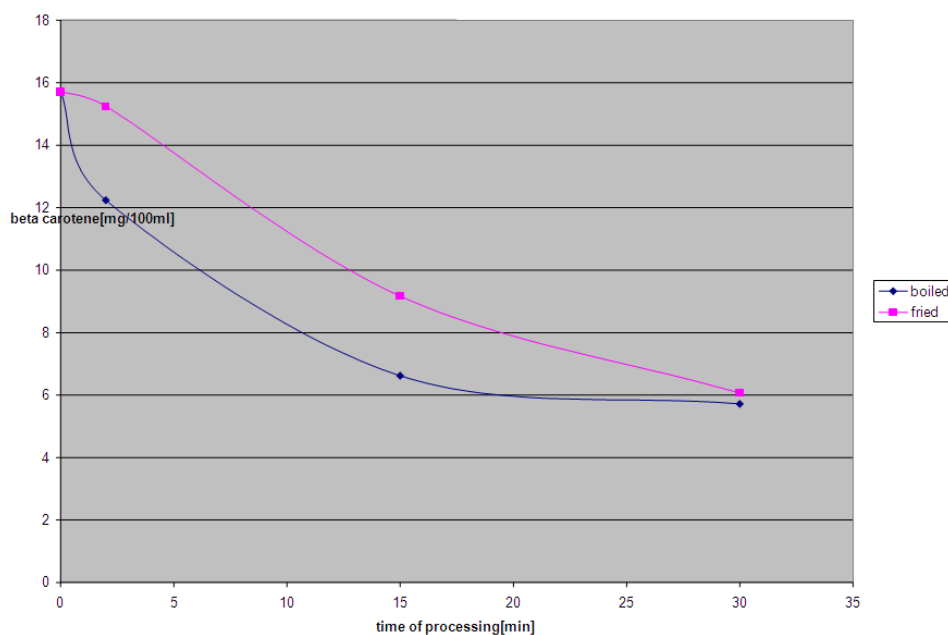


Fig.2. Effect of Period of Processing on Beta - carotene Content of Tomato

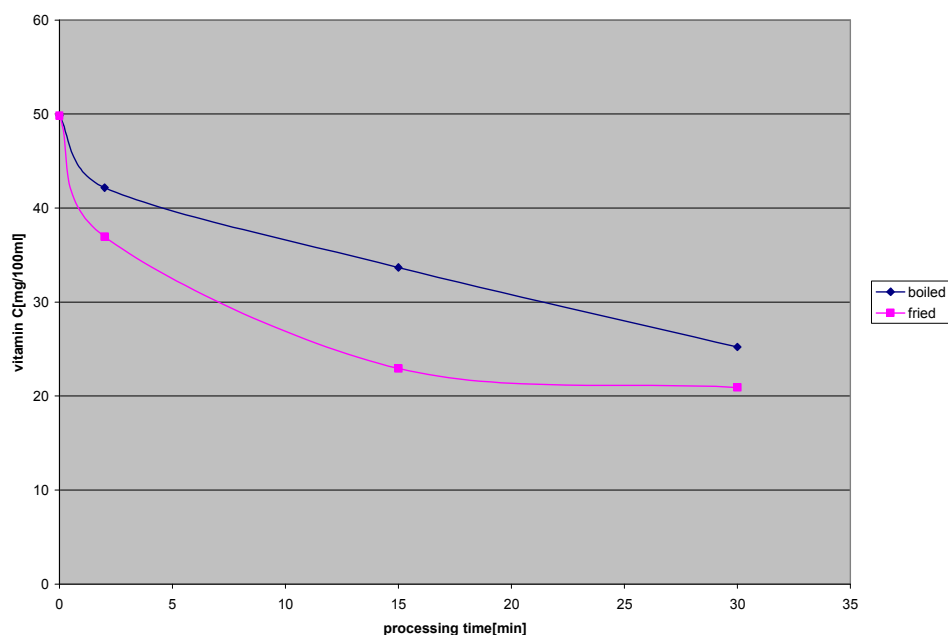


Fig. 3. Effect of Period of Processing on Vitamin C content of Tomato

Vitamin C progressively decreased as the processing times increased therefore, suggesting that it does not require excessive heat treatment. The decrease in Vitamin C content was progressive as boiling time progressed from 2 to 30 minutes. Also, frying tomato pulp caused a progressive decrease in value of its Vitamin C content, in a similar fashion caused by boiling but had more adverse on vitamin C. There is a significant variation in Vitamin C content [$P < 0.05$] between the tomato samples boiled for 30min and its counterpart fried for 30min. Frying the pulp for 30min resulted in higher loss of vitamin C. thermal processing of tomato should be carefully controlled to retain much of this vitamin in the finished product.

6. Conclusion

β -Carotene and vitamin C content of tomato pulp became unavailable as the tomato pulp is subjected to thermal processing (boiling or frying) However, thermal processing makes the lycopene more available in processed tomato. This nutrition information could be a guide to processors and consumers of tomato products.

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