

# Effect the Industrial Process and the Storage Periods on the Nutritional Value of Tomato Juice

## Research Article

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### Abstract

In this study, the effect of processing and storage time on the chemical composition, physical properties and active compound contents of raw and tomato juice was evaluated. The raw tomato had 95% of moisture, 5% total soluble solids, acidity 0.45, PH4.2, 15.6mg vitamin C/100g, 31.5 mg/ kg lycopene, phenolic compound 22.68 mg GAE /kg and flavonoids 6.43 mg RE /kg. The study investigated the effect of storage for tomato juice during 18 months in zero times, 6months, 12 months and 18 months, there was slightly differences through this period in PH from 4.5 to 4.2, acidity from 0.81 to 0.65, phenolic compound between 34.18 and 30.2 mg GAE /kg, flavonoids ranged from 10.51 to 9.0 mg RE /kg vitamin C ranged from 24.50 to 20.18 mg /100g and lycopene from 85.41 to 79.22mg /Kg.

**Keywords:** Tomato juice; Lycopene; Phenolic; Antioxidant; Phytochemical; Processing; Microorganisms

## Introduction

Tomato (*Lycopersicon esculentum*) is one of the most consumed fruits in the world, either as a raw fruit or as a processed product. In fact, in the entire world, tomatoes are second only to potatoes in economic importance and consumption and are used in the food stuff industry as raw material for the production of several products such as juices, sauces, purees, pastes, and canned tomatoes. In recent decades, the consumption of tomatoes has been associated with the prevention of several diseases. Consumption of processed tomato products is rising in western countries. Between 1996 and 2001, the quantity of processed tomatoes increased from 7.88 to 8.45 million tons in the EU (<www.wptc.to>). Tomato, as a fresh or transformed product, possesses a high nutritional value, due to its content of different types of micronutrients: vitamins (C and E), folates, carotenoids and phenolic compounds [1,2]. Fruit juice colour is a primary factor considered by the consumer in assessing juice quality

and sensory acceptance [3]. The nutritional quality of tomato juice is primarily related to the ascorbic acid content and the presence of bioactive compounds, such as lycopene, which is responsible for tomato juice colour [4-6]. Lycopene has been shown to have strong antioxidant activity; it exhibits the highest physical quenching rate constant with singlet oxygen; it induces cell-to-cell communication; and it modulates hormones, immune systems, and other metabolic pathways [7]. Carotenoids, other antioxidant compounds such as phenolics also contribute to the beneficial effects of tomato products. Phenolics possess reducing character, capacity of sequestering reactive oxygen species (ROS) and several electrophiles, tendency to self-oxidation and capacity to modulate the activity of some cell enzymes [8].

Thermal processing is conventionally used to inactivate microorganisms and enzymes and extend the shelf life of juice products. However, thermal processing can adversely affect the

sensory and nutritive qualities of tomato juices [9,10].

The aim of this study, estimate the quality of the tomato juice by finding out the effect of processing, storage process on the properties of the physical, chemical and active compound.

## Material and Methods

### Tomato and juice preparation

Tomatoes fruits (*Lycopersicon esculentum*) were purchased from sanad farm, Damietta Governorate, Egypt during the month of August 2013. Only ripe and fresh tomatoes were used in this study. The tomato juice was prepared according to the method of [11]. Tomato fruits were washed in water manually, chopped, squeezed in a blender (BRAUN 4184, Czech), cold extracted and sieved (0.8 mm holes) to remove seeds and peels. The extract was concentrated to 9% T.S.S (juice) by using a rotary evaporator at 18 °C for 2h under vacuum and packaged in glass cans of 350g net weight. The cans were sterilized at 100 °C for 30 min. and were analyzed after (zero, 6, 12 and 18 month) at room temperature.

### Chemical composition

Chemical composition (moisture, proteins, fat, carbohydrates and ash) using the AOAC procedures (AOAC [12]). The crude protein content ( $N \times 6.25$ ) of the samples was estimated by the macro- Kjeldahl method; the crude fat was determined by extracting a known weight of powdered sample with petroleum ether, using a Soxhlet apparatus; the ash content was determined by incineration at  $600 \pm 15$  °C. Total carbohydrates were calculated by difference.

### Physical properties

**pH value:** pH value was determined according to the method described by A.O.A.C [12], as follows: A known weight of tomatoes and tomato products (juice, puree and ketchup) (10ml) were blended with (100ml) distilled water and pH of the slurry was then measured using (CRISON GLP 21) pH meter.

### Total acidity

Total acidity was measured by titrating (10g) of tomatoes and tomato product (juice, puree and ketchup) with NaOH 0.1N solution using (phph) as indicator. The results were expressed as % Citric acid, as described by A.O.A.C [12].

### Color measurements

The Color measurement in tomato products was determined by Mert [13]. The samples were filled into a clear glass Petri dish and color Parameters ( $a^*$  and  $b^*$ ) were determined using a Minolta colorimeter (laboscientificas.r.l. - parma; Italy model: LS 2000). The Petri dish was placed on the colorimeter sensor during measurements. Three measurements were taken for each sample and average values were reported.

### Taste index and the maturity

A taste index and the maturity were calculated using the equation proposed by Navez, et al., [14] and Nielsen [15] starting from the Brix degree and acidity values which were determined in a previous paper [16].

$$\text{taste index} = \frac{\text{Brix degree}}{20 \times \text{acidity}} + \text{Acidity}$$

$$\text{the maturity} = \frac{\text{Brix degree}}{\text{acidity}}$$

### Determination of phytochemical compounds

**Total phenolic compounds:** Total polyphenolic compounds in the crude extract of raw tomato and tomato products were determined by the folin - ciocalteu method according to Meda et al. [17] as follows:

0.1gm lyophilized powder of tomato samples was dissolved in 1 ml deionized water. This solution (0.1ml) was mixed with 208ml of deionized water, 2ml of 2% Na<sub>2</sub>CO<sub>3</sub> and 0.1ml of 50% folin-ciocalteu reagent. After incubation at room temperature for 30 min. The reaction mixture absorbance was measured at 750 nm against a deionized water blank on a spectrophotometer (JENWAY 6315 made in England). The concentration was calculated using gallic acid (GA) as standard and results were expressed as mg gallic acid equivalents (GAE)/gm lyophilized powder. Finally, the results were converted to mg GAE / 100gm fresh matter of tomato.

### Total flavonoid

The total flavonoid content was determined according as the aluminum chloride colorimetric method described by Chang et al. [18]. Briefly, aliquots of 0.1 g of tomato and tomato products samples were, respectively, dissolved in 1 ml deionized water. This solution (0.5 ml) was mixed with 1.5 ml of 95% alcohol, 0.1 ml of 10% aluminum chloride hexahydrate (AlCl<sub>3</sub>), 0.1 ml of 1 M potassium acetate (CH<sub>3</sub>COOK), and 2.8 ml of deionized water. After incubation at room temperature for 40 min, the reaction mixture absorbance was measured at 415 nm against a deionized water blank on a spectrophotometer (JENWAY 6315 made in England). Quercetin was chosen as a standard using a seven point standard curve (0-50 mg/l).

### Antioxidant activities

**Determination of Total ascorbic acid:** Total ascorbic acid (vit. C) was estimated according Kapur et al., [19]. Samples of tomato products and raw tomato were first chopped and homogenized in a laboratory homogenizer. Approximately 0.23mL of 3% bromine water were added into 4 mL of centrifuged sample solution to oxidize the ascorbic acid to dehydroascorbic acid and after that 0.13 mL of 10 %thiourea to remove the excess of bromine. Then 1 ml of 2, 4 dinitrophenylhydrazine solution was added to form osazone. All standards, samples and blank solution were kept at 37 °C temperature for 3 hours in a thermostatic bath. After it all were cooled in ice bath for 30 minutes and treated with 5 mL chilled 85% H<sub>2</sub>SO<sub>4</sub> with constant stirring. As a result, a colored solution's absorbance was taken at 521 nm on a spectrophotometer (JENWAY 6315 made in England).

### Determination of lycopene

Extraction method was performed according to Fish et al., [20]. Samples of tomato products and raw tomato were first chopped and

homogenized in a laboratory homogenizer. Approximately 0.3 to 0.6 g samples were weighed and 5 mL of 0.05% (w/v) BHT in acetone, 5 mL of ethanol and 10 mL of hexane were added. The recipient was introduced in ice and stirred on a magnetic stirring plate for 15 min. After shaking, 3 mL of deionized water were added to each vial and the samples were shaken for 5 min on ice. Samples were then left at room temperature for 5 min to allow the separation of both phases. The absorbance of the hexane layer (upper layer) was measured in a 1-cm-path-length quartz cuvette at 503 nm blanked with hexane on a spectrophotometer (JENWAY 6315 made in England).

### Statistical analyses

All results were performed in three replicates and the results were statistically analysed. Significant statistical differences of observed chemical parameters means of tomato juices were determined by the Fisher's least significant differences (LSD) test, after the analysis of variance (ANOVA) for trials set up according to the RCB design.

## Results

### Chemical composition

Proximate chemical composition of fresh juice and processed juice are presented in Table 1. Moisture 95 and 91%, protein 0.78 and 1.50%, fat 0.49 and 0.90%, fiber 1.13 and 1.58%, ash 0.90 and 1.20%, carbohydrate 1.70 and 3.28%, total soluble solid (T.S.S) 5 and 9% and total energy 14.33 and 27.22% respectively. From Table 1 all differences between fresh juice and processed juice were significant except ash there was no difference significant among there. The results were in agreement with that reported by Kamil et al. [21].

Chemical composition of processed juices were determined during the storage period and presented in Table 2. From that table

**Table 1:** Chemical composition of raw juice and processed juice.

Processed Juice%	Raw Juice%	Parameters
b91	95a	Moisture
b 1.50	0.78	Protein
b0.9	0.49a	Fat
b1.58	1.13a	Fiber
a1.2	0.9a	Ash
b3.28	1.7a	Carbohydrate
b9	5a	T.S.S

**Table 2:** Effect of storage period on gross chemical of processed juice.

Parameters	Zero	6 months	12 months	18 months	LSD
Moisture	91.00a	91.00a	91.00a	90.50a	1.7
Protein	1.50a	1.30a	1.56a	1.42a	0.24
Fat	0.90a	0.83a	0.92a	0.91a	0.14
Fiber	1.58a	1.53a	1.23b	1.72c	0.10
Ash	1.2a	1.98b	1.24a	1.96b	0.29
Carbohydrate	3.28a	3.36a	4.05c	3.49b	0.20
T.S.S	9.00a	9.00a	9.00a	9.50a	0.82

**Table 3:** Physical properties of raw juice and processed juice.

pH	4.2 <sup>a</sup>	<sup>b</sup> 4.5	0.45
Acidity	0.45 <sup>a</sup>	0.81 <sup>b</sup>	0.21
Color	2.28 <sup>a</sup>	2.20 <sup>a</sup>	-
Maturity	11.11 <sup>a</sup>	<sup>a</sup> 11.11	0.00
Taste index	1.0 <sup>a</sup>	<sup>b</sup> 1.36	0.65

**Table 4:** Effect of storage period on physical properties for processed juice.

Parameters	Zero	6 months	12 months	18 months	LSD
PH	4.50a	4.54a	4.32a	4.20a	0.75
Acidity	0.81a	0.98a	0.76a	0.65ab	0.21
Color	2.28a	2.25a	1.84b	1.90b	0.22
MATURITY	11.11b	9.18a	11.84b	14.62c	1.52
Taste index	1.36a	1.44a	1.35a	1.38a	0.51

**Table 5:** Effect of Thermal treatment on phytochemicals in fresh juice and processed juice.

Phytochemicals	Fresh Juice	Processed juice	LSD
Phenolic compound mg GAE/kg	22.68 <sup>a</sup>	34.18 <sup>b</sup>	2.30
Flavonoids mg RE/kg	6.43 <sup>a</sup>	10.51 <sup>b</sup>	0.93
Vitamin C mg/100g	15.6 <sup>a</sup>	24.5 <sup>b</sup>	1.79
Lycopene mg/Kg	31.5 <sup>a</sup>	85.41 <sup>b</sup>	1.16

it was found that the moisture content is slightly reduced after 18 month storage period comparing other storage periods.

No significant differences obtained during storage periods in protein, fat and T.S.S content for tomato juice. Whereas there were significant differences in fiber, ash and carbohydrates during storage periods. Similar results were reported by [21].

### Physical properties of raw juice and processed juice:

As indicated in Table 3, there was significant difference in pH for raw juice and processed juice 4.2 and 4.5, likewise acidity was 0.45 and 0.81 raw juice and processed juice respectively. Whereas no significant differences in color and maturity between raw juice and processed juice. Such results were in general agreement with those reported by Adekunle et al. [22] and Kamil, et al [21].

### Effect of storage period on physical properties for processed juice

The analysis in Table 4 shows the pH of the processed juices ranged between 4.20 and 4.54 there was no significant differences. Whereas acidity ranged from 0.65 to 0.98, on other hand there was variation on color after 12 months and also maturity ranged from 9.18 to 14.62 among storage periods. There was no significant differences in taste index among storage periods.

### Effect of Thermal treatment on phytochemicals in fresh juice and processed juice

There were high increases in the lycopene contents of the processed juices than the contents determined in the fresh juice as

**Table 6:** Effect of storage periods in processed juice.

Parameters	Zero	6 months	12 months	18 months	LSD
Phenols	34.2 <sup>a</sup>	31.9 <sup>b</sup>	28.4 <sup>c</sup>	30.2 <sup>b</sup>	2.45
Flavonoids	10.5 <sup>a</sup>	9.8 <sup>a</sup>	10.5 <sup>a</sup>	9.8 <sup>a</sup>	1.20
Lycopene	24.5 <sup>a</sup>	22.68 <sup>b</sup>	21.43 <sup>b</sup>	20.18 <sup>b</sup>	1.53
Vitamin C	85.41 <sup>a</sup>	82.11 <sup>b</sup>	80.43 <sup>c</sup>	79.22 <sup>c</sup>	1.47

shown in Table 5. Processing of food may improve the bioavailability of lycopene and hence its concentration by breaking down cell walls, which weakens the bonding forces between lycopene and tissue matrix, thus making lycopene more accessible and enhancing the cisomerization [23]. The lycopene content in the processed juice from recorded the highest value of 85.41 mg/100 g as compared to the fresh juice (31.5 mg/100 g). The increasing of lycopene after processing is attributed to the fact that the trans isomers are converted to the cis isomers which are more bioavailable [24].

Total phenolic compound content in processed juice also increased with increased heating time from 22.68 in fresh juice to 34.18 (mg GAE/kg).

Vitamin C content in fresh juice was 15.6 mg/100g when the ratio of T.S.S. 5 whereas the content of vitamin C in processed juice 24.5 mg/100g when the ratio of T.S.S. 9. As shown the ratio of vitamin C was decreased in processed juice compared fresh juice when taking into consideration the ratio of T.S.S. Flavonoids content of fresh juice was 6.43, while the content of flavonoids after thermal processing increased to 10.51 mg RE/kg.

#### Effect of storage periods in processed juice

As shown in Table 6 phenols, lycopene and vitamin C ratios decreased significantly among storage periods from zero time to 18 months. While there was no significant differences in flavonoids ratio during storage periods in processed juice from zero time to 18 months. Similar result reported by Odriozola-Serrano et al., [25] and Odriozola-Serrano et al., [26].

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