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A study on the thermal effect on quality characteristics of tomato purée

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Abstract

Total antioxidant activity, levels of bio-active compound groups and colour of tomato purée subjected to thermal treatment (70°C/2 min) were measured. The method applied to the dosage of ascorbic acid was with 2,6-diclorophenolindophenol. Total phenols (TP) in purée were determined using the Folin-Ciocalteau method and antioxidant activity by the use of DPPH free radical method. The colour of the samples was measured using a Hunter-Lab colour meter. Heat treatment caused a rapid decrease in ascorbic acid. Phenolic contents were in general unaffected by thermal treatment. Colour parameters were significantly affected by thermal treatment. This provides a helpful tool for understanding the effect of thermal treatment on colour variation of tomato purée in a broader spectrum. This research paper provides scientific evidence of the influence of thermal treatments in retaining important bioactive compounds.

Keywords: antioxidant activity, tomato, total phenols, colour

1. Introduction

Consumers are demanding high quality and convenient products with natural flavor and taste, and greatly appreciate and fresh appearance of minimally processed food [1,2, 3,4,5]. To prolong the shelf life of food products, processing is often necessary (e.g. freezing, drying, heating) [6]. Freeze-drying produces the highest quality food products, but it is the most expensive method of preservation. Osmotic dehydration is a simple and inexpensive alternative process, which has low capital investment and also offers ways to save highly perishable products and makes them available for regions away from production zones [7]. In order to extend the shelf life of food products, they are usually treated thermally using methods such as hot water immersion [8]. Pressure applications (up to 700 MPa with or without addition of heat) can result in either pasteurization or sterilization of food products depending upon the intensity of combined pressure-heat treatment [9].

Tomatoes (*Lycopersicon escullentum*) are widely consumed either raw or after processing and can provide a significant proportion of the total antioxidants in the diet [10]. This is largely in the form of carotenes [11] and phenolic compounds [12]. Carotenoids represent a large group of phytochemicals that may contribute to health and disease prevention [13].

Recently, there has been renewed attention given to the antioxidant content of tomatoes because many epidemiological studies suggest the association of this crop with a range of health benefits such as the prevention of prostate cancer [14].

While many authors have assessed the effect of thermal processing on the nutritional properties of foods, such as antioxidant capacity [15,16], few authors attempted to link their studies with quality measurement such as instrumental colour analyses. A principal objective of the present study was to assess the effect of thermal treatment for retaining the antioxidant capacity.

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We also monitored the colour parameters which can be linked to the visual quality of the purées, an important parameter for consumer acceptance.

2. Materials and Methods

2.1. Preparation of vegetable purées. Tomatoes (*Lycopersicon escullentum*) were obtained from a local market. After washing and dicing samples were blended in a mechanical blender (model, R 555, ROHNSON, Romania). Samples were packed and stored at –20^{0}C until required for thermal treatment.

*2.2. Thermal treatment.*The packed samples (250 g) were boiled in water for 21 – 26 s at which time they had achieved a core temperature of 70^{0}C. After thermal treatment, samples were removed, cooled at room temperature and tested for antioxidant indices and instrumental colour on the same day.

2.3. Ascorbic acid determination. Determination of vitamin C content in tomato purée was achieved by titration with 2.6-diclorophenolindophenol (reagent Tillmans). The method is based on colour change of the reagent, oxidation or reduction. Thus, the ionized form of 2,6-diclorophenolindophenol is red in acid and blue in basic medium. Dehydroascorbic acid is obtained through reaction with vitamin C, and after reducing the identification reactive, 4-(p-hidroxiphenil-amino)-2.6-dichlorophenol. This method is commonly used, due to the fact that it is easy to use and due to the reagent sensitivity.

*2.4. Total phenols.*Total phenols were determined using the Folin-Ciocalteau reagent. 100 mL sample was transferred to a volumetric flask, to which 500 mL undiluted Folin-Ciocalteau reagent was subsequently added. After 1 min, 1.5 mL 20% ($w\cdot v^{-1}$) Na_2CO_3 was added and the volume made up to 10.0 mL with H_2O. After 2 h incubation at 25^{0}C, the absorbance was measured at 760 nm and compared to a gallic acid calibration curve. Results were expressed as mg of Gallic acid equivalent per 100 g of dry weight of sample.

*2.4. 2,2-Di (4-tert-octylphenyl)-1-pycrilhydrazyl (DPPH) scavenging capacity assay.*The method used for determining the antioxidant activity [17] of tomato purée extracts is based on scavenging 2,2-Di (4-tert-octylphenyl)-1-picrylhydrazyl (DPPH) radicals.

The decrease in absorbance was measured at 515 nm against a blank without extract, using a spectrophotometer. Using a calibration curve with different amounts of DPPH, the IC_{50} was calculated. Antioxidant activities were expressed as the IC_{50} i.e., the concentration of antioxidant required to cause 50% reduction in the original concentration of DPPH radicals under the experimental conditions given. For ease of interpretation antiradical powers were also calculated and defined as the inverse of the IC_{50} value. Finally, the antioxidant capacity of the extracts was compared to that of a synthetic antioxidant (Trolox) and expressed as Trolox equivalent antioxidant capacity values (TEAC).

*2.5. Instrumental colour analysis.*The colour of the samples was measured using a Hunter-Lab colour meter. The instrument was calibrated using the black and white tiled provided. Colour was expressed in Hunter Lab units L^*, a^* and b^*. Samples of purée were filled into plastic Petri dishes (i.d. 50 mm) taking care to exclude air bubbles and placed under the aperture of the colour meter. Five replicate measurements were performed and results were averaged. In addition, hue angle and chroma were calculated by the following equations:

$$Hue\ angle = tan^{-1}(b^*/a^*) \qquad (1)$$

$$Chroma = \sqrt{a^2 + b^2} \qquad (2)$$

*2.7. Statistics.*Samples were assayed in triplicate and results are given as averages ± SD. Student's t test was used for the statistical evaluation and $p < 0.05$ was considered statistically significant.

3. Results and discussion

3.1. Effect of thermal processing on antioxidant activity of tomato purée. Anti-radical activity and other antioxidant indices of tomato purée subjected to thermal treatment are presented in Table 1. A slight but non-significant decrease in anti-radical activity was noted for thermally processed tomato purée as compared to the un-processed purée. Phenolic contents reported here were within range of those reported elsewhere [18] and were largely unaffected by processing. Levels of ascorbic acid was also in the range of those reported elsewhere [4]. A significant reduction in ascorbic acid level was noted for thermal treatment as compared to unprocessed sample.

Phenols were poorly correlated with anti-radical activity.

Table 1. Effect of thermal treatment on anti-radical activity, total phenols and ascorbic acid content in tomato purées

Sample	Anti-radical activity $(g/l)^{-1}$	Total phenols mg GAE/100 g	Ascorbic acid mg/100 g
Untreated	0.31 ± 0.03	358.20 ± 3.79	201.02 ± 3.54
Thermally treated	0.29 ± 0.02	340.01 ± 2.79	119.06 ± 4.21

Values are means ± standard deviation, *n* = 3

3.2. Effect of thermal processing on colour parameters of tomato purée. Instrumental colour parameters of tomato purée samples are shown in Table 2. For tomato purées, colour intensity (chroma) was higher for thermally treated sample than un-treated ($p < 0.05$). Redness as measured using hunter a^* values was higher for thermally treated sample as compared to untreated sample. Lightness of processed tomato sample was lower than fresh sample ($p < 0.05$).

Since carotenoids are the major pigments present in tomatoes the increase in hue angle may be a reflection of changes in total carotenoid contents [8]. For example, the carotenoid content was affected by thermal treatment, and this was reflected in the lower hue angle for this sample (Table 2). However this change was not consistent and it appears that a more complex mechanism may be required to explain variations in colour parameters for the tomato purée.

Table 2. Effect of thermal treatment on colour parameters of tomato purées

Samples	L^*	a^*	Colour intensity	Hue angle
Untreated	22.69 ± 0.04	8.12 ± 0.04	23.21 ± 0.023	38.99 ± 0.045
Thermally treated	21.89 ± 0.031	9.22 ± 0.023	24.32 ± 0.034	40.21 ± 0.077

Values are means ± standard deviation, *n* = 3

3.3. Relationship between colour parameters and antioxidant activity. The hue angle and the colour intensity calculated from colour parameters L^*, a^* and b^* of tomato purée samples are illustrated in Table 2, whereas antioxidant indices are shown in Table 1. The redness value increased significantly ($p < 0.05$) when subjected to thermal treatment. This increase was reflected in high antioxidant activity as shown in Table 1. In fact antioxidant activity levels of tomato purée were positively correlated with Hunter a^* values ($r = 0.58$, $p < 0.05$). No significant correlation was observed between antioxidant activity and hue angle.

Higher redness at thermal treatment may be due to better extractability of carotenoids due to disintegration of chromoplast [19, 20].

4. Conclusion

A slight but non-significant decrease in anti-radical activity was noted for thermally processed tomato purée as compared to the un-processed purée. Phenolic contents were largely unaffected by processing. A significant reduction in ascorbic acid level was noted for thermal treatment as compared to unprocessed sample.

Instrumental colour parameters was affected by thermal treatment. However, some of the effects of thermal treatment on colour parameters are still ambiguous, therefore additional research is necessary to understand those relationships.

Compliance with Ethics Requirements

Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human and/or animal subjects (if exists) respect the specific regulations and standards.

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