Study on effect of processing parameters on lycopene content of tomato puree

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ABSTRACT *Lycopene beinga red coloured carotenoid recognized as a potent antioxidant and specified tomatoas a predominant source against other fruits and vegetables. In present study,influence of tomato puree particle size in coordination with thermal processing parameters on lycopene content was investigated by standardizing processing attributes in association with physical characterization(Sieving) of finished puree.Linearpercent decrease in lycopene content(7.80%) of successive sieved puree mass (40-100 mesh) responsible for modulating textural changes represents effect of particle size and inherent adhesion association of lycopene as a molecule. Irrespective of lower lycopene content and small particle size as an ingredient of food beverage to resolve the option against sedimentation process,the 100 mesh puree is considered as a standard mass for enrichment. Thermal treatment base percent linear increase (17.86%) in tomato puree lycopene justifies significant effect of temperature as a process parameter. The temperature range admissible for increased percent yield of lycopene though appeared to be 60-90⁰C but as a functional ingredient its antioxidant efficacy protective critical temperature needs to be optimized. The temperature of 90⁰C is decided to be a reference temperature for higher percent yield of lycopene. Lycopene molecule adhesion base association breaking force as temperature played significant role in coordination with exposure time. Higher exposure tenure reflecting on optimum yield of lycopene justifies parallel review base trend. Hence temperature-time combination as an admissible treatment for molecular lycopene extraction is justified as 90⁰C temperature for 1h under laboratory conditions.*

Keywords: *Lycopene, tomato puree, particle size, processing temperature, processing time*

Introduction

Carotenoids, as a constituent part of fruits and vegetables have underlined review base health benefits coiling around their pharmaceutical value. Recently lycopene has projected substantial interest among nutritionists and medical researchers on the basis of inherent nutraceutical value chain. Inherent capability of human body to explore health benefit potential of lycopene as food ingredient totally depends on outsource consumption against in vivo synthesizing inability (Levy and Sharoni, 2004). Lycopene as a dietary supplement either in sole or mixed form recorded its efficacy as a potential antioxidant than other forms of carotenoid. Lycopene, the most efficient carotenoid antioxidant is a natural pigment which protects the body by neutralizing the negative effects of oxidants. (Lilwani and Nair, 2015). In processed foods it is mainly in the form of the isomers. Lycopene is highly unsaturated hydrocarbon characterized by 11 conjugated bonds against 2 unconjugated bonds(Agarwal and Rao, 2010).Conjugated bonds of lycopene provide antioxidantability to molecule admissible to specify its nature as a functional ingredient of food for human health (Malviya, 2014and Lilwani and Nair, 2015).

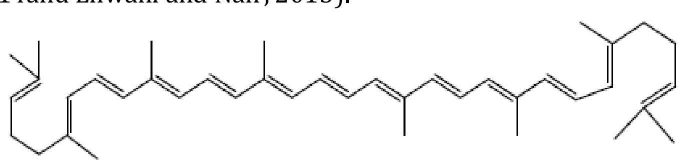

Figure.1Structure of Lycopene (Chauhan *et al.,* 2011)

Lycopene as a red coloured carotenoid specifying tomato as a predominant source against other fruits and vegetables. In general, tomato and tomato base food products provide around 85% of dietary lycopene against 15% synergetic share of other foods including watermelon, pink grapefruit, guava, and papaya (Levy and Sharoni, 2004). Diversity lycopene varietal content (0.85 to 4.2 mg/ 100g) of tomato increasesalong with ripening of fruit (Chauhan *et al*., 2011). Tomato and tomato base food comprises lycopene in 79-91% trans and 9-21% cis forms of isomers(Collins, Perkins Veazie and Roberts, 2006).Bioavailability of lycopene is a function of various factors including processing technology (Trivedi and Patel, 2015). Lycopene from processed tomato products appears to be more bioavailable than raw tomatoes (Agarwal and Rao, 2010). Heat processing of tomatoes facilitates disruption of tissue cell matrix to release lycopene, readily available for absorption in the intestine(Gartner, Stahl and Sies, 1997 and

Agarwal and Rao, 2010).Thermal processing enhances the nutritional goodness value of tomatoes by increasing bio accessible lycopene status and antioxidant activity which is against the existing notion as fruit processing substantially reduces nutritional value and natural freshness (Dewanto *et al*., 2002). In view of this present investigation isoutlined to explore theinfluence of processing parameters in coordination with tissue mass disintegration on lycopene content to standardize the cell maceration generativetomatopuree.

Materials and Methods

Standardization of tomato puree

Fully ripened, deep red colouredand freshly harvestedtomatoes were collected from local tomato producer. Primary processing operations like washing and cleaning to remove dust, dirt and foreign material are undertaken under controlled conditions. The partially treated tomatoes were subjected for tissue maceration in screw type juice extractor to protect the integrity of seeds and also to facilitate enforced maceration leading to liquefied mass of tomato devoid of large size peel flakes. Sincere efforts to monitor the process of tomato pulping with slight change is exclusively in the interest of maintaining the particle size of overall finished mass. The screening process facilitated through sieves of varying size**(**40, 60, 85 and 100 mesh) forlocating intermediary mass standards, streamlined the experimental standard of 100 mesh sieve as fine tomato puree to justify particle size admissible for beverage ingredientanti-sedimentation status.

Thermal processing of tomato puree

Domestic food processor enforced particle size base (100 mesh sieve- 0.15mm)homogenised tomato puree was subjected to varying range temperaturetreatments (60, 70, 80 and 90^{0}C) by using water bath for 10min on trial and error basis. Thermal treatment standardization was carried outby using varying range of process tenure (15, 30, 45 and 60min) at 90^{0}C temperature that could not streamlined process because of marginal yield of lycopene. Further experimental setup was designed on the basis of 90^{0}C temperature as a standard for higher range of time (1, 2, 3, 4, 5 and 6h) for increased percent yield of lycopene. Linear change in percent yield of lycopene is recordedby following standard extraction procedure (Thimmaiah, 2016). TSS (^{0}Brix) was measured for all the samples after heat treatment.

Fully ripened tomatoes (Deep red colour- local variety)
↓
Washing and cleaning
↓
Tissue maceration (Screw type juice extractor)
↓
Screening(Sieving- 100 mesh)
↓
Homogenization
↓
Heat treatment (Temperature time combination)
↓
Refrigerated storage (5-7^{0}C)

Figure2:Process flow chart for preparation of tomato puree

Lycopene content estimation

Lycopene content of tomato puree was estimated by standard method suggested by Thimmaiah (2016) with little modifications. Weighed sample (5-10g)was mashed repeatedly with acetone using pestle and mortar till the residue became colourlessand acetone extractswastransferred to a separating funnel containing 20ml of petroleum ether.20ml of 5% anhydrous sodium sulphate (Na_2SO_4) solution was added in separating funnel to enhance phase separation. The lower phase was transferred to another separating funnel andextracted with petroleum ether till colourless index. The upper functional phase of petroleum ether extract containing pigments was transferred to a clean conical flask covered with aluminium foilcontaining 10g of anhydrous Na_2SO_4.After 60min petroleum extract was decanted into 100ml volumetric flask and volume was made up to 100ml using petroleum ether. The absorbance was measured at 503 nm with a UV spectrophotometerusing petroleum ether as a blank. Lycopene content of sample was calculated by using standard relationship as Absorbance (OD) of 1.0 = 3.1206 µg of lycopene per ml.Extract was analysed in triplicate and average values were calculated.

$$\text{Lycopene content (mg/100g of sample)} = \frac{31.206 \text{ X OD of the sample}}{\text{Weight of sample}}$$

Results and Discussion

In the present investigation, sincere efforts are executed to collect the data on lycopene content of fresh and processed tomato (tomato puree) in coordination with influencing factors (Flesh particle size, processing temperature and time) to justify its status as functional ingredient.

Effect of particle size on lycopene content of tomato puree

The data on lycopene content of tomato pureespecified by maceration process using predetermined set of sieves (40, 60, 85 and 100mesh) depicted in Table1 and presented by graphics (Figure 3) reflects on effect of particle size on adsorption base release of lycopene during processing of puree.Linear increase in sieve size leading to decreased particle size (0.420 to 0.149mm) during puree processing resulted in marginal decrease (3.46to 3.19mg/100g) in lycopene content of tomato puree and unaltered changes in total soluble solids (4 ^{0}Brix). Linear percent decrease in lycopene content (7.80%) of successive sieved puree mass responsible for modulating textural changes represents effect of particle size and inherent adhesion association of lycopene (Anon, 2008) as a molecule.The variation in lycopene content of the tomato puree might be due to the difference in particle size(0.149mm to 0.420mm)of puree. Irrespective of lower lycopene content and small particle size as ingredient of food beverage to resolve the option against sedimentation process, the 100 mesh puree is considered as a standard mass for enrichment.

Table 1: Effect of particle size on lycopene content of tomato puree

Sieve size	Particle size (mm)	TSS (^{0}Brix)	Avg. lycopene content(mg/100g)
40 mesh	0.420	4	3.46
60 mesh	0.250	4	3.37
85 mesh	0.177	4	3.33
100 mesh	0.149	4	3.19

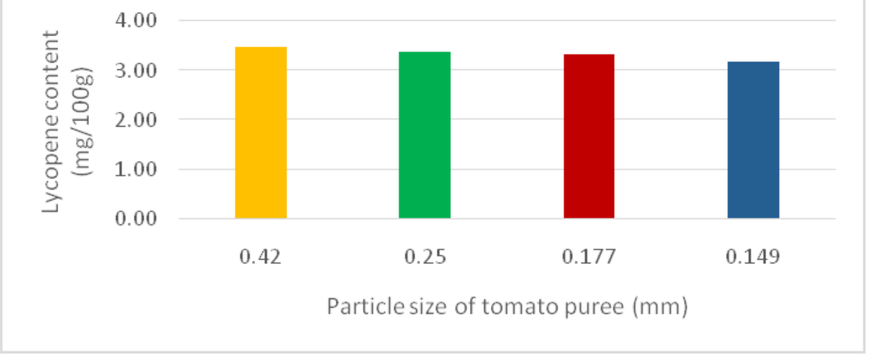

Figure3: Effect of particle size on lycopene content of tomato puree

Effect of processing temperature on lycopene content of tomato puree

The data on effect of processing temperature on lycopene content of tomato puree depicted in Table 2 reflects on effect of processing temperature on release of lycopene during processing.Linear increase in processing temperature during heat processing of tomato puree resulted in increasein lycopene content(3.08to 3.63mg/100g) exhibiting 3.63mg/100g as highest value of puree lycopene along with stabilized total soluble solids (4^{0}Brix).The variation in lycopene content may be associated withvaried processing temperature(60, 70, 80 and 90^{0}C). Thermal treatment base percent linear increase (17.86%) in puree lycopene justifies significant effect of temperature as a process parameter. This may be due to disintegration of cell walls resulted in enhanced lycopene extractability owing to heat induced cell maceration.The concluding database hypothesis leading to increased lycopene content based on effect of thermal treatment from this investigation appears to be analogous to the data reported by Mohammed and Malami (2013). The temperature range admissible for increased percent yield of lycopene though appeared to be 60-90^{0}C but as a functional ingredient its antioxidant efficacy protective critical temperature needs to be optimized (Anese *et al*., 2002 and Dewanto *et al*., 2002). The temperature of 90^{0}C is decided to be a reference temperature for higher percentage yield and optimum antioxidant efficacy of lycopene.The graphical presentation (Figure 4) of data enhances feasibility to acknowledge the correlation between lycopene content and puree processing temperature.

Table 2: Effect of processing temperature on lycopene content of tomato puree

Sample	Heat treatment	TSS (^{0}Brix)	Avg. lycopene content (mg/100g)
Control	Without heat treatment	4	3.08
S_1	60^0 for 5 min	4	3.24
S_2	70^0 for 5 min	4	3.35
S_3	80^0 for 5 min	4	3.46
S_4	90^0 for 5 min	4	3.63

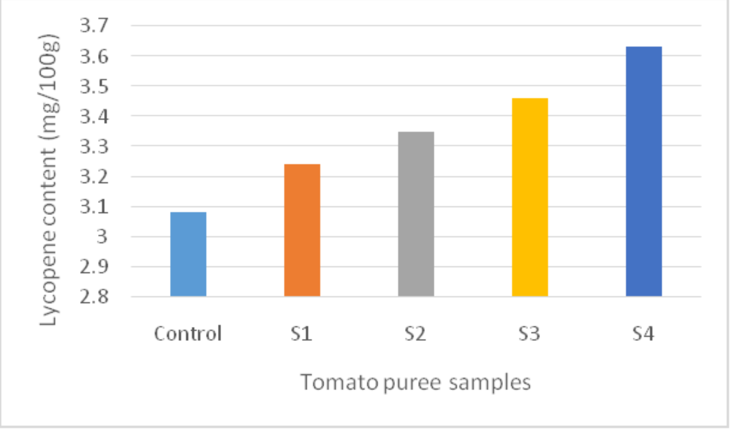

Figure 4: Effect of processing temperature on lycopene content of tomato puree

Effect of processing time on lycopene content of tomato puree

Heat processing time base unit operation has its own significance in overall processing technology to preserve natural quality parameters. The optimum percent yield of lycopene with natural status of *cis* to *trans* isomer quotient appears to be high functionality index of thermal processing (Dewanto *et al*., 2002). In the present investigation sincere efforts are coiling around database collection on thermal processing of tomato puree to justify its efficacy as functional ingredient. The data on effect of processing time on lycopene content of tomato puree depicted in Table 3 and 4reflect on effect ofprocessing time on lycopene content of puree during heat processing.Preliminary trial and error base data on tomato puree heat processing depicted in Table 3 justifies constant increase in lycopene content (2.85 to 4.87mg/100g) even exceeding notified time end point (1h) of experimental set up. Though quantitative (Increased percent yield) lycopene percent yield enhancement appears to be promisingand satisfactory but needs further clarification with functionality index governed by *cis* and *trans* isomer quotient. Data provided an admissible option to reset the experiment characterized by increased processing tenure over and above 1h leading to further admissible range of time (1 to 6h).Moreover,heat processing at90^{0}C temperature for 1-6h scheduledtime span recorded quantitative increase (207.41%)in percent lycopene content of puree at the end of 6h. Thethermal treatment base linear increase (2.97-9.13 mg/100g) in tomato puree lycopene might be due to the difference in processing tenure justifies the significant effect of processing time as a processing parameter. These results are in accordance with the results reported by Mohammed and Malami (2013) and revealed increase in lycopene content with increase in treatment tenureduring heat processing (Figure 5 and Figure 6).

The marginal increase in TSS (+1^{0}Brix) during heat processing recorded positive effect of heat induced maceration (90^{0}C) for precise tenure ranging from 0 to60min. Whereasdetectableincrease in TSS of tomato puree was also recorded over prolonged heat treatment of puree justifiable for more admissible processing time. Hence data generated from 1-6h processing time depicted in Table 4justifies constant increase in TSSof tomato puree (5to 13.5^{0}Brix). Irrespective of increased trend of TSS content in coordination with prolonged processing time justifies techno-economical infeasibility coiling around higher exposure to heat treatment which is unadvisable.

Table 3: Effect of processing time (15-60min) on lycopene content of tomato puree

Sample	Heat treatment	TSS (^{0}Brix)	Avg. lycopene content (mg/100g)
Control	Without heat treatment	4	2.85
S_4T_1	90^0C for 15min	4	3.24
S_4T_2	90^0C for 30min	4	3.64
S_4 T_3	90^0C for 45min	5	4.26
S_4 T_4	90^0C for 60min	5	4.87

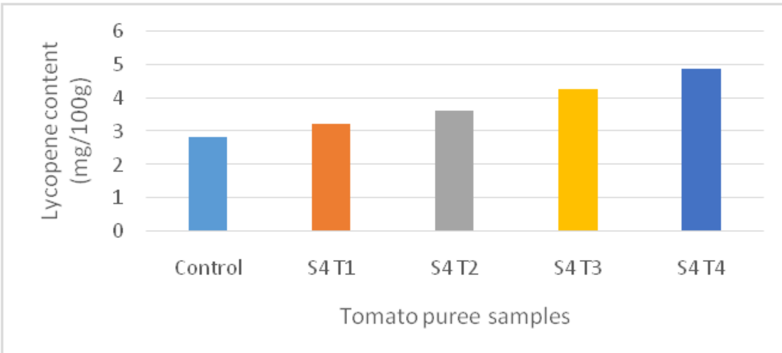

Figure 5: Effect of processing time (15-60min)on lycopene content of tomato puree

Table 4: Effect of processing time (1-6h) on lycopene content of tomato puree

Sample	Heat treatment	TSS (^{0}Brix)	Avg. lycopene content (mg/100g)
Control	Without heat treatment	5	2.97
S_4 T_1	90^0C for 1h	6	5.01
S_4 T_2	90^0C for 2h	7	6.08
S_4 T_3	90^0C for 3h	8.5	7.11
S_4 T_4	90^0C for 4h	9.5	7.92
S_4 T_5	90^0C for 5h	12	8.96
S_4 T_6	90^0C for 6h	13.5	9.13

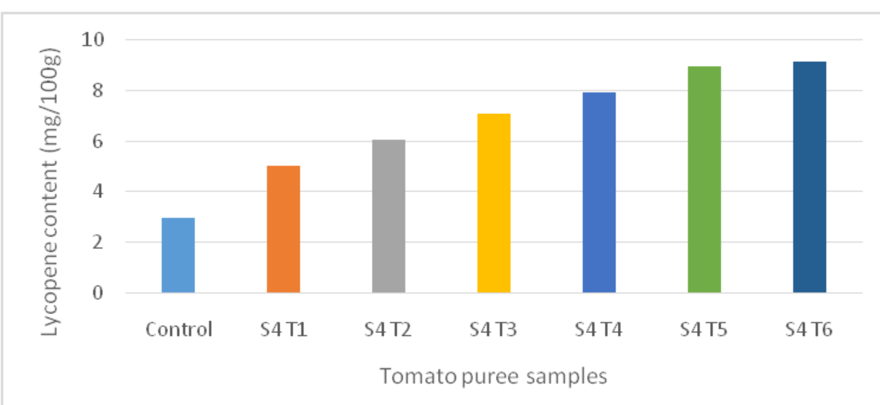

Figure 6: Effect of processing time (1-6h) on lycopene content of tomato puree

Conclusion

Tomato puree heat induced processing technology development is function of loss of integrity of tomato flesh, tissue adhesiveness, temperature, time and controlled conditions. The thermal processing treatment enhances tissue separation resulting in adequate cell maceration and reduces tissue integration of tomato flesh. Progressive cell maceration stimulates lycopene releasing process in coordination with reduced tissue adhesiveness. The worth tenure of 6h as a processing time seems to be unadvisable on the basis of overall lycopene reducingnegative effect of prolonged heat treatment as reported by earlier scientists.This statement may be associated with natural lycopene molecular conversion with impact of surrounding factors (Oxygen, light and heat). The fundamental endeavour of the present investigation is to develop tomato puree processing technology with minimum molecular damage of lycopene for sustainable functional efficacy (antioxidant potential). The standard tomato puree processing technology emerged out from this investigation is characterized by thermal processing of tomato puree at 90^0C temperature for 1h under controlled laboratory conditions. The technology emerged out need to be supported by investigation on *cis* and *trans* isomer quotient effective for minimum deviation in natural antioxidant efficacy.

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