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INFLUENCE ON LEVEL OF LYCOPENE, ANTIOXIDANTS AND OTHER NUTRITIONAL CHANGES ON FORTIFICATION OF LYCOPENE POWDER IN TOMATO JUICE

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ABSTRACT

Tomato juice was fortified with lycopene powder (control, 2, 15, 30 mg/100g), extracted from tomato peel by enzyme-mediated method, and were stored in pre-sterilized 200ml glass bottles at ambient conditions (26.6-32.3 °C and 22.6-53.6 % RH) for 60 days and tested for nutritional changes and sensory evaluation. The treatment of lycopene fortified tomato juice atherate of 30 mg/100g had highest antioxidant activity(23.82 mg Ascorbic Acid Equivalence (AAE)/100g) and it increased at 30th and 60th day (26.37 and 30.23mg AAE/100g respectively).Maximum lycopene content (22.16, 21.49 & 19.39 mg/100g), total phenols (23.10, 21.16 & 18.85mg GAE/100g), protein (16.35, 6.99 & 5.39 mg/100g) and fat content (2.83, 2.28 & 1.89%) was observed in treatment of lycopene fortified tomato juice at rate of 30 mg/100g at 0th, 30th& 60th day and a decreasing trend was shown in these parameters with advancing storage period.

INTRODUCTION

Tomato has drawn the attention of nutrition researchers, as already many epidemiological studies suggested that consumption of tomatoes could plot an important role in preventing cancer, cardiovascular diseases besides many other non-communicable diseases and lifestyle disorders (Giovannucci *et al.*, 1999; Heber, 2000; Rao and Agarwal, 2000; Stewart *et al.*, 2000). Tomato is a rich natural source of vitamin C and antioxidants, whilecomponents like lycopene, phenolic, flavonoids and vitamin C and E are mainly responsible for the antioxidant capacity of raw and processed tomato products (Beutner *et al.*, 2001). Lycopene a precursor of beta-carotene with a well-known antioxidant activity reported to be at least twice that of beta-carotene and stable at low temperature away from light and atmospheric oxygen. Lycopene-rich fruits showed positive hematological activities and can be recommended in the management of anemia and immunity dependent disorders as well as in regulating the cholesterol and triglyceride levels (Kullu *et al.*, 2013). Food fortification or enrichment is the process of adding micronutrients (essential trace elements and vitamins) to food. It can be purely a commercial choice to provideextra nutrients in a food, or sometimes it is a public health policy which aims to reduce the number of people with dietary deficiencies in a population. Vijayanand and Kulkarni (2013) had fortified guava beverages with lycopene and observed that it had stable acceptable sensory quality during thestorage period. In the present experiment, the tomato juice was fortified at different ratios with lycopene powder, which was extracted from tomato peel by the enzyme-mediated method, with the aim to study its influence on the antioxidant activity and also other nutritional qualities of the tomato juice.

MATERIALS AND METHODS

Preparation and fortification of tomato juice

The tomato juice wasprepared using astandard methodology for juice preparation (Lal *et al.*, 1998). The product was fortified using different concentrations of lycopene (control, 2, 15, 30 mg/100g). The product was stored for a period of two months under ambient conditions (26.6-32.3°C and 22.6-53.6 % RH). The samples were analyzed for various quality parameters immediately after preparation and subsequently at monthly intervals upto two months.

Methods of analysis

Total antioxidant activity was measured using FRAP method (Benzie and Strain, 1996), Crude fat estimation was determined by Soxhlet method (de Castro and Capote, 2010) while lycopene content was estimated using spectrophotometer (Ranganna, 1986), protein content was estimated by Lowry's method (Lowry, 1951) and phenols were estimated according to the procedure given by Singleton and Rossi (1965). In order to find out the consumer preference of fortified tomato juice, organoleptic evaluation was done by a panel of trained judges using 9 points hedonic scale (Amerine *et al.*, 1965). All estimations were carried out in triplicate at 30days interval and determinations were made for each attribute and data pertaining were statistically analyzed by using analysis of variance technique of Factorial completely randomized design.

RESULTS AND DISCUSSION

Lycopene content

Initially, the lycopene content of freshly prepared tomato juice was 2.21 mg/100g while highest amount of lycopene was found in treatment 30mg/kg(22.16 mg/100g) (Table 1). During the storage up to 2 months, there was asignificant decrease in lycopene content in all the treatments. The major cause of carotenoid destruction during processing and storage of food is enzymatic and non-enzymatic oxidation. The heat treatment in blanching may aggravate some losses of carotenoids, but the inactivation of oxidative enzymes will prevent further and greater losses during holding before thermal processing, slows processing and storage (Reddy, 2006).

Table 1: Changes in lycopene (mg/100g) of tomato juice fortified with lycopene during storage

Treatments	Lycopene(mg/100g) 0 Days	30 Days	60 Days
Control (T_1)	2.21	1.53	0.78
2 mg lycopene per kg (T_2)	3.43	2.63	1.55
15 mg lycopene per kg (T_3)	15.66	13.97	12.93
30 mg lycopene per kg (T_4)	22.16	21.49	19.39
	CD @ 1%	SEm±	
S	0.57	0.15	
T	0.66	0.17	
S×T	NS	0.29	

S = Storage T = Treatment SxT = Interaction NS = Non significant

Total anti-oxidant activity

The total antioxidant activity of freshly prepared tomato juice was 21.60 mg ascorbic acid equivalence (AAE)/100g while highest was found in the treatment 30mg/kg (23.82 mg AAE/100g) initially. After fortification with extracted lycopene, the antioxidant activity gradually increased and highest amount of antioxidant activity was found in treatment 30mg/kg (30.23 mg AAE/100g) and the lowest in control (28.17 mg AAE/100g)(Table 2). The increase in antioxidant activity could be due to the pro-oxidant activity of peroxides,negated during prolonged storage at ambient temperatures (Gazzani *et al*., 1998) and another could be due to theformation of brown compounds (quinones) as a result of Maillard reaction which occurred during the storage. The Maillard reaction products interfere with the absorbance values while carrying out the estimation of antioxidant activity (Manzocco *et al*., 2001; Nicoli *et al*., 1999).

Phenols

The total phenol content of freshly prepared tomato juice was 22.38 mg Gallic acid equivalence (GAE)/100g while highest was found in the treatment 30mg/kg (23.10mg GAE/100g). After fortification with extracted lycopene, the total phenols gradually decreased and least were found in control (19.25mg GAE/100g) after 60days storage. The phenols in tomato juice were not significantly affected by fortification with lycopene, but the phenols decreased in all the treatments with theadvancement of thestorage period (Table 2). Since tomato pulp was used juice and juices were having a lot of polyphenols and their levelsreduced as phenolic compounds are volatile in nature and get oxidized easily (Gupta *et al*. (2003) and Kaushik *et al*. (2002)).

Table 2: Changes in total antioxidant activity (mg AAE/100g) and total phenols (mg GAE/100g) of tomato juice fortified with lycopene during storage

Treatments	Total Antioxidant activity (mg AAE/100g)			Total Phenols (mg GAE/100g)		
	0 Days	30 Days	60 Days	0 Days	30 Days	60 Days
Control (T_1)	21.6	25.6	28.17	22.38	20.47	19.25
2 mg lycopene per kg (T_2)	21.27	25.47	27.83	22.39	20.78	19.84
15 mg lycopene per kg (T_3)	22.67	25.3	28.95	22.97	20.5	19.9
30 mg lycopene per kg (T_4)	23.82	26.37	30.23	23.1	21.16	18.85
	CD @ 1%	SEm±		CD @ 1%	SEm±	
S	0.77	0.2		0.94	0.24	
T	0.89	0.23		NS	0.28	
S×T	NS	0.39		NS	0.48	

S = Storage ; T = Treatment ; SxT = Interaction; NS = Non significant

Table 3: Changes in proteins (mg/100g) and fats (%) of tomato juice fortified with lycopene during storage

Treatments	Proteins (mg/100g)			Fats (%)		
	0 Days	30 Days	60 Days	0 Days	30 Days	60 Days
Control (T_1)	15.13	5.73	2.7	2.64	2.12	1.88
2 mg lycopene per kg (T_2)	15.57	5.57	2.6	2.74	2.22	1.67
15 mg lycopene per kg (T_3)	16.13	6.29	4.58	2.61	2.19	1.63
30 mg lycopene per kg (T_4)	16.35	6.99	5.39	2.83	2.28	1.89
	CD @ 1%	SEm±		CD @ 1%	SEm±	
S	0.53	0.13		0.13	0.03	
T	0.61	0.15		NS	0.04	
S×T	NS	0.61		NS	0.15	

S = Storage ;T = Treatment; SxT = Interaction; NS = Non significant

Table 4: Changes in appearance and consistency of sensory (organoleptic) quality score for tomato juice fortified with lycopene during storage.

	Appearance			Consistency		
Treatments	0 Days	30 Days	60 Days	0 Days	30 Days	60 Days
Control (T_1)	8.5	8.5	8.63	8.6	8.57	8.67
2 mg lycopene per kg (T_2)	8.67	8.5	8.67	8.77	8.6	8.67
15 mg lycopene per kg (T_3)	8.67	8.63	8.67	8.73	8.67	8.77
30 mg lycopene per kg (T_4)	8.83	8.83	8.83	8.77	8.73	8.9
	CD @ 1%	SEm±		CD @ 1%	SEm±	
S	NS	0.09		NS	0.08	
T	NS	0.11		NS	0.09	
S×T	NS	0.19		NS	0.19	

S = Storage; T = Treatment ; SxT = Interaction; NS = Non significan

Table 5: Changes in taste and overall acceptability of sensory (Organoleptic) quality score for tomato juice fortified with lycopene during storage

	Taste			Overall acceptability		
Treatments	0 Days	30 Days	60 Days	0 Days	30 Days	60 Days
Control (T_1)	8.5	8.3	8.33	8.5	8.07	8.3
2 mg lycopene per kg (T_2)	8.53	8.33	8.33	8.33	8.23	8.23
15 mg lycopene per kg (T_3)	8.47	8.33	7.9	8.4	8.17	8.13
30 mg lycopene per kg (T_4)	8.6	8.5	8.47	8.67	8.2	8.33
	CD @ 1%	SEm±		CD @ 1%	SEm±	
S	NS	0.06		NS	0.1	
T	NS	0.07		NS	0.12	
S×T	NS	0.13		NS	0.2	

S = Storage; T = Treatment ; SxT = Interaction; NS = Non significant

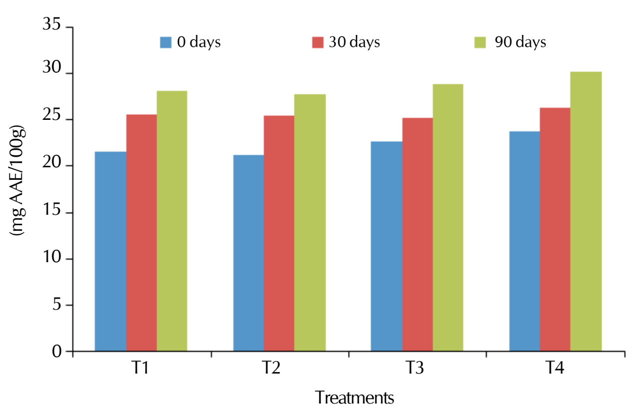

Figure 1: Effect of different treatments on total antioxidant activity (mg AAE/100g) of tomato juice fortified with lycopene during storage

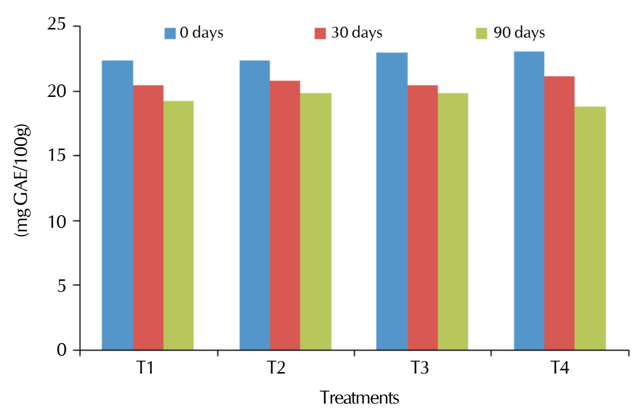

Figure 2: Effect of different treatments on total phenols (mg GAE/ 100g) of tomato juice fortified with lycopene during storage

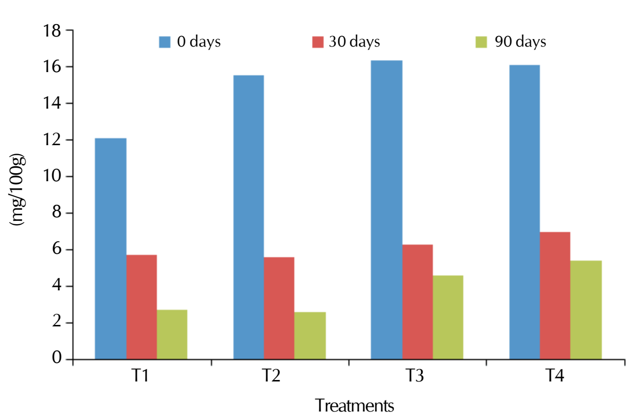

Figure 3: Effect of different treatments on proteins of tomato juice fortified with lycopene during storage

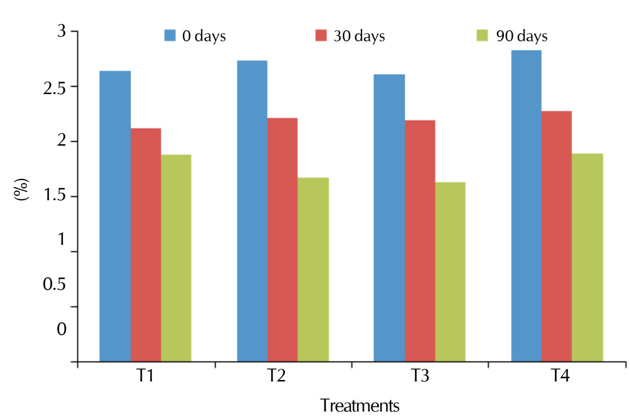

Figure 4: Effect of different treatments on fat content of tomato juice fortified with lycopene during storage

Protein content

The protein content of freshly prepared tomato juice was 15.13 mg/100g while initially maximum protein content value was found in treatment after fortification with extracted 30mg/kg lycopene (16.35 mg/100g). The protein content significantly decreased in all the treatments and least was found in treatment 2mg/kg (2.60 mg/100g) after 60 days of storage (Table 3). Reduction in protein content is due to reaction with non-protein components of the food system, *i.e.*, interaction of theprotein with carbohydrates or secondary lipid oxidation products, or by inter and intra-protein reactions in the presence or absence of oxygen (Manoranjan and Sood, 2007).

Fat content

The fat content of freshly prepared tomato juice was 2.64 percent while the maximum fat content was found in the treatment after fortification with extracted 30mg/kg lycopene from 0^{th} day to 60^{th} day (Table 3).There was asmall variation between the treatments which shows statistically non-significant but with increasing the storage period the fat content in all the treatments was found significant decrease may be due to oxidation. The reduction in fat levels is mainly due to rancidification caused by enzymatic hydrolysis by the production of free fatty acids and by oxidative rancidity which involvesautolysis chemical reaction with atmospheric oxygen characterized by the production of peroxides (Manoranjan and Sood, 2007).

Sensory (organoleptic) score

This includes scores of appearance, consistency, taste and overall acceptability, which determine the marketability of the product. During the storage period of 2 months the product appearance (color), taste, consistency and overall acceptability was found statistically non-significant between the treatments and the overall score for all the treatments and during the storage period was maintained at anacceptable range (Table 4 and 5). Similar results were observed by Yadav *et al*. (2015).

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