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

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ABSTRACT
In the experiment the tomato soup was fortified with different concentrations (control, 2, 15, 30 mg/100g) of tomato soup was with lycopene powder, extracted from extracted from tomato peel by enzyme mediated method. The fortified soups were stored in pre-sterilized 200ml glass bottles at ambient conditions (26.6-32.3°C ad 22.6-53.6 % RH) for 60 days and tested for nutritional changes and sensory evaluation. The treatment of lycopene fortified tomato soup at rate of 30 mg/100g had highest antioxidant activity (12.53 mg Ascorbic Acid Equivalence(AAE)/100g) and it increased at 30th and 60th day (18.77 and 23.04mg AAE/100g respectively). Maximum lycopene content (18.17, 17.31 and 15.97 mg/100g), total phenols (23.01, 22.87 and 21.45 mg GAE/100g), protein (8.71, 6.27 2.97 mg/100g) and fat content (6.14, 5.91 and 5.05 %) was observed in treatment of lycopene fortified tomato soup at rate of 30 mg/100g at 0th, 30th and 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 life style 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, while components like lycopene, phenolics, 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 haematological 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 provide extra nutrients in a food, or sometimes it is a public health policy which aims to reduce numbers 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 storage period. In the present experiment the Tomato soup was fortified at different ratios with lycopene powder, which was extracted from tomato peel by enzyme mediated method, with aim to study its influence on the antioxidant activity and also other nutritional qualities of the tomato soup.

MATERIALS AND METHODS

Preparation and fortification of tomato soup

The tomato soup was prepared using standard methodology for soup preparation (Lal *et al.*, 1998). The product were fortified using different concentrations of lycopene (control, 2, 15, 30 mg/100g). The product were 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 up to two months.

Methods of analysis

Total anti-oxidant 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 soup juice, organoleptic evaluation was done by panel of trained judges using 9 point hedonic scale (Amerine *et al.*, 1965). All estimations were carried out in triplicate at 30 days 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 soup was 1.28 mg/100g, while highest amount of lycopene was found in treatment 30mg/kg (18.17 mg/100g) (Table 1). During the storage up to 2 months there was significant 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 soup fortified with lycopene during storage

Treatments	Lycopene (mg/100g)		
	0 Days	30 Days	60 Days
Control (T_1)	1.28	0.99	0.58
2 mg lycopene per kg (T_2)	2.51	2.00	1.49
15 mg lycopene per kg (T_3)	11.53	10.34	8.82
30 mg lycopene per kg (T_4)	18.17	17.31	15.97
	CD @ 1%	SEm ±	
S	0.44	0.11	
T	0.51	0.13	
ST	0.89	0.22	

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

Total anti-oxidant activity

The total antioxidant activity of freshly prepared tomato soup was 9.72 mg ascorbic acid equivalence (AAE)/100g, while highest was found in the treatment 30mg/kg (12.53 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 (23.04 mg AAE/100g) and the lowest in control (21.00 mg AAE/100g). 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 formation 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 anti-oxidant activity (Manzocco *et al.*, 2001; Nicoli *et al.*, 1999).

Phenols

The total phenol content of freshly prepared tomato soup was 22.38 mg Gallic acid equivalence (GAE)/100g, while highest was found in the treatment 30mg/kg (23.01 mg GAE/100g) . After fortification with extracted lycopene the total phenols gradually decreased and least were found in control (18.54 mg GAE/100g) after 60 days storage. The phenols in tomato soup were not significantly affected by fortification with lycopene, but the phenols decreased in all the treatments with advancement of storage period (Table 2). Since tomato pulp was used soup and juices were having lot of polyphenols and their levels reduced as phenolic compounds are volatile in nature and get oxidized easily (Gupta *et al.* (2003) and Kaushik

Table 2: Changes in total antioxidant activity (mg AAE/100g) and total phenols (mg GAE/100g) of tomato soup 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)	9.72	15.52	21.00	22.38	19.11	18.54
2 mg lycopene per kg (T_2)	10.37	15.76	22.10	20.86	19.84	18.58
15 mg lycopene per kg (T_3)	10.88	17.06	23.00	22.13	20.32	19.49
30 mg lycopene per kg (T_4)	12.53	18.77	23.04	23.01	22.87	21.45
	CD @ 1%	SEm ±		CD @ 1%	SEm ±	
S	0.63	0.16		0.13	0.23	
T	0.73	0.18		1.07	0.27	
ST	NS	0.32		NS	0.47	

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

Table 3: Changes in protein content (mg/100g) and fat content (%) of tomato soup fortified with lycopene during storage

Treatments	Protein content (mg/100g)			Fat content (%)		
	0 Days	30 Days	60 Days	0 Days	30 Days	60 Days
Control (T_1)	6.15	4.24	1.97	6.04	5.84	5.03
2 mg lycopene per kg (T_2)	6.07	4.89	1.94	6.10	5.86	5.03
15 mg lycopene per kg (T_3)	7.72	5.69	2.59	6.07	5.80	5.00
30 mg lycopene per kg (T_4)	8.71	6.27	2.97	6.14	5.91	5.05
	CD @ 1%	SEm ±		CD @ 1%	SEm ±	
S	0.48	0.12		0.11	0.03	
T	0.55	0.14		NS	0.03	
ST	0.96	0.24		NS	0.05	

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

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

Treatments	Appearance			Consistency		
	0 Days	30 Days	60 Days	0 Days	30 Days	60 Days
Control (T_1)	8.67	8.00	8.50	8.17	8.00	8.33
2 mg lycopene per kg (T_2)	8.17	8.30	8.50	8.00	8.33	8.67
15 mg lycopene per kg (T_3)	8.50	8.17	8.50	8.17	8.33	8.33
30 mg lycopene per kg (T_4)	8.50	8.50	8.67	8.67	8.67	8.67
	CD @ 1%	SEm ±		CD @ 1%	SEm ±	
S	NS	0.11		NS	0.10	
T	NS	0.12		NS	0.11	
ST	NS	0.22		NS	0.19	

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

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

Treatments	Taste			Overall acceptability		
	0 Days	30 Days	60 Days	0 Days	30 Days	60 Days
Control (T_1)	8.17	7.83	8.00	7.83	7.83	8.13
2 mg lycopene per kg (T_2)	7.67	8.00	8.00	8.00	8.47	8.17
15 mg lycopene per kg (T_3)	8.00	8.33	8.17	8.07	8.17	8.00
30 mg lycopene per kg (T_4)	8.00	8.17	8.33	8.07	8.20	8.67
	CD @ 1%	SEm ±		CD @	1% SEm ±	
S	NS	0.12		NS	0.14	
T	NS	0.14		NS	0.16	
ST	NS	0.24		NS	0.28	

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

et al. (2002)).

Protein content

The protein content of freshly prepared tomato soup was 6.15 mg/100g, while initially maximum protein content value was found in treatment after fortification with extracted 30mg/kg lycopene (8.71 mg/100g). The protein content significantly decreased in all the treatments and least was found in treatment 2mg/kg (1.94 mg/100g) after 60 days of storage. Reduction in protein content is due to reaction with non-protein components of the food system, *i.e.*, interaction of protein 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 soup was 6.04 percent, while the maximum fat content was found in the treatment after fortification with extracted 30mg/kg lycopene from 0th day to 60th day. There was small 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 involves autolysis 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 (colour), 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 acceptable range (Table 4 and 5). Similar results were observed by Yadav *et al*. (2015).

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