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Development and Quality Characteristics Studies of Tomato Paste Stored at Different Temperatures

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Abstract: A comparative study was done to determine the most suitable storage temperature for tomato paste at which there would be minimum damage to the product quality. Tomato paste samples were prepared, 0.1% sodium benzoate preservative added, stored at 25°C, 6°C and -10°C and were analyzed for chemical parameters as well as subjected to sensory evaluation at 30 days storage intervals till 240 days. A gradual increase in Total Soluble Solids (TSS) and acidity was observed during storage whereas pH and ascorbic acid were decreased. These changes were more pronounced at 25°C than at 6°C and -10°C. Results of sensory evaluation revealed that samples stored at lower temperatures such as 6°C and -10°C remained acceptable after 240 days storage. However, samples were rejected organoleptically at higher temperature storage i.e. 25°C.

Key words: Tomato paste, chemical analysis, sensory evaluation, temperature, storage studies

INTRODUCTION

Tomato (*Lycopersicon esculentum* L.*)* is considered as prize vegetable in western countries and extensively used in fresh condition as well as in the preparation of various food products. In Pakistan, tomato is one of the major vegetables grown at an area of 47.1 thousand hectre with total production 502.3 metric tons during 2006-07 (GOP, 2008). Tomato represents an essential part of human diet. It is a good nutritional resource rich in vitamin C and antioxidant mainly lycopene, carotenes, organic acids and phenolics (Giovanelli and Paradiso, 2002). Consumption of beta-carotene and lycopene, has been related to lower incidence of cardiovascular disease and prostate, gastrointestinal and epithelial cell cancer (Ishida and Chapman, 2004; Rao and Rao, 2007). Organic acids which influence its shelf-life and organoleptic properties such as colour brightness and texture contribute to acid-base balance for the consumer (Adedeji *et al*., 2006); while plant phenolics can have anti-inflammatory, anti-allergic and anti-thrombotic properties and may be beneficial in cardiovascular, neoplastic and neurological pathologies (Kuskoski *et al*., 2005).

In Pakistan, about 20% of the tomato produce are wasted due to negligence, defective marketing system and lack of processing facilities. During the peak season tomato sells at low prices due to larger supplies "glut" resulting in less return to growers. With the spread of education, change in habits of populace, growth in working women force and increase in per capita income and urbanization, the demand for processed vegetable/fruit products is increasing progressively. Tomato is processed in the forms of pulp, paste, juice, ketchup, sauce and purée (Hayes *et al*., 1998). It has a limited storage life and cannot be stored over extended periods. The problem is further compounded by lack of cold chain system. Conversion of tomato into paste provides a way out for extended shelf life/storage periods. Food processors store tomato pulp under conditions available in their premises. It has been observed that temperatures varying from as high as 20-40°C, refrigeration (4-10°C) to as low as -20°C are employed for storage purpose. High temperature storage is detrimental to product quality while lower temperature adds cost to the product (Jamil, 1990). Therefore a study had been designed to determine the suitable temperature for tomato paste storage at which there would be minimum damage to the product quality.

MATERIALS AND METHODS

Fully matured tomatoes of "Roma" variety were procured from wholesale market and taken to Food Quality and Nutrition Program (FQNP) Lab. National Agricultural Research Centre (NARC). Fresh tomatoes were sorted, washed and blanched at 90°C for 5 min, passed through a pulper using sieve of 0.058 cm dia holes and vacuum concentrated at 85°C for 34 min to 26 °brix paste as described by Apaiah and Barringer (2007). Sodium benzoate @ 0.1% was added as preservative. Tomato paste was immediately filled in pre-sterilized glass bottles, capped airtight, processed in boiling water for ten minutes and subsequently cooled. It was stored at room temperature (25°C), refrigerated (6°C) and freezing (-10°C) temperature. Chemical and sensory analysis of tomato paste was carried out just after processing and at 30 days intervals till storage period of 240 days.

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Chemical analysis: Tomato paste samples were analyzed for Total Soluble Solids (TSS), percent acidity, pH and ascorbic acid according to standard procedures described by AOAC (2007). Total Soluble Solids of tomato paste were estimated by using Abbe refractometer (ATAGO 3T) and the readings were corrected at 20°C whereas, pH was measured by digital pH meter (Orion 420 A^+).

Sensory evaluation: Sensory evaluation of tomato paste was carried out for colour, taste, flavour and overall acceptability by a panel of seven judges at intervals of 0, 30, 60, 90, 120, 150, 180, 210 and 240 days. Samples were presented in succession and panelists were asked to rate evaluation variables according to 9- point Hedonic scale as described by Larmond (1977).

Statistical analysis: The data obtained for each parameter was subjected to statistical analysis according to methods described by Steel *et al.* (1996) using Statisca software.

RESULTS AND DISCUSSION

Tomato paste samples stored at three different temperatures i.e. 25°C, 6°C and -10°C were analyzed for changes in total soluble solids, percent acidity, pH, ascorbic acid as well as sensory attributes. The composition of tomato paste (Table 1) was found within limits prescribed by Codex Alimentarius Commission (1981).

Chemical characteristics: Data regarding changes in total soluble solids of tomato paste during storage reveals that there was a gradual increase in T.S.S. throughout the storage period at all the storage temperatures (Table 1). Maximum increase (5.36%) was observed in samples stored at 25°C, whereas samples stored at -10°C had the minimum increase (2.28%). Thus the increase in T.S.S. was more in tomato paste samples stored at higher temperature than at lower temperature. Increase in T.S.S. during storage may be due to acid hydrolysis of polysaccharides especially gums and pectin (Luh and Woodroof, 1975).

Percent acidity of tomato paste stored at different temperatures exhibited a gradual increase throughout the storage period (Table 1). However, rise in acidity was more at higher temperature than at lower temperature. Highest increase (18.39%) was recorded in samples stored at 25°C followed by 6°C storage conditions (10.34%), while least increase (7.47%) occurred in samples stored at -10°C. Increase in titratable acidity of tomato paste may be due to acids produced by *Bacilus coagulans*, *Clostridium butyricum* and as a result of phenolic compounds produced by *Bacillus coagulans*. It may also be due to oxidation of alcohol and aldehyde during processing and is influenced by storage temperature, higher the temperature greater the increase in acidity (Gould, 1992).

As regards pH of tomato paste held at different temperatures, a decreasing trend was observed during the storage period (Table 1). The overall decrease in pH was maximum (4.63%) and minimum (2.19%) in samples stored at 25°C and at -10°C respectively. The temperature influences the decrease in pH. Change in pH is directly related to change in acidity of samples. Similar findings were reported by Ahmad (1997) during his study on tomato concentrate.

It is evident from the data on ascorbic acid content of tomato paste stored at different temperatures that there was a gradual and considerable decline in ascorbic acid throughout the storage period at all temperatures (Table 1). The declining trend was more pronounced (87.10%) at higher temperature i.e. 25°C and least (32.25%) in paste samples stored at -10°C. Ascorbic acid may be destroyed by oxidation, especially at higher temperature. Its stability is greatly influenced by temperature, oxygen and metal ion content. Vitamin C is the most labile of the nutrients, so its degradation is used as an indicator of quality (Smith and Hui, 2004). The losses of ascorbic acid is probably attributable to oxidation of ascorbic acid to dehydroascorbic acid followed by hydrolysis of the latter to 2,3-diketogluconic acid, which then undergoes polymerization to other nutritionally inactive products (Dewanto *et al.*, 2002).

Sensory evaluation: Tomato paste samples stored at different temperatures were sensory evaluated at 30 days interval for colour, taste, flavour and overall acceptability (Table 2). A decreasing trend in sensory scores of tomato paste samples was observed at all temperatures with the length of time. However, decline was more prominent in samples stored at higher temperature. As regards colour, a gradual decrease was observed with highest loss in colour (47.29%) in samples stored at 25°C and least loss (22.77%) at -10°C. The colour score of tomato paste samples reveals that after 240 days storage, samples stored at 25°C were rejected (4.19), at 6°C neither liked nor disliked (5.57), whereas samples were still acceptable (6.14) at -10°C storage condition. In addition to degradation of lycopene by an auto catalytic mechanism, darkening occurs during storage due to non-enzymatic browning (Mudahar *et al.*, 1986).

In case of changes in taste as affected by storage conditions, a gradual decline was observed throughout the storage period being maximum (46.85%) and minimum (21.26%) in samples stored at 25°C and -10°C respectively. Mean score for taste (4.05) was below acceptable range and thus rejected at 25°C while samples stored at -10°C got the acceptable taste score (6.00) after 240 days storage. With respect to flavour of

Table 1: Effect of storage time and temperature on TSS, acidity, pH and ascorbic acid content of tomato paste

Storage interval	TSS (%)			Acidity (%)			pH			Ascorbic acid (mg/100g)		
(Days)	25°C	6°C	-10°C	25°C	6°C	-10°C	25°C	6°C	-10°C	25°C	6°C	-10°C
0	26.30	26.30	26.30	1.74	1.74	1.74	4.10	4.10	4.10	31.00	31.00	31.00
	±0.10	±0.10	±0.10	±0.03	±0.03	±0.03	±0.02	±0.02	±0.02	±3.00	±3.00	±3.00
30	26.41	26.37	26.35	1.77	1.75	1.75	4.08	4.09	4.09	26.00	29.00	30.00
	±0.09	±0.08	±0.07	±0.02	±0.01	±0.01	±0.02	±0.01	±0.01	±2.64	±2.00	±2.00
60	26.62	26.48	26.42	1.81	1.77	1.76	4.06	4.07	4.08	23.00	27.00	29.00
	±0.06	±0.05	±0.05	±0.02	±0.02	±0.01	±0.02	±0.02	±0.02	±2.00	±3.00	±2.64
90	26.79	26.63	26.48	1.84	1.79	1.78	4.05	4.06	4.08	19.00	25.00	29.00
	±0.06	±0.06	±0.06	±0.02	±0.01	±0.02	±0.01	±0.02	±0.01	±4.00	±2.00	±2.00
120	26.90	26.72	26.58	1.86	1.82	1.80	4.03	4.05	4.07	15.00	24.00	28.00
	±0.05	±0.07	±0.08	±0.01	±0.02	±0.01	±0.02	±0.02	±0.01	±3.00	±1.00	±1.53
150	27.02	26.80	26.65	1.90	1.84	1.82	4.01	4.04	4.06	12.00	22.00	26.00
	±0.06	±0.05	±0.10	±0.02	±0.01	±0.01	±0.02	±0.01	±0.01	±3.00	±2.00	±2.00
180	27.23	26.90	26.74	1.95	1.86	1.83	3.98	4.02	4.04	9.00	21.00	25.00
	±0.07	±0.05	±0.08	±0.01	±0.02	±0.01	±0.03	±0.02	±0.02	±2.00	±2.64	±1.53
210	27.48	27.08	26.80	2.00	1.89	1.85	3.95	4.00	4.02	7.00	18.00	23.00
	±0.07	±0.08	±0.10	±0.03	±0.02	±0.02	±0.02	±0.02	±0.01	±1.00	±2.00	±2.00
240	27.71	27.20	26.90	2.06	1.92	1.87	3.91	3.99	4.01	4.00	17.00	21.00
	±0.08	±0.09	±0.12	±0.02	±0.01	±0.01	±0.03	±0.01	±0.01	±1.53	±2.00	±1.00

All values are mean of three replications

Table 2: Effect of storage time and temperature on sensory attributes of tomato paste

Storage interval	Colour			Taste			Flavour			Overall acceptability		
Days	25°C	6°C	-10°C	25°C	6°C	-10°C	25°C	6°C	-10°C	25°C	6°C	-10°C
0	7.95	7.95	7.95	7.62	7.62	7.62	7.71	7.71	7.71	7.67	7.67	7.67
	±0.22	±0.22	±0.22	±0.22	±0.22	±0.22	±0.14	±0.14	±0.14	±0.22	±0.22	±0.22
30	7.71	7.71	7.90	7.38	7.48	7.57	7.43	7.57	7.62	7.43	7.57	7.62
	±0.14	±0.14	±0.17	±0.09	±0.08	±0.14	±0.14	±0.14	±0.16	±0.14	±0.14	±0.16
60	7.09	7.48	7.71	7.00	7.33	7.43	6.91	7.28	7.43	7.00	7.38	7.48
	±0.21	±0.08	±0.14	±0.28	±0.09	±0.14	±0.08	±0.28	±0.14	±0.14	±0.17	±0.08
90	6.76	7.28	7.43	6.62	7.14	7.28	6.67	7.00	7.19	6.67	7.14	7.28
	±0.30	±0.14	±0.14	±0.16	±0.14	±0.14	±0.17	±0.14	±0.16	±0.17	±0.14	±0.14
120	6.38	6.95	7.14	6.24	6.86	7.09	6.43	6.71	6.95	6.33	6.81	7.05
	±0.22	±0.22	±0.28	±0.17	±0.28	±0.16	±0.14	±0.14	±0.22	±0.09	±0.17	±0.08
150	6.14	6.81	7.00	6.00	6.67	6.81	6.19	6.48	6.71	6.14	6.67	6.86
	±0.14	±0.22	±0.14	±0.14	±0.17	±0.17	±0.16	±0.08	±0.14	±0.14	±0.17	±0.14
180	5.62	6.47	6.67	5.19	6.28	6.62	5.57	6.14	6.38	5.47	6.38	6.57
	±0.22	±0.22	±0.22	±0.22	±0.14	±0.22	±0.29	±0.14	±0.09	±0.22	±0.17	±0.14
210	5.00	6.05	6.43	4.38	6.00	6.33	4.66	5.86	6.14	4.71	6.00	6.33
	±0.14	±0.21	±0.14	±0.17	±0.14	±0.09	±0.08	±0.14	±0.28	±0.14	±0.28	±0.09
240	4.19	5.57	6.14	4.05	5.33	6.00	4.00	5.47	5.90	4.05	5.52	6.00
	±0.16	±0.29	±0.14	±0.21	±0.09	±0.14	±0.14	±0.17	±0.17	±0.16	±0.16	±0.14

All values are mean of three replications

tomato paste held at different storage conditions, a gradual loss was observed throughout the storage period. Flavour loss was highest (48.12%) in samples stored at 25°C followed by samples (29.05%) stored at 6°C. The flavour of tomato paste stored at 25°C was disliked (4.00) and therefore rejected by sensory panel after 240 days storage. The Maillard reaction is the major mode of deterioration during storage of canned fruit and vegetable products and leads to a bitter off-flavour (OTA, 1979) Changes in flavour are the most sensitive index to quality deterioration during storage followed by colour (Eckerle *et al*., 1984). For overall acceptability score of tomato paste, the decreasing trend was more rapid (47.20%) and slower (21.77%) in samples stored at 25°C and -10°C respectively. The overall acceptability score of tomato paste samples shows that after 240 days storage, at 25°C samples stored were rejected (4.05), at 6°C neither liked nor disliked (5.52), whereas samples remained acceptable (6.00) at -10°C storage condition.

Conclusion: It was concluded that tomato paste could be stored at varying storage condition for 240 days with minimum damage to the product quality at lowest possible cost. It may be stored even for longer periods at low temperature such as 6°C and -10°C. During sensory studies, it was observed that samples stored at lower temperatures such as 6°C and -10°C remained acceptable after 240 days storage. However, samples were rejected organoleptically at higher temperature storage i.e. 25°C.

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