Research Article

Recipes for Production of Litchi Squash and Storage Behavior at Different Conditions

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Abstract

Litchi fruit is rich source of ascorbic acid, phenols and minerals like potassium, phosphorus etc. The present study was undertaken for development of recipe for production of squash from litchi cv. Shahi fruit and its quality evaluation during storage. Various combinations of juice, sugar syrup/ T.S.S. and ascorbic acid were tried to standardized proper combination for squash. The litchi squash prepared by different combination of recipe were packed in PET (Polyethylene teraphthalate) bottles and stored at ambient (25-37 °C) and refrigerated condition (5-7 °C). It has been found that the best selected recipe (30% litchi juice, 40 to 45°Brix sugar syrup and 25mg ascorbic acid) of litchi squash can be safely stored for a period of 6 months under ambient conditions and 9 months under refrigerated conditions without much change in quality parameters. The various quality parameters increased/ decreased like T.S.S. (40 to 46.35 °B), titratable acidity (0.89 to 0.60 %), ascorbic acid (69.08 to 7.33 mg/100ml) and non enzymatic browning value (0.058 to 0.126) during storage. The maximum sensory evaluation scores like colour (8.25), taste (8.0), aroma (8.35) and overall acceptability (8.15) was observed under the squash prepared from best combination of recipe even after six month of storage.

Keywords: Ascorbic acid, Juice, litchi, squash, storage

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Introduction

Litchi is a rich source of vitamins and minerals as well as a powerful antioxidant. Litchis contain Vitamin K, Vitamin B6, and more Vitamin C (more than citrus fruit), Niacin, Riboflavin, Thiamin and Folate. Minerals abundant in the litchi fruit include Magnesium, Iron, Calcium, Copper, Phosphorous and Potassium. It is low in Sodium, saturated fat and cholesterol. They are also purported to have some anti-inflammatory properties, aid in gastrointestinal health, and have as much fiber as an apple [1]. Litchi is highly perishable and susceptible to browning and rotting besides very short period of availability. It is negligibly exploited at post harvest level for processing and value addition of fruits in India [2]. The value addition to fruits and vegetables through processing is as low as 7 percent in India as against 23 percent in China and 88 percent in U.K. This situation would normally encourage effort to develop various litchi products like various beverages (fruits/juices, squash, wines), nut, resin etc.

Storage of litchi and its processing is one of the main challenges for litchi traders and processors because of its browning and discoloration during subsequent storage [3]. To insure year round availability of litchi products and reduce huge post-harvest losses, viable processing technology needs to be developed and promoted to transform raw materials into products particularly squash. This product can be prepared by a medium level entrepreneur and consumer can be benefited by getting tasty and nutritious drink throughout the year. Considering all these facts the present study has been carried out to standardize the recipe of litchi squash for better quality and shelf life.

Materials and Methods

The fully ripe and healthy fruits of litchi cv. Shahi were harvested from experimental block of ICAR-NRC on Litchi, Mushari, Muzaffarpur farm for physio-chemical analysis and juice extraction. The extracted juice was preserved with 750 ppm of sulphur dioxide and 1.0% citric acid. The fresh litchi pulp/ juice was used for preparation of squash by mixing different concentration of juice (25 & 30%), sugar syrup/ TSS (40 & 45 °B) and ascorbic acid (25 & 50 mg/100ml) as given in **Table 1**. A constant amount of potassium metebisulphite (500ppm) was also added to all the treatments. The squash prepared were packed in fresh and clean PET bottles of 700 ml. They were divided into two lots and one lot was stored at ambient storage (25-37 °C) and another at refrigerated storage (5-7 °C).

The physico-chemical and sensory characteristics were analysed at periodic interval (0, 3, 9 months) during storage. The TSS (Total soluble solids) was measured with digital hand refractometer, titratable acidity and ascorbic

acid content of the samples was determined according to Ranganna [4]. Non enzymatic browning was measured in terms of optical density at 420nm by procedure of Ranganna [4]. Nine point hedonic rating [5] for conducting the sensory evaluation of litchi squash. The panel of ten judges comprising of faculty members and young professionals of the National Research Centre on Litchi (NRCL), Muzaffarpur were selected to evaluate the products.

Table 1 Treatment combinations

Treatments	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**T_9**	**T_{10}**	**T_{11}**	**T_{12}**
Juice (%)	25	25	25	25	25	24	30	30	30	30	30	30
Sugar Syrup (%)	40	40	40	45	45	45	40	40	40	45	45	45
Ascorbic acid (mg/100 ml)	0	25	50	0	25	50	0	25	50	0	25	50

The experiment was carried out at post harvest laboratory of NRC on Litchi, Muzaffarpur, Bihar. The treatments were laid out in completely randomized design (CRD) for statistical analysis of data on physico-chemical characteristics of squash, where as randomized block design for sensory parameters.

Results and Discussion

Physico-chemical characteristics

The chemical changes of litchi squash during storage are presented in **Tables 2-5**. The various recipes had significant effect on the TSS and ascorbic acid; however the variation in TSS and ascorbic acid content of the squash is due to different level of these constituents maintained initially in the squash. An increasing trend in TSS level (40 to 46.35 °B) was recorded (Table 2 and 3) throughout the storage period; however the rate of increase was slower at refrigerated condition as compare to ambient storage. This slight increase in TSS could be due to hydrolysis of polysaccharides into monosaccharide and disaccharides. Similar results were also observed during storage in the squash prepared from sapota, jackfruit, and pomegranate by Relekar et al. [6], Shwetha and Ranganna [7], Thakur et al. [8]. Irrespective of various concentrations of different constituents of the squash, the titratable acidity showed slight decrease during storage which was higher under ambient storage as compare to refrigerated conditions. This might be attributed to the utilization of acids for converting polysaccharides and hexose sugar in the presence of metal ions as reported by Srinivas et al., [9]. Ascorbic content in the squash decreased significantly during storage; however the decrease was lower under refrigerated conditions (Tables 4 and 5) as ascorbic acid is highly sensitive to heat. T_3, T_6, T_9 and T_{12}, treatments showed highest ascorbic content (45.52, 46.92, 52.09 and 51.67 mg/1ooml) at refrigerated condition and 40.42, 40.86, 45.00 and 44.23 mg/100 ml respectively at ambient condition after six months of storage which is due to effect of recipe. The decrease in ascorbic acid content could be attributed to its degradation into dehydro-acorbic acid or furfural during storage. The non enzymatic value increased significantly during storage which was slower under refrigerated conditions than ambient conditions (Tables 4 and 5). The treatments containing ascorbic acid showed less browning as optical density (OD) value was found minimum (0.072 to 0.079) after six month of storage at ambient condition as compared to treatments not having ascorbic acid (0.102 to 0.126). This might be increased rate of oxidation of acids and maillard reaction at room temperature.

Table 2 Change in chemical composition of litchi squash during ambient storage (25-37°C)

Treatments	**Total soluble solids (°Brix)**			**Acidity (%)**		
	Storage period (in months)			**Storage period (in months)**		
	0	**3**	**6**	**0**	**3**	**6**
T_1	40.01	40.35	40.63	0.82	0.70	0.62
T_2	40.02	40.45	41.10	0.85	0.78	0.75
T_3	40.00	40.56	41.08	0.89	0.82	0.78
T_4	45.00	45.64	45.95	0.86	0.69	0.64
T_5	45.00	45.72	46.08	0.88	0.79	0.76
T_6	45.01	45.85	46.05	0.89	0.80	0.79
T_7	40.02	40.33	40.70	0.84	0.71	0.63
T_8	40.00	40.52	40.76	0.90	0.80	0.77
T_9	40.01	40.65	40.80	0.88	0.82	0.79
T_{10}	45.02	45.60	45.81	0.86	0.68	0.60
T_{11}	45.00	45.74	46.18	0.90	0.79	0.75
T_{12}	45.01	45.84	46.35	0.91	0.81	0.78
CD @ 5%	Tr.- 0.37, Period-0.28, T x P-NS			Tr.- 0.020, Period-0.019, T x P-NS		

Table 3 Change in chemical composition of litchi squash during refrigerated storage (5-7°C)

Treatments	Total soluble solids (°Brix)				Acidity (%)			
	Storage period (in months)				Storage period (in months)			
	0	3	6	9	0	3	6	9
T_1	40.01	40.06	40.34	40.85	0.81	0.76	0.70	0.60
T_2	40.02	40.14	41.94	41.26	0.85	0.82	0.78	0.75
T_3	40.00	40.26	40.88	41.23	0.89	0.84	0.80	0.77
T_4	45.00	45.24	45.56	45.78	0.86	0.80	0.74	0.63
T_5	45.02	45.46	45.78	46.20	0.88	0.85	0.81	0.77
T_6	45.01	45.54	45.70	46.10	0.89	0.86	0.82	0.76
T_7	40.02	40.11	40.31	40.96	0.84	0.81	0.70	0.61
T_8	40.00	40.42	40.65	41.25	0.90	0.86	0.83	0.76
T_9	40.01	40.44	40.62	41.02	0.88	0.84	0.80	0.78
T_{10}	45.02	45.200	45.65	46.00	0.86	0.81	0.71	0.64
T_{11}	45.00	45.54	46.02	46.30	0.90	0.88	0.85	0.78
T_{12}	45.01	45.48	40.95	46.21	0.89	0.87	0.84	0.77
CD @ 5%	Tr.- 0.42, Period-0.21, T x P-NS				Tr.-0.018, Period- 0.023, T X P- NS			

Table 4 Change in chemical composition of litchi squash during ambient storage (25-37°C)

Treatments	Ascorbic acid (mg/100ml)			Non enzymatic browning (OD unit)		
	Storage period (in months)			Storage period (in months)		
	0	3	6	0	3	6
T_1	15.63	10.33	07.33	0.048	0.055	0.106
T_2	40.37	32.12	28.08	0.054	0.051	0.072
T_3	60.06	50.20	40.42	0.043	0.050	0.070
T_4	15.56	10.05	07.57	0.056	0.068	0.109
T_5	40.50	34.10	28.56	0.053	0.060	0.075
T_6	60.66	50.36	40.86	0.055	0.061	0.074
T_7	19.37	13.12	08.96	0.056	0.066	0.112
T_8	43.26	36.08	27.60	0.052	0.062	0.076
T_9	66.66	55.20	45.00	0.054	0.061	0.077
T_{10}	19.66	12.36	08.57	0.058	0.069	0.126
T_{11}	44.12	36.33	29.22	0.055	0.060	0.079
T_{12}	67.08	57.37	44.23	0.053	0.060	0.078
CD @5%	Tr.-4.67, Priod-2.52, T x P- NS			Tr.-0.016, Period-0.012, T x P-NS		

Table 5 Change in chemical composition of litchi squash during ambient storage (5-7°C)

Treatments	Ascorbic acid (mg/100ml)			Non enzymatic browning (OD unit)		
	Storage period (in months)			Storage period (in months)		
	0	3	6	0	3	6
T_1	15.63	12.37	10.05	0.047	0.051	0.076
T_2	40.37	36.43	29.69	0.053	0.055	0.068
T_3	60.60	53.27	45.52	0.055	0.058	0.070
T_4	15.56	12.44	10.08	0.055	0.060	0.082
T_5	40.50	34.16	30.26	0.062	0.065	0.070
T_6	60.66	51.55	46.92	0.060	0.063	0.073
T_7	19.37	16.67	11.10	0.050	0.056	0.080
T_8	43.26	33.18	26.08	0.052	0.055	0.069
T_9	66.67	60.48	52.09	0.053	0.055	0.068
T_{10}	19.68	16.16	11.69	0.058	0.066	0.085
T_{11}	44.03	43.40	36.00	0.063	0.068	0.072
T_{12}	67.08	60.56	51.67	0.064	0.070	0.074
CD @5%	Tr.-4.07, Period-1.78, T x P-NS			Tr.-0.013, Period-0.015, T x P-NS		

Sensory Characteristics

The sensory parameters were significantly influenced by recipes over a period of storage (**Table 6**). The highest colour, taste, aroma and overall acceptability score was founded under T_{11} (8.25, 8.00, 8.35 and 8.20) which is statistically at par with T_5, T_6, T8, T_9, T_{12} while lowest score has been awarded to recipe T_1. The colour score decreased significantly during storage and more pronounced under ambient condition as compare to refrigerated condition. The browning of litchi squash might be due to oxidation and amino acid sugar interaction [10]. A decrease in colour score in plum squash was also observed due to co-polymerization, interaction between phenolic compounds and proteins as well as formation of cation complex with pectin [11]. The sensory score for aroma and taste was maximum (8.35 and 8.25) in litchi squash with 30% juice + 40-45 °B + 25mg ascorbic acid/ 100 ml. Similarly higher level of juice and addition of ascorbic acid had highly significant effect on overall acceptability of litchi squash even after six months of storage. In storage all sensory parameters were found in decreasing trend which might be due to loss of volatile aromatic compounds responsible for aroma, loss of sugar-acid blend responsible for taste. There was decrease in the overall acceptability of litchi squash but acceptable score up to six months of storage which might be attributed due to loss in colour, taste, aroma and appearance of the product. These results are in conformity with the findings of Prasad and Mali [12] in pomegranate, Sethi [13] in litchi and Thakur et al. [14] in aonla squash.

Table 6 Sensory characteristics of litchi squash after storage

Treatments	Ambient condition (After 6 months)				Refrigerated condition (After 9 months)			
	Colour	Taste	Aroma	Overall acceptability	Colour	Taste	Aroma	Overall acceptability
T_1	5,85	6.65	6.50	6.15	5,65	6.55	6.40	6.05
T_2	7.65	7.20	7.40	7.35	7.45	7.00	7.35	7.15
T_3	7.80	7.30	7.50	7.40	7.70	7.20	7.40	7.30
T_4	6.15	7.00	7.10	6.50	6.05	7.00	7.00	6.35
T_5	7.95	7.80	7.65	7.70	7.75	7.65	7.50	7.55
T_6	8.00	7.75	7.65	7.75	7.90	7.65	7.50	7.70
T_7	6.30	7.15	7.20	6.55	6.00	7.15	7.05	6.50
T_8	8.15	7.95	8.10	7.85	8.00	7.75	8.00	7.80
T_9	8.05	7.90	8.05	7.90	7.85	7.80	7.95	7.80
T_{10}	6.45	7.05	7.05	6.55	6.20	7.05	7.00	6.45
T_{11}	8.25	8.00	8.35	8.20	8.00	7.90	8.25	8.00
T_{12}	8.10	7.90	7.90	8.10	7.90	7.80	7.90	8.00
CD at 5%	0.32	0.41	0.36	0.36	0.30	0.39	0.40	0.28

Conclusion

The results revealed that litchi squash was found to be stable for a period of six and nine months at ambient and refrigerated conditions respectively with respect to bio-chemical parameters and sensory characters. The recipe with 30% juice/ pulp, 40 to 45 °B TSS and 25 mg ascorbic acid / 100ml was found best on the basis of all the sensory and physic-chemical parameters. Addition of ascorbic acid has been found to check browning during storage.

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