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SS Kundu
KVK, Sadalpur (Hisar), Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana, India

RK Sharma
KVK, Sadalpur (Hisar), Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana, India

RK Goyal
KVK, Sadalpur (Hisar), Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana, India

VK Sharma
KVK, Sadalpur (Hisar), Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana, India

Correspondence
SS Kundu
KVK, Sadalpur (Hisar), Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana, India

Quality status of jam prepared from of plum CV. Satluj purple

SS Kundu, RK Sharma, RK Goyal and VK Sharma

Abstract
Quality evaluation of jam prepared from fresh and stored pulp of Plum fruits was carried out in the laboratory of Department of Horticulture, CCS HAU, Hisar, Haryana during 2013-14. Jam prepared from fresh as well as from stored pulp at refrigerated (6±2°C), frozen (-10±5°C) and ambient temperature after two and four months of storage was filled in sterilized glass jars of 500g capacity, sealed and stored at room temperature. Quality of jam was assessed for physico-chemical and organoleptic evaluation at 15 day intervals during four months of storage. Total soluble solids increased with the increase in storage period whereas acid content decreased with the advancement of storage period. No variation in TSS and acid contents was observed in jam prepared from fresh and stored pulps, whereas their ratio increased significantly with the increase in storage period with maximum found in jam prepared from fresh pulp. The reducing and total sugars increased, while non-reducing sugar decreased significantly during storage. However, no significant variation in total, reducing and non-reducing sugars was observed in jam prepared both from fresh and stored pulps. Jam prepared from fresh and stored pulps remained consumer acceptable up to four months of storage. However, jam prepared from the fresh as well as pulp stored for two months at frozen temperature attained maximum acceptability.

Keywords: Plum, Pulp, Jam, Glass jars, Storage, Quality, Sutlej Purple

Introduction
Plum, a member of genus *Prunus*, belongs to the family Rosaceae and subfamily Prunoideae. Plum has been cultivated since prehistoric times, perhaps longer than any other fruit except apple (Anonymous, 2004) [2]. It was introduced in India as early as in 1870. In India, it occupies an area of 24601 hectares with an annual production of 199241 tonnes (Anonymous, 2011) [3]. Among temperate fruits, plum is unique as it can be grown successfully under varying climatic conditions (temperate high hills to subtropical plains). Plum is a climacteric fruit but has a short shelf life. In Haryana, the fruits ripen in the month of May-June, when the day temperature is very high (>45 ºC) and relative humidity is very low. The fruits cannot be stored for a longer period at ambient room temperature and more over the storage of plum fruit is a time consuming, tedious and costly process and it compels the growers to sell their produce at throwaway price. Even at low temperature (1 °C), the Japanese plum can only be stored for 3 to 5 weeks (Navarro *et al*., 2005) [11], but at ambient room temperature, its fruit cannot be stored for more than 4 days, which increases the post-harvest losses. These losses can be minimized by preparing the different value added products from fresh as well as stored pulp. In the present era, there is a drastic change in the life style and eating habits of the population. People have an attraction toward value added products and there is a great demand of jam, nectar, RTS, *etc*.
Although the literature reveals ample work (Durrani *et al*., 2010; Jain *et al*., 2011; Sakhale *et al*., 2012) [4, 7, 14] on storage of fruits pulp but the information on the plum pulp preservation and preparation of RTS-beverage, squash, nectar, jam, jelly, *etc*. from stored pulp is rather scanty. Gothwal *et al*. (1998) [5] found the three commercially important varieties of plum *viz*., Santa Rosa, Mariposa and Early Transparent Gage acceptable for the preparation and storage of pulp, squash, nectar, jam and ready to serve for a period of nine months at room temperature (13 to 42 ºC). The objective of present investigation was to evaluate the quality status of jam prepared from fresh and stored pulp of plum cv. Satluj Purple.

Materials and Methods
The present study to evaluate quality of jam prepared from fresh and stored pulp of Plum fruits was carried out during 2013-14 in the laboratory of Department of Horticulture, CCS HAU, Hisar, Haryana. Jam prepared from fresh as well as from stored pulp at refrigerated (6±2 °C),

frozen(-10±5 °C) and ambient temperature after two and four months of storage was filled in glass jars of 500 g capacity, sealed and stored at room temperature. The treatments were replicated four times under completely randomized design. The quality of jam was analyzed at 15 days interval up to 4 month of storage for physico-chemical and organoleptic parameters *viz.*, TSS (%), acidity (%), TSS to acid ratio, total sugars (%), reducing sugars (%), non-reducing sugars (%) and organoleptic rating. The total soluble solids of jam samples were determined at room temperature by Digital Refractometer, acidity was determined as per the method suggested by AOAC (1990) [1], the ratio of total soluble solids to acid was obtained by dividing the total soluble solid with total acid, sugars were determined by using the potassium ferricyanide method of Hulme and Narain (1993) and the organoleptic rating was judged by following the 9 points hedonic rating scale as described by Rangana (1977) [13]. The statistical method described by Panse and Sukhatme (1967) [12] was followed for analysis and interpretation of the experimental results.

Results

There was no significant change in total soluble solids of jam prepared from fresh and stored pulp. The TSS increased with the increase in storage period (Table 1) and the maximum TSS (68.95%) was recorded on120th day of storage, whereas, it was minimum (68.20%) on 0 day of storage. The interaction between treatments and storage periods was non- significant.

It is evident from the data that there was no significant change in per cent acidity in jam prepared from fresh and stored pulp (Table 2). It varied from 1.57 to 1.64% among the jam prepared from different treatments. A significant decreasing trend was observed in per cent acidity with the advancement in storage period. The Minimum acidity (1.57%) was recorded on 105th day of storage, whereas, maximum (1.65%) at initial day of storage. The interactions between treatments and storage periods in combination were found to be non-significant. TSS to acid ratio varied significantly in the jam prepared from the pulp of different treatments (Table 3). The maximum TSS to acid ratio (43.6) was recorded in jam prepared from fresh pulp (T_1), which was at par with jam prepared from pulp stored at frozen temperature for two months (T_4) and the minimum (42.0) was found in jam from pulp stored at ambient room temperature for four months (T_7). A significant increase in TSS to acid ratio was also observed with the increase in storage period. It was minimum 41.4 on initial day of storage and increased to 44.1 on 120th day of storage, which was at par with 105th day of storage. The interaction between treatments and storage duration was found non-significant.

The data shown in the Table 4 reveal that no significant variation in total sugars content was found in jam prepared from fresh and stored pulp. However, a significant increasing trend was observed in total sugars of jam with the increase in storage period after 30 days of storage and maximum of 61.36% was recorded on 120thday of storage which was at par with 90th and 105th day of storage, whereas, the minimum of 60.60% was on 0 day of storage. The interactions between treatments and storage periods in combination were found non-significant. It is evident from the data that there was no significant difference in reducing sugars in jam prepared from fresh and stored pulp and it varied between 53.24 and 54.36% among the jam prepared from different treatments (Table 5). However, it increased significantly with increase in storage period and recorded maximum(54.99%) on 120th day of storage which was at par with105th day of storage, whereas, the minimum (52.08%) was obtained on 0 day of storage. The interaction between treatments and storage periods was found non-significant.

The perusal of data in Table 6 reveals that no significant difference in non-reducing sugar was observed in jam prepared from various treatments and it ranged between 7.10 and 7.38 per cent. The non-reducing sugar decreased significantly with the advancement in storage period and the maximum (8.51%) was observed on initial day of storage and it decreased to 6.36% on 120th day of storage, which was at par with 90th and 105th day of storage. The interaction between treatments and storage periods was non-significant. The average maximum acceptability score (8.0) was given (Table 7) for the jam prepared from fresh pulp (T_1) and pulp stored at frozen temperature for two and four months (T_4 and T_5), which was at par with T_2, whereas, the minimum score (7.2) to the jam prepared from pulp stored at ambient room temperature for four months (T_7). The organoleptic acceptability score decreased with the advancement of storage period and the minimum score (7.4) was observed on 105thday of storage. However, the jam prepared from all the treatments remained acceptable up to 120th day of storage at ambient room temperature.

The total soluble solids remained unchanged in the jam prepared from fresh and stored pulp of plum. It indicates that stored pulp was similar to fresh pulp. An increasing trend was observed in total soluble solids with the increase in storage period and it might be due to the conversion of protopectin into water soluble pectin during storage. These results are in conformity with the results of Kannan and Thirumaran (2004) [8] and Khan *et al*. (2012) [9] who observed a gradual increase in TSS of *jamun* and strawberry jams stored for 6 and 2 months, respectively. Contrary to above findings, Kumari and Sandal (2011) [10] observed no significant variation in TSS in mango jam during storage of 100 days.

The acid content in jam prepared from fresh and stored pulp did not differ significantly (Table 2), whereas, it decreased significantly during storage up to 105th day of storage and thereafter no change was observed. The conversion of organic acids into sugars might have resulted into lowering of acidity in jam during storage. Similarly, Kannan and Thirumaran (2004) [8] and Shivani *et al*. (2010) [15] also observed a decreasing trend in acid content in *jamun* jam during storage for six and three months at room temperature, respectively. Contrary to these results, Kumari and Sandal (2011) [10] noticed a significant increase in acidity of jam prepared from local mango during storage for 100 days at ambient temperature.

The maximum TSS to acid ratio was found in jam prepared from fresh pulp, followed by pulp stored at frozen temperature for four months, whereas, the minimum TSS to acid ratio noticed in jam prepared from pulp stored at ambient room temperature for four months. The TSS to acid ratio increased significantly with the increase in storage period and its value ranged from 41.4 to 44.1 from 0 day to end of storage period (Table 3). The increase in TSS to acid ratio was due to increase in TSS and decrease in acid contents during storage. Contrary to this, Khan *et al*. (2012) [9] reported decrease in TSS to acid ratio in strawberry jam with the increase in storage period. The results reveal that no variation in total sugars content was observed in jam prepared by various treatments using fresh and stored pulp of plum (Table 4).

Table 1: Changes in total soluble solid (%) of jam prepared from fresh and stored pulp of during storage

Treatment	Storage period (days)									
	0	15	30	45	60	75	90	105	120	Mean
T_1	68.20	68.20	68.30	68.41	68.49	68.63	68.71	68.75	68.78	68.50
T_2	68.20	68.30	68.43	68.51	68.65	68.70	68.78	68.83	68.85	68.58
T_3	68.20	68.35	68.50	68.61	68.73	68.80	68.85	68.89	68.90	68.65
T_4	68.20	68.20	68.33	68.41	68.54	68.60	68.73	68.78	68.81	68.51
T_5	68.20	68.30	68.40	68.53	68.60	68.73	68.80	68.85	68.85	68.58
T_6	68.20	68.40	68.55	68.70	68.85	69.05	69.15	69.20	69.20	68.81
T_7	68.20	68.43	68.60	68.71	68.90	69.08	69.20	69.25	69.28	68.85
Mean	68.20	68.31	68.44	68.56	68.68	68.80	68.89	68.93	68.95	
CD at 5%	Treatment- NS Storage period - 0.12 T x SP - NS									

T_1- Fresh pulp, T_2- Pulp stored at refrigerating temperature (6±2°C) for two months, T_3 - Pulp stored at refrigerating temperature (6±2°C) for four months, T_4 - Frozen pulp stored for two months (-10 ±5°C), T_5 - Frozen pulp stored for four months (-10 ±5°C), T_6 - Pulp stored at ambient temperature for two months, T_7 - Pulp stored at ambient temperature for four months.

Table 2: Changes in acidity (%) of jam prepared from fresh and stored pulp during storage

Treatment	Storage period (days)									
	0	15	30	45	60	75	90	105	120	Mean
T_1	1.63	1.61	1.59	1.57	1.57	1.56	1.55	1.54	1.53	1.57
T_2	1.64	1.63	1.61	1.59	1.58	1.57	1.57	1.56	1.55	1.59
T_3	1.65	1.64	1.62	1.61	1.61	1.60	1.59	1.58	1.57	1.61
T_4	1.63	1.62	1.61	1.59	1.57	1.56	1.55	1.54	1.54	1.58
T_5	1.64	1.62	1.61	1.60	1.59	1.58	1.57	1.56	1.55	1.59
T_6	1.67	1.66	1.65	1.64	1.63	1.62	1.62	1.61	1.60	1.63
T_7	1.68	1.67	1.66	1.65	1.64	1.63	1.63	1.62	1.61	1.64
Mean	1.65	1.63	1.62	1.61	1.60	1.59	1.58	1.57	1.57	
CD at 5%	Treatment- NS Storage period- 0.01 T x SP - NS									

Table 3: Changes in TSS to acid ratio of jam prepared from fresh and stored pulp during storage

Treatment	Storage period (days)									
	0	15	30	45	60	75	90	105	120	Mean
T_1	41.9	42.4	43.0	43.5	44.0	44.1	44.4	44.7	44.9	43.6
T_2	41.6	42.0	42.5	43.0	43.4	43.8	44.0	44.2	44.4	43.2
T_3	41.3	41.8	42.4	42.6	42.8	42.9	43.2	43.6	44.1	42.7
T_4	41.9	42.2	42.6	43.1	43.6	43.9	44.3	44.6	44.8	43.4
T_5	41.6	42.2	42.5	42.8	43.3	43.6	43.9	44.1	44.4	43.2
T_6	40.8	41.3	41.6	41.8	42.2	42.6	42.8	43.0	43.2	42.2
T_7	40.6	41.1	41.4	41.8	42.1	42.4	42.6	42.8	42.9	42.0
Mean	41.4	41.9	42.3	42.7	43.0	43.3	43.6	43.9	44.1	
CD at 5%	Treatment- 0.32 Storage period - 0.36 T x SP - NS									

Table 4: Changes in total sugars (%) of jam prepared from fresh and stored pulp during storage

Treatment	Storage period (days)									
	0	15	30	45	60	75	90	105	120	Mean
T_1	60.23	60.24	60.30	60.48	60.60	60.77	60.87	60.98	61.04	60.61
T_2	60.54	60.61	60.76	60.91	61.04	61.11	61.18	61.25	61.25	60.96
T_3	60.71	60.84	60.91	61.09	61.20	61.26	61.31	61.38	61.41	61.12
T_4	60.30	60.40	60.64	60.71	60.84	60.98	61.11	61.11	61.16	60.80
T_5	60.40	60.54	60.71	60.91	60.98	61.08	61.13	61.21	61.25	60.91
T_6	60.98	61.13	61.21	61.34	61.45	61.54	61.60	61.67	61.67	61.40
T_7	61.04	61.16	61.29	61.41	61.52	61.60	61.69	61.71	61.73	61.46
Mean	60.60	60.70	60.83	60.98	61.09	61.19	61.27	61.33	61.36	
CD at 5%	Treatment- NS Storage period - 0.13 T x SP - NS									

Table 5: Changes in reducing sugars (%) of jam prepared from fresh and stored pulp during storage

Treatment	Storage period (days)									
	0	15	30	45	60	75	90	105	120	Mean
T_1	51.71	51.90	52.21	52.66	53.23	53.81	54.32	54.59	54.69	53.24
T_2	51.98	52.42	52.83	53.37	53.71	54.32	54.66	54.79	54.82	53.66
T_3	52.19	52.61	53.03	53.54	53.91	54.51	54.79	54.94	55.02	53.84
T_4	51.78	52.36	52.59	53.13	53.47	54.08	54.49	54.66	54.73	53.48
T_5	51.85	52.39	52.77	53.20	53.71	54.23	54.63	54.76	54.82	53.59
T_6	52.49	53.10	53.57	53.91	54.25	54.71	55.16	55.31	55.38	54.21
T_7	52.60	53.31	53.71	54.01	54.42	54.99	55.31	55.43	55.51	54.36
Mean	52.08	52.58	52.96	53.40	53.81	54.38	54.76	54.92	54.99	
CD at 5%	Treatment- NS Storage period - 0.22 T x SP - NS									

Table 6: Changes in non-reducing sugar (%) of jam prepared from fresh and stored pulp during storage

Treatment	Storage period (days)									
	0	**15**	**30**	**45**	**60**	**75**	**90**	**105**	**120**	**Mean**
T_1	8.52	8.34	8.09	7.82	7.37	6.97	6.55	6.39	6.35	7.38
T_2	8.55	8.19	7.94	7.54	7.34	6.79	6.52	6.45	6.42	7.31
T_3	8.52	8.23	7.88	7.55	7.29	6.76	6.52	6.44	6.40	7.29
T_4	8.52	8.05	8.05	7.57	7.37	6.90	6.63	6.46	6.43	7.33
T_5	8.55	8.15	7.94	7.71	7.27	6.85	6.50	6.45	6.42	7.32
T_6	8.49	8.03	7.64	7.43	7.20	6.83	6.44	6.35	6.28	7.19
T_7	8.45	7.85	7.59	7.40	7.10	6.61	6.39	6.29	6.22	7.10
Mean	8.51	8.12	7.87	7.57	7.27	6.82	6.51	6.40	6.36	
CD at 5%	Treatment- NS Storage period - 0.21 T x SP - NS									

Table 7: Changes in overall acceptability of organoleptic score (out of 9) in jam prepared from fresh and stored pulp during storage

Treatment	Storage period (days)									
	0	**15**	**30**	**45**	**60**	**75**	**90**	**105**	**120**	**Mean**
T_1	8.3	8.2	8.2	8.1	8.0	7.8	7.8	7.6	7.6	8.0
T_2	8.3	8.2	8.2	8.0	7.9	7.8	7.7	7.6	7.6	7.9
T_3	8.2	8.2	8.1	8.0	7.8	7.6	7.6	7.5	7.5	7.8
T_4	8.4	8.3	8.3	8.2	8.1	7.9	7.9	7.7	7.7	8.0
T_5	8.3	8.3	8.2	8.1	8.0	7.9	7.8	7.7	7.6	8.0
T_6	8.1	8.0	7.7	7.6	7.4	7.3	7.2	7.0	7.0	7.5
T_7	7.8	7.6	7.3	7.2	7.2	7.0	6.9	6.9	6.8	7.2
Mean	8.2	8.1	8.0	7.9	7.8	7.6	7.5	7.4	7.4	
CD at 5%	Treatment- 0.12 Storage period - 0.13 T x SP - NS									

A gradual increasing trend in total sugars in jam noticed with the increase in storage period from 30th to 90th day of storage and thereafter no significant variation was observed. The increase in total sugars content during storage might be attributed to the hydrolysis of polysaccharides like pectin, starch *etc*. into simple sugars. Similarly, Vidhya and Narain (2011) [16] also reported a gradual increase in total sugar content in wood apple jam during storage of 90 days. However, Kannan and Thirumaran (2004) [8] observed a decreasing trend in total sugars content in jamun jam during storage for 6 months at room temperature.

The reducing sugars in jam prepared from fresh and stored pulp did not differ significantly (Table 5), but it increased significantly with the increase in storage period. Increase in reducing sugars might be due to hydrolysis of sugar by acid, which might have resulted in degradation of disaccharides to monosaccharides. Khan *et al*. (2012) [9] reported similar findings in strawberry jam during storage of 60 days at ambient temperature. Kumari and Sandal (2011) [10] also reported increasing trend in reducing sugars during storage in jam of mango for 100 days.

In the present investigation, no significant variation in non-reducing sugar was observed in jam prepared from fresh and stored pulp. However, with the increase in storage period, there was a significant and progressive decrease in non-reducing sugar was noticed (Table 6). The reduction in non-reducing sugar might be due to conversion of non-reducing sugar into reducing sugars during storage. The present findings are in agreement with those of Khan *et al*. (2012) [9] who observed decrease in non-reducing sugar in strawberry jam during storage of 60 days at ambient temperature. Kumari and Sandal (2011) [10] also reported a similar trend in jam, squash and RTS beverage of local mango stored for 100 days.

The jam prepared from all the treatments using fresh and stored pulp remained acceptable up to 120th day of storage at ambient room temperature because each of these scored more than 6.0 overall acceptability score (Table 7). However, the maximum acceptability score was attained by jam prepared from fresh pulp and pulp stored at frozen temperature for two and four months. The least acceptability was noticed for jam from pulp stored at room temperature for four months. The acceptability score of jam decreased during storage but remained in the acceptable range up to 120th day of storage at room temperature. Similarly, Shivani *et al*. (2010) [15] also reported that the *jamun* jam was found acceptable even after 3 months of storage at ambient temperature, however, the overall acceptability of jam decreased significantly with the advancement in storage period. Khan *et al.* (2012) [9] noticed similar trend in case of strawberry jam stored in sterilized glass jars for 60 days.

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