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Studies on Effect of Cultivars and Picking Dates on Shelf Life of Jelly Prepared from Karonda (*Carissa carandas* L.)

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A B S T R A C T

Karonda jelly was prepared from cultivars viz 'Pant Manohar', 'Pant Sudarshan' and 'Pant Suvarna' at picking dates of 40, 60 and 80 days after fruit set. The shelf stability of the jelly samples were evaluated at ambient temperature for a period of nine months. The 'Pant Suvarna' jelly exhibited maximum moisture, total soluble solids (TSS), reducing sugar, non-reducing sugar, total sugar, non-enzymatic browning and pectin content. Among picking dates, the maximum and minimum pectin content, colour, appearance, taste, consistency and overall acceptability scores were observed in jelly prepared at 60 and 80 Days after fruit set, respectively. During storage period of nine months, a gradual reduction in moisture content, non-reducing sugar, total sugar, ascorbic acid, pectin, colour, appearance, taste, consistency and overall acceptability scores were observed in jelly. However, TSS, reducing sugar, titratable acidity, non-enzymatic browning and flavour score were increased with the increase in storage period. No yeast and mold growth were observed in jelly during entire storage period.

Introduction

Karonda (*Carissa carandas* L.) is well known indigenous, evergreen, multipurpose horticultural bush of family Apocynaceae and popularly known as 'Christ's thorn'. It is an important fruit crop of tropical and subtropical regions of the world and grown extensively as a protective bio-fencing hedge plant on the boundaries for their protection due to presence of thorn and dense foliage (Sturrock 1980). It is grown as an ornamental plant due to its beautiful cherry like fruits. The fruit of karonda has several medicinal properties. It is antiscorbic, richest sources of iron, therefore, very useful for curing of anaemia, used as an astringent and as a remedy for biliousness (Jadhav *et al.*, 2004).

Although, karonda is not popular as a fresh fruit due to its astringent and sour taste but it has a great potential for processing into several value added products such as appetizer, candy, chutney, jam, jelly, pickle, puddings, squash, sauces, tart and wine (Hayes 1957). Mature Karonda fruits contain

high amount of pectin and, therefore, besides being used for making pickles and chutney, it can be exploited for making jelly. Jelly is made from slightly unripe fruits or a combination of ripe and unripe fruits to enhance the colour (Mortan, 1987). Almost all the available recognised cultivars of karonda are sour in taste and somewhat having astringent property which renders them unsuitable for fresh consumption. Therefore, present study was undertaken to evaluate the storage quality of jelly developed from karonda cultivars at different picking dates.

Materials and Methods

The fresh fruits of three karonda cultivars viz 'Pant Manohar', 'Pant Sudarshan' and 'Pant Suvarna' at three different picking dates i.e. 40, 60 and 80 days after fruit set were procured from the experimental orchard of Horticultural Research Centre, Patharchatta, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand.

Extraction of juice from fruits:

Fruits were washed in running water to remove the adhered dust and microflora. The fruits were cut into thin slices and boiled in water and pulp ratio of 1:1. The extract were boiled gently for about 20 minutes till they become soft. The boiled extract was drained and a second extract was taken by boiling the same mass again using water and pulp ratio of 1:2.

The two extracts were combined and strained through coarse muslin cloth to get a clear extract. The strained extract was allowed to settled overnight in a tall vessel. Next day, the clear supernatant liquid was syphoned off without disturbing the sediment at the bottom of the vessel.

Preparation of jelly

The jellies from three karonda cultivars at three different picking dates were developed according to the standardized procedure as described by Girdharilal *et al.,* (1960). The sugar was added in the clear fruit extract in the proportion of 45:55 (Fruit extract: Sugar) and boil the mixture with continuous stirring and scumming until the desired consistency with 65°Brix reached. Pectin (medium set pectin of 150 grade) at the rate of 0.03 to 0.07 per cent on the basis of extract and citric acid at the rate of 2g/litre of extract were added after being dissolved in small quantities of the hot syrup was then added at a temperature of 104-105ºC. End point was noted by sheet test and confirmed by clot formation of jelly in cold water. Heating was discontinued, the finished hot jelly was cooled to 90ºC and filled into sterilized wide mouth glass jars of 250g capacity. A thin layer of hot molten paraffin wax seal was poured on the surface of jelly and after its solidification, the jelly was cooled and stored at ambient temperature. The samples were withdrawn at 3 monthly intervals for analysis during 9 months of storage.

Quality analysis

Moisture in jelly was determined by drying a known weight of sample in the hot oven at 65ºC to a constant weight. Total soluble solids (TSS) were determined using hand refractometer (Erma, Tokyo, Japan). Titratable acidity was estimated by titrating against 0.1 N NaoH solution using phenolphthalein as indicator. The method of Lane and Eynon (1923) was followed for the determination of reducing, non-reducing and total sugars. The 2,6-dichlorophenol-indophenol titration method described by Ranganna (1986) was used for the estimation of ascorbic acid content. The degree of non-enzymatic browning in the jelly and pectin content were

determined by methods elucidated by Ranganna (1986). All reported results were average of three replicates. A panel of 7 to 9 selected judges evaluated the sensory quality of jelly in terms of colour, appearance, flavour, taste, consistency and overall acceptability on a 9-point hedonic scale (9 for like extremely and 1 for dislike extremely) as described by Amerine *et al.,* (1965). The microbial load in the stored jelly samples were analysed initially and once in 90 days, up to a period of 270 days. The yeast and mold counts were enumerated by serial dilution as per the method described by Harrigan and Mccance (1976).

Statistical analysis

For analysis of stored jelly samples, factorial completely randomized design was used as described by Cochron and Cox (1967). The critical difference (CD) value at 5% level of probability with 3 replications was compared for making the comparison among different treatments.

Results and Discussion

Physico-chemical characteristics of fresh fruit

The data on physico-chemical characteristics in Table 1 reveal that the maximum length (3.07 cm), width (2.30 cm) and weight (5.86 cm) were observed in 'Pant Suvarna' at 80 days after fruit set. The maximum flesh to seed ratio (23.90) was observed in 'Pant Suvarna' at 40 days after fruit set and minimum flesh to seed ratio (10.01) was observed in 'Pant Manohar' at 80 days after fruit set. Almost similar values for various physical characteristics were reported earlier by Awasthi *et al.,* (1988) and Misra and Jaiswal (1999). The moisture and TSS content of different cultivars at different picking dates were ranged between 85.08 to 89.41% and 4.33 to 8.53 ºBrix, respectively. The reducing sugar, non-reducing sugar and total sugars content were increased with the increase in picking dates from 40 to 80 days after fruit set. The highest reducing sugar (6.20%), non-reducing sugar (2.03%) and total sugars (8.33%) were recorded in 'Pant Suvarna' at 80 day after fruit set. The maximum and minimum titratable acidity was recorded for 'Pant Sudarshan' (3.79%) at 40 days after fruit set and 'Pant Suvarna' (1.74%) at 80 days of fruit set, respectively. The ascorbic acid content of different cultivars at different picking dates was varied from 9.41 to 18.81 mg/100g. The maximum pectin content (0.712%) was recorded in 'Pant Suvarna' at 60 days after fruit set, whereas, minimum pectin content (0.0.291%) was recorded in 'Pant Sudarshan' at 40 days after fruit set. The results of our study for various chemical characteristics are in close agreement with those reported earlier by Joshi *et al.,* (1986) and Manivasagan *et al.,* (2006).

Changes in chemical constituents upon storage

Data presented in Table 2 revealed that among cultivars, the mean moisture content in karonda jelly varied from 33.09 to 34.18%. Among picking dates, the mean moisture content were increased from 32.17 to 34.80% from 40 to 80 days after fruit set. During storage, the mean moisture content were decreased from 35.65 to 31.16% from 0 to 9 months of storage irrespective of cultivars and picking dates. A significant interaction between cultivars, picking dates and storage intervals were observed. The maximum moisture content (38.75%) were recorded in jelly of 'Pant Suvarna' prepared at 80 days after fruit set at 0 month of storage and the minimum moisture content (29.49%) were recorded in jelly of 'Pant Sudarshan' prepared at 40 days after fruit set at 9 months of storage. The higher moisture content in jelly of 'Pant Suvarna' might be attributed to the variation in cell structure and composition of

cell wall which is a genetic character of each cultivar. The increase moisture content of jelly with the increase in picking date might be due to the increase in moisture content in fresh fruits. The moisture content of jelly decreased gradually throughout the nine months of storage period which might be attributed to the loss of residual moisture content from the crystalline to the amorphous form of components in jelly which permits the binding of water. Similar findings have also been reported by Sudhagar *et al.,* (2003) in pear jelly and Yousif and Alghamdi (1999) in Date jelly. The mean TSS content in jelly of karonda cultivars varied from 67.34 to 67.95ºBrix. Among picking dates, the mean TSS content were increased from 67.30 to 68.01 ºBrix from 40 to 80 days after fruit set. During storage, the mean TSS content were increased from 65.50 to 69.94ºBrix from 0 to 9 months of storage irrespective of cultivars and picking dates. A significant interaction between cultivars, picking dates and storage intervals were observed. The maximum TSS content (71.87ºBrix) were recorded in jelly of 'Pant Suvarna' prepared at 80 days after fruit set at 9 months of storage and the minimum TSS content (65.13ºBrix) were recorded in jelly of 'Pant Sudarshan' prepared at 40 days after fruit set at 0 month of storage. The increase in TSS content of jelly with the increase in picking dates might be due to the increase in TSS content in fresh fruits from 40 to 80 days after fruit set. The increase in TSS content of jelly during storage might be due to the degradation of polysaccharides into simple sugars. Similar observations were also reported by Barmanray *et al.,* (1996) in guava jelly and Jadhav *et al.,* (2004) in Karonda jelly. The mean reducing sugar, non-reducing sugar and total sugars contents in jelly of karonda cultivars varied from 25.53 to 30.04%, 28.84 to 30.78% and 56.99 to 60.62%, respectively. Among picking dates, the mean reducing sugar, non-reducing sugar and total sugars contents were increased from 26.40 to 28.99%, 29.39 to 30.22% and 58.46 to 60.43%, respectively, from 40 to 80 days after fruit set. During storage, the mean reducing sugar content was increased from 24.22 to 31.21%, whereas, mean non-reducing sugar and total sugar contents were decreased from 35.43 to 23.99% and 61.48 to 57.62%, respectively, from 0 to 9 months of storage. A significant interaction between cultivars, picking dates and storage intervals were observed. The maximum reducing sugar content (34.13%) were recorded in jelly of 'Pant Suvarna' prepared at 80 days after fruit set at 9 months of storage and the minimum reducing sugar content (20.32%) were recorded in jelly of 'Pant Sudarshan' prepared at 40 days after fruit set at 0 month of storage, whereas, the maximum non-reducing sugar (37.26%) and total sugars contents (63.72%) were observed in jelly of 'Pant Suvarna' prepared at 80 days after fruit set at 0 month of storage and the minimum non-reducing (23.13%) and total sugars contents (53.14%) were recorded in jelly of 'Pant Sudarshan' prepared at 40 days after fruit set at 9 months of storage. The higher reducing sugar content in 'Pant Suvarna' jelly might be due to the higher reducing sugars in their fresh fruits. During storage, reducing sugar content of jelly was increased which might be due to sucrose inversion in the presence of acidic environment. Similar results have also been reported by Chaudhary *et al.,* (2007) and Jadhav *et al.,* (2004) in karonda jelly. The non-reducing sugar content of jelly decreased continuously with the increase in storage period which might be due to the hydrolysis of polysaccharides and inversion of non-reducing sugars into reducing sugars during storage, whereas, decrease in total sugar content of with the advancement in storage period irrespective of cultivars and picking dates might be due to the utilization of sugars in non-enzymatic browning reactions and also due to the breakdown of total sugar into simpler ones. Similar results have also been

reported by Yousif and Alghamdi (1999) in Date jelly and Selvamuthukumaran (2007) in sea buckthorn jelly. Among cultivars, the mean titratable acidity in karonda jelly varied from 1.51 to 1.76%. Among picking dates, the mean titratable acidity were decreased from 1.80 to 1.44% from 40 to 80 days after fruit set. During storage, the mean titratable acidity was increased from 1.32 to 1.98% from 0 to 9 months of storage. A significant interaction between cultivars, picking dates and storage intervals were observed. The maximum titratable acidity (2.27%) was recorded in jelly of 'Pant Sudarshan' prepared at 40 days after fruit set at 9 months of storage and the minimum titratable acidity (0.93%) was recorded in jelly of 'Pant Suvarna' prepared at 80 days after fruit set at 0 month of storage. The increase in titratable acidity of jelly was probably due to de-esterification of pectin molecules and formation of free fatty acids during storage. Similar evidences have also been reported by Chaudhary *et al.,* (2007) in Karonda jelly, Kalarani (2000) in custard apple jelly and Shah and Bhatia (1983) in culled apple jelly. The mean ascorbic acid content in jelly of karonda cultivars varied from 5.84 to 9.62 mg/100g. Among picking dates, the mean ascorbic acid content were increased from 6.34 to 8.76 mg/100g from 40 to 80 days after fruit set. During storage, the mean ascorbic acid content were decreased from 9.83 to 5.27 mg/100g from 0 to 9 months of storage irrespective of cultivars and picking dates. A significant interaction between cultivars, picking dates and storage intervals were observed. The maximum ascorbic acid content (13.92 mg/100g) was recorded in jelly of 'Pant Sudarshan' prepared at 80 days after fruit set at 0 month of storage and the minimum moisture content (3.40 mg/100g) was recorded in jelly of 'Pant Suvarna' prepared at 40 days after fruit set at 9 months of storage. Continuous decrease in ascorbic acid content of jelly during storage period might be due to oxidation of ascorbic acid into dehydroascorbic acid by trapped oxygen in the containers and due to its role as a substrate in non-enzymatic browning reactions. However, ascorbic acid is very sensitive to heat and oxidation, therefore, it might have destroyed during various steps in processing of jelly. Similar evidences have been reported by Jadhav *et al.,* (2004) in Karonda jelly and Selvamuthukumaran (2007) in sea buckthorn jelly. The mean pectin content in jelly of karonda cultivars varied from 0.88 to 0.97%. Among picking dates, the mean pectin content was varied from 0.88 to 0.97%. During storage, the mean pectin content was decreased from 0.97 to 0.86% from 0 to 9 months of storage. A significant interaction between cultivars, picking dates and storage intervals were observed. The maximum pectin content (1.22%) was recorded in jelly of 'Pant Suvarna' prepared at 60 days after fruit set at 0 month of storage and the minimum pectin content (0.80%) was recorded in jelly of 'Pant Sudarshan' prepared at 80 days after fruit set at 9 months of storage. The highest pectin content in the jelly prepared at 60 days after fruit set might be due to the higher soluble pectin content in the fruit extracts and the lesser pectin content in the jelly prepared at 40 days after fruit set was due to the higher insoluble protopectin content in the fruit extracts, whereas, the lower pectin content in the jelly prepared at 80 days after fruit set was probably due to the higher insoluble pectic acid in the fruit extracts. During storage, the pectin content of jelly was decreased continuously which might be due to the conversion of pectin into pectic acid and further into sugars and galacturonic acids. Similar result was observed by Shah and Bhatia (1983) in culled apple jelly. Among cultivars, the mean non-enzymatic browning values in karonda jelly varied from 0.34 to 0.39 OD. Among picking dates, the mean non-enzymatic browning values were increased from 0.34 to 0.39 OD from 40 to 80

days after fruit set. During storage, the mean non-enzymatic browning values were increased from 0.24 to 0.50 OD from 0 to 9 months of storage. A significant interaction between cultivars, picking dates and storage intervals were observed. The maximum non-enzymatic browning value (0.57 OD) was recorded in jelly of 'Pant Suvarna' prepared at 80 days after fruit set at 9 months of storage and the minimum non-enzymatic browning value (0.22 OD) was recorded in jelly of 'Pant Sudarshan' prepared at 40 days after fruit set at 0 month of storage. During storage, non-enzymatic browning of jelly was increased continuously which might be due to the reactions between amino acids and reducing sugars and due to the oxidation of ascorbic acid and various other phenolic compounds. However, several factors such as temperature, moisture, carbonyl compounds, organic acids, water activity, oxygen and sugars have been reported to be responsible for causing non-enzymatic browning in stored products. Similar result was also reported by Selvamuthukumaran (2007) in sea buckthorn jelly. The yeast and molds were not found in the jelly of karonda cultivars prepared at 40, 60 and 80 days after fruit set during entire storage period which indicate the hygienic handling during processing and storage of the products which might have restricted the increase of microbial population. Similar observations have been reported by Selvamuthukumaran (2007) in sea buckthorn jelly and Sudhagar *et al.*, (2003) in pear jelly.

Changes in sensory quality upon storage

The sensory quality was considerably affected during 9 months of storage (Table 3), however, it was significantly higher in 'Pant Manohar' jelly. The jelly prepared at 60 days after fruit set maintained better sensory quality. The highest sensory scores for colour, appearance, taste and overall acceptability were found in jelly of 'Pant Manohar' which might be due to their higher sensory scores at the time of preparation, whereas, the higher sensory scores for flavour and consistency were observed in the jelly of 'Pant Suvarna' which might be due to their higher volatile compounds and pectin content.

Table.1 Physico-chemical composition of fresh karonda fruits at three different picking dates

Parameter	'Pant Manohar'			'Pant Sudarshan'			'Pant Suvarna'		
	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3
Length, cm	2.31	2.53	2.70	2.05	2.16	2.41	2.47	2.60	3.07
Width, cm	1.64	1.78	1.88	1.71	1.76	1.81	1.75	1.96	2.30
Weight, g	3.79	4.41	4.62	3.38	3.61	4.20	4.78	5.23	5.86
Flesh:seed ratio	21.18	11.54	10.01	13.77	11.26	10.80	23.90	20.34	13.53
Moisture, %	85.08	86.18	87.99	85.13	86.14	87.88	85.64	87.63	89.41
TSS, ºBrix	4.47	5.83	7.26	4.33	5.67	7.13	4.67	6.26	8.53
Reducing sugar, %	2.24	2.76	5.15	2.07	2.61	5.10	2.90	3.87	6.20
Non-reducing sugar, %	1.05	1.20	1.53	1.00	1.11	1.18	1.54	1.68	2.03
Total sugars, %	3.29	4.02	6.77	3.17	3.77	6.33	4.52	5.64	8.33
Titratable acidity, %	3.75	3.06	2.52	3.79	3.24	2.56	2.63	2.54	1.74
Ascorbic acid, mg/100g	15.09	15.35	17.88	15.24	15.74	18.81	9.41	9.85	12.06
Pectin, %	0.298	0.424	0.392	0.291	0.407	0.389	0.366	0.712	0.569
D_1 = 40 days after fruit set; D_2 =60 days after fruit set; D_3 =80 days after fruit set; C=Cultivar; D=Picking date									

Table.2 Change in moisture, TSS, reducing sugar, non-reducing sugar, total sugars, titratable acidity, ascorbic acid, pectin, non-enzymatic browning and yeast and mold count of karonda jelly on storage

Cultivar	Picking dates (days)	Storage interval (months)				Mean (C)	Mean (D)
		0	3	6	9		
			Moisture, %				
'Pant Manohar'	D_1	33.88	32.69	30.98	29.49	31.76	32.17
	D_2	35.87	33.90	32.54	30.75	33.26	33.41
	D_3	36.59	35.01	33.51	32.11	34.30	34.80
	Mean	35.44	33.86	32.34	30.78	33.11	
'Pant Sudarshan'	D_1	33.81	33.42	32.65	31.06	32.73	
	D_2	34.71	33.69	32.05	29.92	32.59	
	D_3	36.14	34.74	33.33	31.62	33.96	
	Mean	34.89	33.95	32.68	30.87	33.09	
'Pant Suvarna'	D_1	34.36	32.66	31.06	30.03	32.02	
	D_2	36.75	35.48	33.19	32.04	34.36	
	D_3	38.75	37.12	35.20	33.49	36.14	
	Mean	36.62	35.09	33.15	31.85	34.18	
	Mean (S)	35.65	34.30	32.72	31.16		
			TSS, ºBrix				
'Pant Manohar'	D_1	65.26	66.09	68.08	69.03	67.11	67.30
	D_2	65.26	66.71	68.27	69.84	67.52	67.44
	D_3	65.53	66.94	68.27	70.24	67.74	68.01
	Mean	65.35	66.58	68.21	69.70	67.46	
'Pant Sudarshan'	D_1	65.13	66.80	68.37	70.03	67.58	
	D_2	65.26	66.52	67.52	69.00	67.07	
	D_3	65.33	66.61	68.17	69.40	67.38	
	Mean	65.24	66.64	68.02	69.48	67.34	
'Pant Suvarna'	D_1	65.49	66.66	67.12	69.57	67.21	
	D_2	65.75	66.57	68.08	70.53	67.73	
	D_3	66.51	67.88	69.37	71.87	68.91	
	Mean	65.91	67.04	68.19	70.66	67.95	
	Mean (S)	65.50	66.75	68.14	69.94		
			Reducing sugars, %				
'Pant Manohar'	D_1	22.26	25.14	26.81	29.05	25.81	26.40
	D_2	23.60	25.86	28.26	30.65	27.09	27.58
	D_3	25.15	27.77	30.62	33.56	29.28	28.99
	Mean	23.67	26.26	28.57	31.08	27.39	
'Pant Sudarshan'	D_1	20.32	22.53	24.99	27.62	23.87	
	D_2	22.63	24.48	26.42	28.79	25.58	
	D_3	23.98	25.80	28.01	30.82	27.15	

Table.2 Contd…

	Mean	22.31	24.27	26.47	29.08	25.53	
'Pant Suvarna'	D_1	25.76	28.33	30.89	33.10	29.52	
	D_2	26.77	28.59	30.76	34.13	30.06	
	D_3	27.52	29.88	31.56	33.19	30.54	
	Mean	26.68	28.93	31.07	33.47	30.04	
	Mean (S)	24.22	26.48	28.70	31.21		
		Non-reducing sugars, %					
'Pant Manohar'	D_1	35.51	31.55	28.08	25.34	29.56	29.39
	D_2	35.56	31.56	27.56	23.77	29.62	29.85
	D_3	36.50	32.00	28.37	24.42	30.35	30.22
	Mean	35.84	31.90	27.93	23.86	29.84	
'Pant Sudarshan'	D_1	33.14	30.28	27.87	23.13	28.17	
	D_2	33.71	31.62	28.13	23.57	29.15	
	D_3	34.08	30.28	25.91	24.22	29.21	
	Mean	33.64	30.73	27.37	23.63	28.84	
'Pant Suvarna'	D_1	36.63	33.23	28.99	24.22	30.46	
	D_2	36.64	32.58	28.47	24.44	30.77	
	D_3	37.26	33.44	28.90	24.82	31.10	
	Mean	36.80	32.89	28.79	24.49	30.78	
	Mean (S)	35.43	31.84	28.03	23.99		
		Total sugars, %					
'Pant Manohar'	D_1	60.68	58.83	56.79	55.11	59.09	58.46
	D_2	62.26	61.06	58.69	56.78	60.75	59.10
	D_3	62.43	61.76	61.12	59.06	61.30	60.43
	Mean	62.00	60.88	58.87	58.35	60.38	
'Pant Sudarshan'	D_1	58.90	56.83	54.86	53.14	55.93	
	D_2	59.85	57.71	55.43	53.82	56.70	
	D_3	61.37	59.02	57.35	55.63	58.34	
	Mean	60.04	57.85	55.88	54.20	56.99	
'Pant Suvarna'	D_1	61.31	60.20	58.17	56.70	60.35	
	D_2	62.84	61.87	60.38	58.48	59.84	
	D_3	63.72	62.75	61.15	59.87	61.67	
	Mean	62.41	61.28	59.89	60.32	60.62	
	Mean (S)	61.48	60.00	58.21	57.62		
		Titratable acidity, %					
'Pant Manohar'	D_1	1.50	1.64	1.93	2.08	1.79	1.80
	D_2	1.30	1.44	1.67	1.96	1.59	1.64
	D_3	1.11	1.36	1.60	1.83	1.47	1.44
	Mean	1.30	1.48	1.73	1.96	1.62	
'Pant Sudarshan'	D_1	1.66	1.78	2.08	2.27	1.95	
	D_2	1.54	1.70	1.97	2.13	1.84	

Table.2 Contd…

	D_3	1.17	1.37	1.51	1.88	1.48	
'Pant Suvarna'	Mean	1.46	1.62	1.85	2.09	1.76	
	D_1	1.38	1.56	1.75	1.97	1.66	
	D_2	1.27	1.37	1.47	1.82	1.48	
	D_3	0.93	1.24	1.46	1.86	1.37	
	Mean	1.19	1.39	1.56	1.88	1.51	
	Mean (S)	1.32	1.50	1.71	1.98		
		Ascorbic acid, mg/100g					
'Pant Manohar'	D_1	7.63	6.51	4.81	3.71	5.66	6.34
	D_2	8.86	7.17	5.63	5.06	6.68	7.27
	D_3	11.00	9.48	7.57	5.65	8.42	8.76
	Mean	9.16	7.72	6.00	4.80	6.93	
'Pant Sudarshan'	D_1	11.32	9.68	6.75	5.39	8.28	
	D_2	13.24	10.21	7.70	6.13	9.32	
	D_3	13.92	12.03	10.19	8.58	11.25	
	Mean	12.82	10.74	8.21	6.70	9.62	
'Pant Suvarna'	D_1	6.85	5.48	4.64	3.40	5.09	
	D_2	7.30	6.45	5.11	4.44	5.82	
	D_3	8.30	7.55	5.60	5.04	6.62	
	Mean	7.48	6.49	5.11	4.29	5.84	
	Mean (S)	9.83	8.32	6.44	5.27		
		Pectin, %					
'Pant Manohar'	D_1	0.95	0.92	0.87	0.82	0.89	0.90
	D_2	0.99	0.95	0.91	0.89	0.94	0.97
	D_3	0.93	0.91	0.89	0.87	0.88	0.88
	Mean	0.95	0.92	0.89	0.86	0.91	
'Pant Sudarshan'	D_1	0.94	0.93	0.89	0.82	0.89	
	D_2	0.97	0.95	0.89	0.82	0.91	
	D_3	0.91	0.87	0.81	0.80	0.85	
	Mean	0.94	0.91	0.86	0.81	0.88	
'Pant Suvarna'	D_1	0.96	0.94	0.91	0.88	0.92	
	D_2	1.22	1.16	0.99	0.97	1.08	
	D_3	0.95	0.92	0.90	0.89	0.91	
	Mean	1.04	1.01	0.93	0.91	0.97	
	Mean (S)	0.97	0.94	0.89	0.86		
		Non-enzymatic browning, OD at 440 nm					
'Pant Manohar'	D_1	0.23	0.27	0.38	0.48	0.34	0.34
	D_2	0.24	0.31	0.40	0.49	0.36	0.36
	D_3	0.27	0.34	0.45	0.52	0.39	0.39
	Mean	0.24	0.30	0.41	0.50	0.36	
'Pant Sudarshan'	D_1	0.22	0.25	0.36	0.47	0.32	
	D_2	0.23	0.28	0.38	0.49	0.34	

Table.2 Contd…

	D_3	0.25	0.30	0.41	0.49	0.36	
'Pant Suvarna'	Mean	0.23	0.28	0.38	0.48	0.34	
	D_1	0.25	0.30	0.39	0.48	0.35	
	D_2	0.27	0.33	0.41	0.51	0.38	
	D_3	0.28	0.35	0.48	0.57	0.42	
	Mean	0.26	0.33	0.42	0.52	0.39	
	Mean (S)	0.24	0.30	0.41	0.50		
		Yeast and mold count, cfu/g					
'Pant Manohar'	D_1	ND	ND	ND	ND	ND	ND
	D_2	ND	ND	ND	ND	ND	ND
	D_3	ND	ND	ND	ND	ND	ND
	Mean	ND	ND	ND	ND	ND	
'Pant Sudarshan'	D_1	ND	ND	ND	ND	ND	
	D_2	ND	ND	ND	ND	ND	
	D_3	ND	ND	ND	ND	ND	
	Mean	ND	ND	ND	ND	ND	
'Pant Suvarna'	D_1	ND	ND	ND	ND	ND	
	D_2	ND	ND	ND	ND	ND	
	D_3	ND	ND	ND	ND	ND	
	Mean	ND	ND	ND	ND	ND	
	Mean (S)	ND	ND	ND	ND		
$CD_{0.05}$							
Moisture: C=0.241; D=0.241; S=0.279; CxD=0.418; CxS=0.483; DxS=0.483; CxDxS=0.837							
TSS: C=0.152; D=0.152; S=0.176; CxD=0.264; CxS=0.305; DxS=0.305; CxDxS=0.528							
Reducing sugar: C=0.177; D=0.177; S=0.204; CxD=0.307; CxS=0.354; DxS=0.354; CxDxS=0.614							
Non-reducing sugar: C=0.302; D=0.302; S=0.349; CxD=0.524; CxS=0.605; DxS=0.605; CxDxS=1.049							
Total sugar: C=1.419; D=1.419; S=1.639; CxD=2.453; CxS=2.839; DxS=2.839; CxDxS=4.915							
Titratable acidity: C=0.011; D=0.011; S=0.013; CxD=0.019; CxS=0.023; DxS=0.023; CxDxS=0.039							
Ascorbic acid: C=0.168; D=0.168; S=0.194; CxD=0.292; CxS=0.337; DxS=0.337; CxDxS=0.584							
Pectin: C=0.007; D=0.007; S=0.008; CxD=0.012; CxS=0.014; DxS=0.014; CxDxS=0.024							
Non-enzymatic browning: C=0.005; D=0.005; S=0.006; CxD=0.008; CxS=0.010; DxS=0.010; CxDxS=0.017							
Yeast and mold: C=ND; D=ND; S=ND; CxD=ND; CxS=ND; DxS=ND; CxDxS=ND							
D_1 = 40 days after fruit set; D_2 =60 days after fruit set; D_3 =80 days after fruit set; C=Cultivar; D=Picking date;							
S=Storage interval							

Table.3 Change in sensory score of karonda jelly on storage

Cultivar	Picking dates (days)	Storage interval (months)				Mean (C)	Mean (D)
		0	3	6	9		
			Colour				
'Pant Manohar'	D_1	8.72	8.53	8.32	8.24	8.45	8.28
	D_2	8.95	8.79	8.71	8.50	8.74	8.36
	D_3	8.27	8.11	7.97	7.84	8.05	7.81
	Mean	8.65	8.48	8.33	8.19	8.41	
'Pant Sudarshan'	D_1	8.47	8.37	8.29	8.09	8.31	
	D_2	8.68	8.56	8.44	8.28	8.49	
	D_3	8.23	8.18	8.08	8.00	8.12	
	Mean	8.46	8.37	8.26	8.13	8.30	
'Pant Suvarna'	D_1	8.28	8.12	8.03	7.97	8.09	
	D_2	7.99	7.90	7.85	7.64	7.85	
	D_3	7.48	7.31	7.20	7.08	7.27	
	Mean	7.91	7.78	7.69	7.56	7.74	
	Mean (S)	8.34	8.21	8.09	7.96		
			Appearance				
'Pant Manohar'	D_1	8.65	8.48	8.29	8.22	8.41	8.24
	D_2	8.86	8.77	8.69	8.48	8.70	8.31
	D_3	8.26	8.06	7.96	7.83	8.03	7.77
	Mean	8.59	8.44	8.31	8.17	8.38	
'Pant Sudarshan'	D_1	8.44	8.35	8.25	8.08	8.28	
	D_2	8.63	8.52	8.41	8.23	8.44	
	D_3	8.18	8.09	8.03	7.99	8.07	
	Mean	8.41	8.32	8.23	8.10	8.26	
'Pant Suvarna'	D_1	8.21	8.10	7.97	7.91	8.05	
	D_2	7.97	7.89	7.80	7.50	7.79	
	D_3	7.43	7.29	7.11	7.03	7.21	
	Mean	7.87	7.76	7.63	7.48	7.68	
	Mean (S)	8.29	8.17	8.05	7.92		
			Flavour				
'Pant Manohar'	D_1	8.55	8.36	8.21	8.18	8.32	8.09
	D_2	8.90	8.85	8.79	8.65	8.80	8.41
	D_3	8.24	8.33	7.99	7.87	8.11	7.86
	Mean	8.56	8.51	8.33	8.23	8.41	
'Pant Sudarshan'	D_1	8.27	8.18	8.04	7.87	8.09	
	D_2	8.48	8.34	8.18	7.89	8.22	
	D_3	8.14	8.03	7.94	7.63	7.94	

Table.2 Contd…

	Mean	8.29	8.18	8.05	7.79	8.08	
'Pant Suvarna'	D_1	8.20	8.01	7.78	7.52	7.88	
	D_2	8.48	8.31	8.16	7.94	8.22	
	D_3	7.88	7.59	7.43	7.26	7.54	
	Mean	8.19	7.97	7.79	7.57	7.88	
	Mean (S)	8.35	8.22	8.05	7.86		
		Taste					
'Pant Manohar'	D_1	8.70	8.58	8.42	8.27	8.49	8.23
	D_2	8.96	8.86	8.82	8.77	8.85	8.51
	D_3	8.32	8.20	8.04	7.90	8.11	7.93
	Mean	8.66	8.54	8.42	8.31	8.48	
'Pant Sudarshan'	D_1	8.37	8.28	8.05	7.87	8.14	
	D_2	8.57	8.43	8.27	8.05	8.33	
	D_3	8.20	8.11	7.95	7.77	8.01	
	Mean	8.38	8.27	8.08	7.89	8.16	
'Pant Suvarna'	D_1	8.29	8.18	7.96	7.82	8.06	
	D_2	8.57	8.43	8.34	8.16	8.37	
	D_3	7.95	7.72	7.57	7.46	7.68	
	Mean	8.27	8.11	7.95	7.81	8.04	
	Mean (S)	8.43	8.31	8.15	8.00		
		Consistency					
'Pant Manohar'	D_1	8.67	8.53	8.39	8.27	8.46	8.43
	D_2	8.82	8.71	8.55	8.34	8.60	8.46
	D_3	8.40	8.31	8.24	7.99	8.23	8.09
	Mean	8.63	8.51	8.39	8.20	8.43	
'Pant Sudarshan'	D_1	8.50	8.37	8.22	8.09	8.30	
	D_2	8.74	8.59	8.37	8.21	8.48	
	D_3	8.23	8.11	8.06	7.91	8.08	
	Mean	8.49	8.36	8.21	8.07	8.28	
'Pant Suvarna'	D_1	8.76	8.62	8.47	8.25	8.53	
	D_2	8.45	8.32	8.24	8.13	8.28	
	D_3	8.22	8.04	7.92	7.72	7.97	
	Mean	8.47	8.32	8.21	8.03	8.26	
	Mean (S)	8.53	8.40	8.27	8.10		
		Overall acceptability					
'Pant Manohar'	D_1	8.66	8.50	8.33	8.24	8.43	8.25
	D_2	8.90	8.79	8.71	8.55	7.92	8.41
	D_3	8.30	8.16	8.04	7.88	8.09	7.89
	Mean	8.62	8.48	8.36	8.22	8.42	
'Pant Sudarshan'	D_1	8.41	8.31	8.17	8.00	8.22	
	D_2	8.62	8.49	8.33	8.13	8.39	

Table.2 Contd…

	D_3	8.19	8.10	8.01	7.86	8.04	
'Pant Suvarna'	Mean	8.41	8.30	8.17	8.00	8.22	
	D_1	8.35	8.21	8.04	7.89	8.12	
	D_2	8.29	8.17	8.07	7.87	8.10	
	D_3	7.79	7.59	7.44	7.31	7.53	
	Mean	8.15	7.99	7.85	7.69	7.92	
	Mean (S)	8.39	8.26	8.12	7.97		
$CD_{0.05}$							
Colour: C=0.021; D=0.021; S=0.024; CxD=0.037; CxS=0.043; DxS=0.043; CxDxS=0.074							
Appearance: C=0.027; D=0.027; S=0.031; CxD=0.047; CxS=0.055; DxS=0.055; CxDxS=0.095							
Flavour: C=0.036; D=0.036; S=0.041; CxD=0.062; CxS=0.072; DxS=0.072; CxDxS=0.125							
Taste: C=0.020; D=0.020; S=0.023; CxD=0.035; CxS=0.041; DxS=0.041; CxDxS=0.071							
Consistency: C=0.016; D=0.016; S=0.019; CxD=0.028; CxS=0.033; DxS=0.033; CxDxS=0.057							
Overall acceptability: C=0.012; D=0.012; S=0.013; CxD=0.020; CxS=0.024; DxS=0.024; CxDxS=0.041							
D_1 = 40 days after fruit set; D_2 =60 days after fruit set; D_3 =80 days after fruit set; C=Cultivar; D=Picking date; S=Storage interval							
* Source on 9-Point Hedonic Scale by 7 panelists (Like extremely–9, like very much–8, like moderately–7, like slightly–6, neither like nor dislike–5, dislike slightly –4, dislike moderately –3, dislike very much -2, and dislike extremely–1)							

Among picking dates, the highest sensory scores for colour, appearance, taste and overall acceptability were observed in the jelly prepared at 60 days after fruit set which might be due to their higher sensory scores for colour, appearance, taste and overall acceptability at the time of preparation, whereas, the highest sensory score for consistency was observed in the jelly prepared at 60 days after fruit set which might be due to the higher pectin content in fruits at 60 days after fruit set. The sensory score for colour, appearance, taste, consistency and overall acceptability followed decreasing trend during nine months of storage. A general trend was observed in reduction of sensory scores during storage period which might be attributed to change in chemical composition of jelly, change in sugar-acid blend and loss of aromatic compounds due to oxidation. The decrease in sensory score for colour and appearance during storage were observed which might be due to non-enzymatic browning reactions (millard reaction). This might be attributed to the oxidation of ascorbic acid into dehydroascorbic acid and tannins to gallic acid. The increase in sensory score of flavour during storage was probably due to the breakdown of volatile compounds. The sensory score of consistency was decreased continuously with increase in storage period which might be due to the decrease in the pectin content of jelly. Similar observations have been reported by Chaudhary *et al.,* (2007) and Joshi and Jain (2006) in karonda jelly, Barmanray *et al.,* (1996) in guava jelly and Selvamuthukumaran (2007) in sea buckthorn jelly.

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