DOI : 10.5958/0974-0112.2016.00059.1

Indian J. Hort. 73(2), June 2016: 267-273

Studies on suitability of cultivars, picking dates and drying methods for the preparation of *karonda* (*Carissa carandus* L.) fruit powder

Deepika Saxena, K.K. Misra and Ratna Rai*

Department of Horticulture, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar 263145, Uttarakhand

ABSTRACT

Three cultivars of *karonda* (*Carissa carandus* L.), *viz.*, Pant Suvarna, Pant Manohar and Pant Sudarshan were picked at 40, 55 and 70 days after fruit set and used for the preparation of fruit powder. The powder was prepared by two methods of drying, *i.e.*, Sun and cabinet drying. The maximum yield (21.7%) of powder was obtained in the sun-dried samples of Pant Sudarshan. Highest ascorbic acid content (30.45 mg/100 g) was found in the cabinet dried samples of 70-day-old fruits of cv. Pant Sudarshan. Phosphorus (0.447%), potassium (18.73%), iron (0.365 mg/100 g), copper (0.012 mg/100 g), and manganese (0.193 mg/100 g) contents were higher in the powder prepared from the fruits of cv. Pant Suvarna. Among the drying methods, cabinet drying resulted in better retention of nutrients and less non-enzymatic browning. In general, organoleptic score in respect of colour, texture and overall acceptability was more in cabinet-dried powder of *karonda* fruits picked 70 days after fruit set.

Key words: *Carissa carandus* L., drying, physico-chemical characters, storage.

INTRODUCTION

Karonda (*Carissa carandas* L.) known as 'Christ's Thorn' is a hardy, spiny, evergreen, multipurpose horticultural bush flourishing well without much care in the arid and semi-arid areas. It is an indigenous fruit of India and belongs to the family Apocynaceae. The fresh fruits of *karonda* are less popular due to their sour and astringent taste but are one of the richest sources of iron (0.46-4.95 mg/100 g) and contain appreciable amount of vit. C (1.6-17.90 mg/100 g), besides other minerals required for human health (Misra, 13). Therefore, the fruits are very much helpful in curing anaemia. The fruits possess appreciable amount of jelly grade pectin and acidity (Rai and Misra, 16). Though, fresh fruits of *karonda* are not much popular but have great potential for processing into several value-added products such as pickle, chutney, jelly, candy, squash, sauce, jam *etc*. Among the various processing methods, drying and dehydration of fruits is an important alternative in reducing post-harvest losses of fruits. The dried product not only retains most of the nutritive and medicinal properties but is easy to handle, store and transport to long distances. The present investigations were, therefore, undertaken to study the suitability of different *karonda* cultivars picked at different dates of maturity and processed to powder form by two methods of drying.

*Corresponding author's E-mail: ratnarai1975@gmail.com

MATERIALS AND METHODS

The experiment was conducted during 2011-12 in the Department of Horticulture, G.B.P.U.A. & T., Pantnagar. The experimental site is located at 29°N latitude and 79.3°E in the *Tarai* region of Uttarakhand in the foothills of Shivalik ranges at an altitude of 243.84 m above msl. The fruits of three cultivars, *viz.*, Pant Suvarna, Pant Manohar and Pant Sudarshan were picked at three stages of maturity, *i.e.*, 40, 55 and 70 days after fruit set. Fruit powder was prepared by two methods of drying, *viz.*, cabinet and sun drying. For the preparation of powder uniform size, healthy and firm fruits were selected. After thorough washing, the fruits were bleached in 15% brine solution containing 500 ppm potassium meta-bisulphate for 24 h. The fruits were blanched for 2 min. and then before removal of seeds were cut into two halves, which were further cut into three pieces. The pieces were spread uniformly in aluminium trays and were dried both under the sun and in the cabinet drier to 4% moisture level. In the cabinet drier, first the drying of pieces was carried out at 60 ± 1°C to 10% moisture content and then again dried at 70°C to 4% moisture content. The pieces were then cooled to room temperature in desiccators containing fused calcium chloride for about 10 min. and then packed in high density poly-ethylene bags. Later the dried pieces were ground to form powder which was sieved through 30 mesh sieve to obtain uniform samples.

The per cent yield of powder was calculated by dividing the weight of final product by the weight of fresh fruits. Moisture content of the powder was determined as per the method of AOAC (3) by drying the samples at 60 ± 1°C till constant weight was obtained. TSS was determined by Erma hand refractometer and expressed in °Brix at 20°C (Ranganna, 17). The titratable acidity, ascorbic acid, crude protein and crude fat were calculated as per the methods outlined by Ranganna (17). For determination of the minerals, the sample was digested in di-acid mixture of HNO_3: $HClO_4$ (9:4). Phosphorus was estimated by vandomolybdo phosphoric yellow colour method (Jackson, 9). Potassium and calcium were estimated by flame photometer (Chapman and Pratt, 4). Magnesium content was indirectly calculated by EDTA method (Cheng and Bray, 5). The micronutrients, *viz*., zinc, iron, manganese and copper contents were estimated by atomic absorption spectrophotometer (Model GBC-6). Non-enzymatic browning was estimated by recording the transmittance of filtrate at 440 mm and was expressed in terms of optical density (Ranganna, 17). Microbial analysis was carried out as per the procedure of APHA (1). Organoleptic evaluation was done by a panel of 12 judges and a 9 point hedonic scale was used for calculating the mean scores (Amerine *et al.*, 2). The samples were also analyzed for moisture, acidity, ascorbic acid, non enzymatic browning, organoleptic evaluation and bacterial and mould counts after 4-month storage period. The data were subjected to analysis of variance using Factorial Completely Randomized Design (Cochran and Cox, 6). The critical differences at 0.05 level of probability were worked out for comparing the means.

RESULTS AND DISCUSSION

The effect of cultivars, picking dates and drying methods on chemical composition of powder of *karonda* fruit is presented in Table 1. The highest yield of powder (22.7%) was recorded from sun-dried fruits of cv. Pant Sudarshan harvested 40 days after fruit set, while the lowest yield (19.34%) was recorded in the powder prepared from cabinet dried fruits of cv. Pant Manohar harvested at 70 days after fruit set. Cabinet dried fruits of cv. Pant Manohar harvested at 40 days after fruit set recorded the lowest moisture content (11.60%), while in general all the sun dried samples had higher moisture content. The higher rate of drying in cabinet drier as compared to sun drying resulted in higher titratable acidity of the cabinet dried samples. Dabhade and Khedkar (7) also reported increase in titratable acidity in the oven-dried mango powder as compared to sun dried samples. Similar results have also been observed by Rai and Misra (15) in the cabinet dried powder of *bael*. Highest titratable acidity (15.36%) was recorded in the powder prepared from the fruits of cv. Pant Sudarshan harvested 40 days after fruit set and dried in cabinet drier.

There was significant difference in the ascorbic acid content of the powders prepared from various cultivars. The highest ascorbic acid content in fresh as well as stored samples was found in cabinet dried samples of cv. Pant Sudarshan. The ascorbic acid loss was more during sun-drying as compared to cabinet drying. This might have been due to higher rate of oxidation of ascorbic acid during sun-drying (low temperature long time process) as compared to cabinet drying, which is high temperature short time process (Mrak and Phaff, 12). The sun-dried samples showed higher non-enzymatic browning than the respective cabinet dried samples. The variation in genetic constitution of the cultivars, moisture content of powder and phenolics significantly affected non enzymatic browning (Mayer and Harel, 11). The drying parameters and types of oxidation reactions taking place between different components of the samples might also have affected the non-enzymatic browning.

The data on analysis of proximate composition (Table 2) reveal that maximum crude fibre content (8.10%) was obtained in the sun-dried samples prepared from fruits of cv. Pant Sudarshan harvested 70 days after fruit set. In cabinet drying, there might have been some destruction of fibre content due to constant high temperature (Rai and Misra, 15). The crude protein content was higher in the sun-dried samples. During cabinet drying, some of proteins might have interacted with peroxides produced during lipid oxidation resulting in protein damage during cabinet drying. The protein efficiency ratio (PER) might also have reduced at higher temperature in cabinet drying (Rai and Misra, 16). The carbohydrate (68.49%) and fat (5.28%) contents were higher in the cabinet dried powder of cv. Pant Suvarna fruits harvested 40 days after fruit set. The ash content was found to be higher in the sun-dried powder (19.91%) prepared from fruits of cv. Pant Manohar harvested 70 days after fruit set. During sun-drying, chances of mixing of impurities from the atmosphere in terms of dust and dirt was more, which probably increased the ash content of the samples.

The data on mineral composition of *karonda* fruit powder are presented in Table 3. Pant Suvarna was rich in phosphorus (0.447%), potassium (18.73%), calcium (4.53%), copper (0.012 mg/100 g), iron (0.365 mg/ 100 g) and manganese (0.193 mg/ 100 g). Pant Sudarshan gave higher zinc (0.098 mg/100 g)

Table 1. Effect of cultivars, picking dates and drying methods on chemical composition of *karonda* fruit powder.

Parameter		Pant Suvarna			Mean	Pant Manohar			Mean	Pant Sudarshan			Mean
		D_1	D_2	D_3		D_1	D_2	D_3		D_1	D_2	D_3	
Yield (%)	M_1	13.7 (21.7)	12.5 (20.7)	12.0 (20.3)	12.7 (20.9)	12.0 (20.3)	11.5 (19.84)	11.04 (19.4)	11.5 (19.84)	14.9 (22.7)	13.2 (21.3)	13 (21.1)	13.7 (21.7)
	M_2	13.6 (21.7)	12.4 (20.6)	11.9 (20.2)	12. 6 (20.8)	11.9 (20.2)	11.4 (19.8)	10.9 (19.34)	11.4 (19.8)	14.8 (22.6)	13.1 (21.2)	12.9 (21)	13.6 (21.6)
Mean		13.6 (21.7)	12.4 (20.6)	11.9 (20.2)		11.9 (20.2)	11.4 (19.8)	10.9 (19.37)		14.8 (22.6)	13.1 (21.2)	12.9 (21)	
CD at 5%		C = 0.075				D = 0.075			M = 0.061			C×D×M = 0.184	
Moisture (%)	M_1	4.14 (11.73)	4.15 (11.75)	4.28 (11.94)	4.19 (11.80)	4.22 (11.85)	4.37 (12.07)	4.40 (12.10)	4.33 (12.00)	4.15 (11.76)	4.23 (11.87)	4.49 (12.24)	4.29 (11.95)
	M_2	4.04 (11.59)	4.07 (11.64)	4.16 (11.76)	4.09 (11.66)	4.16 (11.77)	4.21 (11.84)	4.29 (11.96)	4.22 (11.85)	4.05 (11.60)	4.10 (11.69)	4.24 (11.88)	4.13 (11.72)
Mean		4.09 (11.66)	4.11 (11.69)	4.22 (11.85)		4.19 (11.81)	4.29 (11.96)	4.34 (12.03)		4.1 (11.68)	4.16 (11.78)	4.36 (12.06)	
CD at 5 %		C = 0.01				D = 0.01			M = 0.01			C×D×M = 0.03	
Titratable acidity (%)	M_1	4.44 (12.16)	3.99 (11.52)	3.05 (10.06)	3.82 (11.24)	5.56 (13.63)	4.95 (12.85)	3.75 (11.17)	4.75 (12.55)	5.99 (14.16)	5.05 (12.99)	4.00 (11.53)	5.01 (12.89)
	M_2	6.02 (14.20)	5.35 (13.38)	4.87 (12.75)	5.41 (13.44)	6.88 (15.21)	5.87 (14.02)	4.45 (12.18)	5.73 (13.80)	7.02 (15.36)	5.95 (14.12)	5.58 (13.66)	6.18 (14.38)
Mean		5.23 (13.18)	4.67 (12.45)	3.96 (11.40)		6.22 (14.42)	5.41 (13.43)	4.1 (11.67)		6.50 (14.76)	5.5 (13.55)	4.79 (12.59)	
CD at 5%		C = 0.07				D = 0.07			M = 0.06			C×D×M = 0.18	
Ascorbic acid (mg/ 100 g)	M_1	12.40	13.11	14.85	13.45	17.44	18.21	19.86	18.50	18.42	18.88	22.16	19.82
	M_2	23.09	24.12	26.86	24.69	25.89	26.01	26.43	26.11	27.58	28.04	30.45	28.69
Mean		17.74	18.61	20.85		21.66	22.11	23.14		23.00	23.46	26.30	
CD at 5%		C = 0.18				D = 0.18			M = 0.15			C×D×M = 0.45	
Non enzymatic browning (nm)	M_1	12.40	16.30	18.30	15.66	13.60	14.80	10.70	13.03	16.70	13.00	19.70	16.46
	M_2	9.10	14.30	15.70	13.03	9.59	10.70	9.30	9.86	12.40	11.30	16.70	13.46
Mean		10.75	15.3	17.00		11.59	12.75	10.00		14.55	12.15	18.20	
CD at 5%		C = 0.275				D = 0.275			M = 0.226			C×D×M = 0.673	

*Figures in parentheses are transformed values; M_1 = Sun-drying, M_2 = Cabinet drying, D_1 = 40 days after fruit set, D_2 = 55 days after fruit set, D_3 = 70 days after fruit set, C = Cultivar

content but was low in calcium and copper contents. The phosphorus, calcium and copper contents were higher in sun dried samples, while potassium content was higher in cabinet-dried samples. This difference might be attributed to the difference in the drying atmosphere (Dubrowska, 8). The differences in nutrient contents of cultivars might be due to the variation in the uptake of the minerals from the soil, their translocation to the leaves and finally their accumulation in the fruits. The interaction of cultivars, picking dates and methods of drying was significant for nitrogen, phosphorus, potassium and the minor elements.

The storage studies revealed that the sun-dried samples gained more moisture despite similar packaging and storage conditions as compared to the cabinet-dried samples but were low in titratable acidity (Table 4). However, the per cent retention of titratable acidity was more in cabinet-dried samples. The loss of ascorbic acid in powder prepared from different cultivars picked at different dates was in the range of 56 to 69 per cent. The maximum ascorbic

Table 2. Effect of cultivars, picking dates and drying methods on proximate composition of *karonda* fruit powder.

Parameter		Pant Suvarna			Mean	Pant Manohar			Mean	Pant Sudarshan			Mean
		D_1	D_2	D_3		D_1	D_2	D_3		D_1	D_2	D_3	
Crude fibre (%)	M_1	1.55 (7.15)	1.61 (7.29)	1.68 (7.46)	1.61 (7.3)	1.29 (6.53)	1.38 (6.74)	1.45 (6.92)	1.37 (6.73)	1.75 (7.60)	1.87 (7.85)	1.98 (8.10)	1.86 (7.85)
	M_2	1.32 (6.59)	1.48 (7.00)	1.45 (6.92)	1.41 (6.83)	1.19 (6.28)	1.25 (6.42)	1.30 (6.55)	1.24 (6.41)	1.69 (7.47)	1.43 (6.76)	1.84 (7.79)	1.65 (7.34)
Mean		1.43 (6.87)	1.54 (7.14)	1.56 (7.19)		1.24 (6.40)	1.31 (6.58)	1.37 (6.73)		1.72 (7.53)	1.65 (7.30)	1.91 (7.94)	
CD at 5%		C = 0.24				D = 0.24			M = 0.20			C×D×M = 0.59	
Crude protein (%)	M_1	1.17 (6.20)	1.35 (6.68)	1.12 (6.07)	1.21 (6.31)	0.913 (5.48)	0.826 (5.21)	0.733 (4.91)	0.824 (5.2)	0.856 (5.30)	0.783 (5.07)	0.613 (4.49)	0.750 (4.95)
	M_2	1.43 (6.88)	1.11 (6.06)	0.866 (5.34)	1.13 (6.09)	0.653 (4.63)	0.610 (4.47)	0.480 (3.97)	0.581 (4.35)	0.683 (4.74)	0.700 (3.97)	0.430 (3.75)	0.604 (4.15)
Mean		1.3 (6.54)	1.23 (6.37)	0.993 (5.70)		0.78 (5.05)	0.718 (4.84)	0.606 (4.44)		0.769 (5.02)	0.741 (4.52)	0.521 (4.12)	
CD at 5%		C = 0.04				D = 0.04			M = 0.04			C×D×M = 0.11	
Crude fat (%)	M_1	0.76 (5.00)	0.64 (4.61)	0.56 (4.31)	0.65 (4.64)	0.68 (4.72)	0.60 (4.45)	0.57 (4.32)	0.61 (4.49)	0.95 (5.59)	0.68 (4.72)	0.25 (2.86)	0.62 (4.39)
	M_2	0.85 (5.28)	0.71 (4.84)	0.61 (4.50)	0.72 (4.87)	0.74 (4.95)	0.71 (4.83)	0.66 (4.65)	0.70 (4.81)	1.03 (5.82)	0.79 (5.09)	0.39 (3.58)	0.73 (4.83)
Mean		0.81 (5.14)	0.67 (4.72)	0.58 (4.40)		0.71 (4.83)	0.65 (4.64)	0.61 (4.48)		0.99 (5.70)	0.73 (4.90)	0.32 (3.22)	
CD at 5%		C = 0.07				D = 0.07			M = 0.06			C×D×M = 0.18	
Total ash (%)	M_1	6.6 (14.88)	7.2 (15.56)	10.4 (18.81)	8.06 (16.41)	9.8 (18.24)	10.4 (18.81)	11.6 (19.91)	10.6 (18.98)	9.6 (18.04)	10 (18.43)	10.8 (19.18)	10.1 (18.55)
	M_2	5.8 (13.93)	6.2 (14.41)	9.4 (17.85)	7.13 (15.39)	8 (16.40)	9 (17.44)	10.2 (18.65)	9.06 (17.49)	8.6 (17.05)	9.4 (17.85)	9.6 (18.04)	9.2 (17.64)
Mean		6.2 (14.40)	6.7 (14.98)	9.9 (18.33)		8.9 (17.32)	9.7 (18.12)	10.9 (19.28)		9.1 (17.54)	9.7 (18.14)	10.2 (18.61)	
CD at 5%		C = 0.25				D = 0.25			M = 0.21			C×D×M = 0.63	
Total carbohydrates (%)	M_1	85.24 (67.40)	85.03 (67.23)	81.95 (64.85)	84.07 (66.49)	83.07 (65.70)	82.42 (65.21)	81.28 (64.36)	82.25 (65.09)	82.68 (65.41)	82.42 (65.21)	81.85 (64.78)	82.31 (65.13)
	M_2	86.56 (68.49)	86.49 (68.43)	83.52 (66.04)	85.52 (67.65)	85.23 (67.39)	84.22 (66.59)	83.07 (65.70)	84.17 (66.56)	83.95 (66.38)	83.23 (65.82)	83.5 (66.03)	83.56 (66.07)
Mean		85.9 (67.94)	85.76 (67.83)	82.73 (65.44)		84.15 (66.54)	83.32 (65.90)	82.17 (65.03)		83.31 (65.89)	82.82 (65.51)	82.67 (65.51)	
CD at 5%		C = 0.07				D = 0.07			M = 0.06			C×D×M = 0.18	

*Figures in parentheses are transformed values; M_1 = Sun-drying, M_2 = Cabinet drying, D_1 = 40 days after fruit set, D_2 = 55 days after fruit set, D_3 = 70 days after fruit set, C = Cultivar

acid (20.17 mg/100 g) content was recorded in cabinet-dried samples of cv. Pant Sudarshan picked at 70 days after fruit set and minimum ascorbic acid content (6.05 mg/100 g) was recorded in sun-dried samples of Pant Suvarna picked at 40 days after fruit set. Khurdiya and Roy (10) reported 85 to 91 per cent loss of ascorbic acid after 6 month storage of guava powder. The fluctuating storage conditions in terms of temperature and humidity might have contributed to the loss of ascorbic acid. Cabinet-dried samples of cv. Pant Suvarna showed least non-enzymatic browning (12.89 nm), while the samples of cv. Pant Sudarshan showed maximum browning (19.68 nm) after 4 months storage. The per cent increase in browning

Table 3. Effect of cultivars, picking dates and drying methods on mineral composition of *karonda* fruit powder.

Parameter		Pant Suvarna			Mean	Pant Manohar			Mean	Pant Sudarshan			Mean
		D_1	D_2	D_3		D_1	D_2	D_3		D_1	D_2	D_3	
Phosphorus (%)	M_1	0.006 (0.455)	0.006 (0.443)	0.006 (0.443)	0.006 (0.447)	0.007 (0.479)	0.005 (0.405)	0.005 (0.405)	0.005 (0.429)	0.006 (0.455)	0.006 (0.443)	0.004 (0.376)	0.005 (0.424)
	M_2	0.004 (0.362)	0.004 (0.376)	0.005 (0.418)	0.004 (0.385)	0.004 (0.362)	0.003 (0.346)	0.004 (0.362)	0.0036 (0.356)	0.005 (0.405)	0.005 (0.405)	0.002 (0.256)	0.004 (0.355)
Mean		0.005 (0.408)	0.005 (0.409)	0.005 (0.430)		0.0055 (0.280)	0.004 (0.375)	0.004 (0.362)		0.005 (0.43)	0.005 (0.424)	0.003 (0.316)	
CD at 5%		C = 0.009				D = 0.009			M = 0.007				C×D×M = 0.022
Potassium (%)	M_1	10.30 (18.71)	10.20 (18.62)	9.66 (18.11)	10.05 (18.48)	9.70 (18.14)	9.53 (17.98)	9.40 (17.85)	9.54 (17.99)	10.10 (18.53)	9.60 (18.04)	9.20 (17.65)	9.63 (18.07)
	M_2	10.56 (18.96)	10.30 (18.71)	10.10 (18.53)	10.32 (18.73)	10.10 (18.53)	9.60 (18.04)	9.30 (17.75)	9.66 (18.10)	10.20 (18.62)	9.83 (18.27)	9.33 (17.78)	9.78 (18.02)
Mean		10.43 (18.83)	10.25 (18.66)	9.88 (18.32)		9.9 (18.33)	9.56 (18.01)	9.35 (17.80)		10.15 (18.57)	9.71 (18.15)	9.26 (17.71)	
CD at 5%		C = 0.019				D = 0.019			M = 0.015				C×D×M = 0.047
Calcium (%)	M_1	0.530 (4.17)	0.620 (4.51)	0.740 (4.93)	0.630 (4.53)	0.490 (4.01)	0.590 (4.40)	0.696 (4.78)	0.592 (4.39)	0.413 (3.68)	0.536 (4.20)	0.613 (4.49)	0.520 (4.12)
	M_2	0.496 (4.04)	0.580 (4.36)	0.690 (4.38)	0.588 (4.38)	0.453 (3.85)	0.550 (4.25)	0.660 (4.65)	0.554 (4.25)	0.370 (3.48)	0.500 (4.05)	0.580 (4.36)	0.483 (3.96)
Mean		0.513 (4.10)	0.60 (4.43)	0.715 (4.845)		0.471 (3.93)	0. 570 (4.32)	0.678 (4.71)		0.391 (3.58)	0.518 (4.12)	0.596 (4.42)	
CD at 5%		C = 0.050				D = 0.050			M = 0.041				C×D×M = 0.124
Zinc (mg/100 g)	M_1	0.096	0.068	0.094	0.086	0.087	0.077	0.075	0.079	0.125	0.100	0.063	0.096
	M_2	0.088	0.091	0.103	0.094	0.050	0.089	0.074	0.071	0.150	0.078	0.067	0.098
Mean		0.092	0.079	0.098		0.068	0.083	0.082		0.137	0.089	0.062	
CD at 5%		C = 0.0001				D = 0.0001			M = 0.0001				C×D×M = 0.0004
Copper (mg/100 g)	M_1	0.016	0.010	0.012	0.012	0.015	0.011	0.010	0.012	0.011	0.013	0.008	0.010
	M_2	0.011	0.010	0.010	0.010	0.005	0.009	0.009	0.007	0.005	0.005	0.005	0.005
Mean		0.013	0.01	0.011		0.01	0.01	0.009		0.008	0.009	0.006	
CD at 5%		C = 0.0006				D = 0.0006			M = 0.0005				C×D×M = 0.0016
Iron (mg/100 g)	M_1	0.055	0.041	0.053	0.049	0.282	0.014	0.007	0.101	0.066	0.140	0.066	0.090
	M_2	0.719	0.169	0.208	0.365	0.060	0.129	0.059	0.082	0.130	0.078	0.056	0.088
Mean		0.387	0.105	0.130		0.171	0.071	0.033		0.098	0.109	0.061	
CD at 5%		C = 0.0007				D = 0.0007			M = 0.0006				C×D×M = 0.0018
Manganese (mg/100 g)	M_1	0.023	0.170	0.180	0.124	0.190	0.020	0.019	0.076	0.019	0.019	0.019	0.019
	M_2	0.180	0.210	0.190	0.193	0.180	0.020	0.018	0.072	0.021	0.017	0.013	0.017
Mean		0.101	0.19	0.185		0.185	0.02	0.018		0.02	0.018	0.016	
CD at 5%		C = 0.005				D = 0.005			M = 0.004				C×D×M = 0.014

*Figures in parentheses are transformed value; M_1 = Sun-drying, M_2 = Cabinet drying, D_1 = 40 days after fruit set, D_2 = 55 days after fruit set, D_3 = 70 days after fruit set, C = Cultivar

Table 4. Chemical composition of *karonda* fruit powder after 4 month of storage.

Parameter		Pant Sudarshan			Mean	Pant Manohar			Mean	Pant Suvarna			Mean
		D_1	D_2	D_3		D_1	D_2	D_3		D_1	D_2	D_3	
Moisture (%)	M_1	5.01 (12.94)	5.16 (13.13)	5.25 (13.24)	5.14 (13.10)	5.35 (13.38)	5.44 (13.48)	6.05 (14.24)	5.61 (13.7)	5.10 (13.05)	5.29 (13.30)	5.49 (13.55)	5.29 (13.3)
	M_2	4.94 (12.84)	5.04 (12.97)	5.09 (13.04)	5.02 (12.95)	5.22 (13.20)	5.29 (13.30)	5.77 (13.89)	5.42 (13.46)	4.96 (12.87)	5.17 (13.14)	5.28 (13.29)	5.13 (13.1)
Mean		4.97 (12.89)	5.1 (13.05)	5.17 (13.14)		5.28 (13.29)	5.36 (13.39)	5.91 (14.06)		5.03 (12.96)	5.23 (13.22)	5.38 (13.42)	
CD at 5%		C = 0.010				D = 0.010			M = 0.008				C×D×M = 0.024
Titratable acidity (%)	M_1	3.42 (10.66)	2.98 (9.94)	2.02 (8.17)	2.80 (9.59)	4.55 (12.32)	3.96 (11.47)	2.76 (9.56)	3.75 (11.11)	4.98 (12.89)	4.06 (11.62)	3.01 (9.99)	4.01 (11.5)
	M_2	5.61 (13.69)	4.96 (12.86)	4.45 (12.17)	5.006 (12.90)	6.51 (14.78)	5.48 (13.53)	4.05 (11.61)	5.34 (13.30)	6.61 (14.90)	5.58 (13.66)	5.18 (13.16)	5.79 (13.90)
Mean		4.51 (12.17)	3.97 (11.4)	3.23 (10.17)		5.53 (13.55)	4.72 (12.5)	3.40 (10.58)		5.79 (13.89)	4.82 (12.64)	4.09 (11.57)	
CD at 5%		C = 0.085				D = 0.085			M = 0.069				C×D×M = 0.208
Ascorbic acid (mg/100 g)	M_1	6.05	6.98	7.64	6.89	11.55	12.07	13.01	12.21	12.66	12.92	16.14	13.90
	M_2	11.45	12.31	14.25	12.67	14.46	15.32	17.07	15.61	17.22	18.36	20.17	18.58
Mean		8.75	9.64	10.94		13.01	13.69	15.04		14.94	15.64	18.15	
CD at 5%		C = 0.246				D = 0.246			M = 0.200				C×D×M = 0.602
Non enzymatic browning (nm)	M_1	17.56	18.12	14.01	16.56	15.69	19.33	20.49	18.50	22.08	19.52	25.77	22.45
	M_2	12.13	13.60	12.95	12.89	11.27	18.35	17.45	15.69	18.89	17.58	22.59	19.68
Mean		14.84	15.86	13.48		13.48	18.84	18.97		20.48	18.55	24.18	
CD at 5%		C = 0.260				D = 0.260			M = 0.212				C×D×M = 0.638

*Figures in parentheses are transformed values M_1 = Sun-drying, M_2 = Cabinet drying, D_1 = 40 days after fruit set, D_2 = 55 days after fruit set, D_3 = 70 days after fruit set, C = Cultivar

Table 5. Organoleptic evaluation of fresh *karonda* fruit powder after 4 month storage.

Treatment	Sun-dried						Cabinet-dried					
	Colour		Texture		Overall acceptability		Colour		Texture		Overall acceptibility	
	Fresh powder	After 4 month	Fresh powder	After 4 month	Fresh powder	After 4 month	Fresh powder	After 4 month	Fresh powder	After 4 month	Fresh powder	After 4 month
C_1D_1	5.4	5.4	6.2	6.2	5.4	5.4	5.4	5.4	7.3	7.3	7.3	7.3
C_1D_2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	7.3	7.3	7.3	7.3
C_1D_3	6.2	6.2	7.3	7.3	7.3	7.3	7.3	7.3	8.8	8.8	8.8	8.8
C_2D_1	5.4	4.1	6.2	6.2	6.2	6.2	7.3	7.3	6.2	6.2	7.3	7.3
C_2D_2	5.4	5.4	6.2	6.2	6.2	6.2	6.2	6.2	7.3	7.3	7.3	7.3
C_2D_3	6.2	6.2	7.3	7.3	7.3	7.3	7.3	6.2	7.3	7.3	7.3	7.3
C_3D_1	5.4	4.1	8.8	8.8	6.2	6.2	5.4	5.4	8.8	8.8	6.2	6.2
C_3D_2	6.2	6.2	6.2	6.2	7.3	7.3	6.2	6.2	7.3	7.3	7.3	7.3
C_3D_3	6.2	6.2	6.2	6.2	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3

C_1 = Pant Suvarna, C_2 = Pant Manohar, C_3 = Pant Sudarshan, D_1 = 40 days after fruit set, D_2 = 55 days after fruit set,D_3 = 70 days after fruit set

was more in sun-drying (26) than in cabinet drying (15). This was probably due to the presence of high moisture content in the sun-dried samples, which increased non enzymatic browning during storage. The increase in NEB in samples of *bael* powder after 4 month storage has also been reported by Rai (14). The yeast and mould counts were found to be nil in both the cabinet and sun-dried samples after 4 months storage. This might be due to low moisture content of the samples and hygienic handling during processing and storage of the products. The cabinet dried samples had better organoleptic acceptability (Table 5) than the sun-dried samples due their relatively appealing colour and better texture. The overall organoleptic acceptability of the *karonda* fruit powder after 4 months of storage was again higher in the cabinet-dried powder samples.

The present study showed that the cabinet-dried powder prepared from the fruits of Karonda cv. Pant Suvarna harvested at 70 days after fruit set was better in terms of nutritional quality, which was also retained during storage. Cabinet drying resulted in less non-enzymatic browning and better retention of ascorbic acid.

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Received : January, 2014; Revised : November, 2015; Accepted : January, 2016