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Evaluation of different packaging materials on quality and storability of osmotically preserve Karonda (*Carissa carandas* L.) fruits under refrigerated storage conditions

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Abstract
Karonda fruits were osmotically preserve and packed in three different packaging materials viz. polyethylene, aluminium laminated and shrink packages. The osmotically preserved fruits were stored under refrigerated conditions for six months and analysed for quality and sensory attributes at two months intervals. Aluminium laminated packaging proved to be best among the all packaging in maintaining superior quality up to six months of storage as indicated by higher mean titratable acidity (5.78%), reducing sugars (10.11%), total sugars (37.71%), ascorbic acid (4.77mg/100g) and lower moisture content (11.14%). All the sensory parameters including colour, taste, texture, flavour and overall acceptability declined significantly during storage period of six months.

Keywords: Karonda, packaging material, osmotically preserve, sensory quality

Introduction
Karonda 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 1990) [21]. It is grown as an ornamental plant due to its beautiful cherry like fruits. 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 1997) [8]. Among the various processed products, osmotically preserve Karonda fruit has been proved to be more viable, appropriate and can attract both internal and export market because there is always a great demand from the consumers all over the world for fruit products which are nutritionally rich, medicinally important, delicately flavoured and having good storability. The principle involved in processing of osmotically preserve karonda fruit consists of sweetening of fruits to a high degree, adding preservative and imparting brilliant red colour artificially, so as to make a preserved product that closely resembles canned cherry fruits (Mandal *et al.*, 1992) [12]. Taking into cognizance of the problem, it becomes imperative to develop appropriate technology for the efficient utilization of karonda fruits. Therefore, the present investigation was conducted to study the effect of different packaging materials on quality and storability of karonda under refrigerated conditions.

Materials and Methods
The fruit of karonda were purchased at optimum maturity from local market of Dehradun and brought to the laboratory of Horticulture Department, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, Uttarakhand. Healthy, firm and uniform sized fruits were selected and washed thoroughly with water. The processors opinion is that the original red colour of the fruit surface (anthocyanin pigment) hinders its uniform staining with the red-coloured dye. Hence, just after harvest, the fruits were bleached by suitably steeping in 15 per cent brine solution containing 0.05 per cent potassium metabisulphite (KMS) for 24 hours followed by washing and then removal of seeds were done by giving a half-silt to the fruits with the help of a sharp knife. Thereafter, pricking operation (punching) of fruits was done with a fork specially made for this purpose. Syrup was made by hot

process. To one litre water, added 400 grams sugar, 0.25 per cent citric acid and 0.05 per cent Ponceau Supra 4R powder to fix artificial colour and boiled till TSS reached 40 per cent. After pricking, fruits were steeped in sugar syrup of 40 per cent containing 200 ppm of KMS for 24 hours. After 24 hours, the fruits were removed from syrup and 250 grams sugars were added to raise its concentration. Then the syrup was boiled for 5 minutes and again fruits were steeped for 24 hours. Subsequently the sugar syrup concentration was raised in phased manner till the fruits were steeped in 75 per cent sugar syrup. After that the steeped fruits were removed from the sugar syrup by keeping fruits on sieve and allow to surface drying in shade.

The osmo preserve fruits were packed in three different packaging materials viz., polyethylene packages (25µ), laminated aluminium packages (10µ) and shrink packages (20µ) and stored at refrigerated condition for a period of six months. The experiment consisted of three treatments and four storage intervals with three replications for each treatment and each storage interval. The change in physico-chemical and sensory parameters were evaluated periodically (0 month, 2, 4, 6 months) at two month interval. The moisture content after each interval of storage was determined by drying the samples to a constant weight in a hot air oven at 70 $\pm$ 1^{o}C and expressed in percentage. The titratable acidity, reducing sugars, total sugars and ascorbic acid were estimated as per standard procedures (Ranganna, 2009) [14]. The osmo preserve fruits were evaluated by a panel of 7 semi-trained members using 9 point Hedonic scale for colour, taste, texture and overall acceptability i.e. 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, dislike extremely 1 (Amerine *et al.*, 1965) [3]. Statistical analysis of the data pertaining to the sensory evaluation of osmotically preserve fruits were analysed according to randomized block design (Mahony, 1985) [11] while, that on physico-chemical characteristics by factorial completely randomized design (Cochron and Cox, 1967) [6]. The values were compared at 5% level of significance.

Results and Discussion

A steady increase in mean moisture content of the osmotically preserve karonda fruits from 11.32 to 12.70 per cent was observed with the advancement of storage period (Table 1). Aluminium laminated packaging registered the lowest mean moisture content (11.14%) followed by shrink wrapped packaging (12.68%). The polyethylene packed osmotically preserve fruits, on the other hand, had maximum moisture content and registered average moisture content of 12.99 per cent at the end of the storage period of six months. The moisture content of the osmotically preserve fruits during different storage intervals for polyethylene packaging, aluminium laminated packaging and shrink wrapped packaging ranged between 11.32 - 13.68, 11.32 -11.08 and 11.32-13-33 per cent, respectively between 0 to 6 months of storage. The gradually increase in mean moisture content in osmotically preserve fruits throughout six months of storage might be due to absorption of moisture from atmosphere by the product stored at ambient conditions. Similar results were also reported by Abdelhaq and Labuza (1998) [1] in dried apricot. The higher mean moisture content in osmotically preserve fruits packed in polyethylene packaging during six months of storage was observed which might be attributed to permeability of polyethylene packages to air and water, whereas minimum loss in moisture content in the samples stored in aluminium laminated packages was due to the better moisture barrier properties of the package. A similar trend has also been documented in dried apples (Sharma *et al*., 2016) [22].

During storage period of six months the titratable acidity of osmotically preserve fruits experienced a small reduction from an average initial value of 5.82 to 5.66 per cent. The titratable acidity of osmotically preserve fruits packed in different packaging materials showed a linear declining trend with the advancement of storage period (Table 1). The highest mean titratable acidity (5.78%) was recorded in the osmotically preserve fruits packed in aluminium laminated packages, followed by shrink wrapped packages (5.73%). The lowest mean titratable acidity (5.71%) was recorded in polyethylene packed osmotically preserve fruits. A gradual decline in titratable acidity with the advancement of storage period might be due to the utilization of acids during various biochemical reactions occurring in the products during storage. The maintenance of higher acidity in aluminium laminated packages may be due to the decreased hydrolysis of organic acids and subsequent accumulation of organic acids which were oxidized to the slower rate. The delay in the reduction of acidity of osmotically preserve fruits packed in aluminium laminated packages confirms the similar findings of Bhardwaj and Kaushal (2008) [5] in dried apples.

The mean reducing sugar content of osmotically preserve fruits were increased from 9.25 to 10.48 per cent after six months of storage (Table 1), which was probably due to the hydrolysis of non-reducing sugars during storage. Similar findings have also been reported in Papaya powder by Aruna *et al*. (1998) [4]. Among packages, although the mean contents of reducing sugars varied between maximum (10.11 %) to a minimum (9.87 %) for aluminium laminated packages and polyethylene packages, respectively, but the differences were statistically non-significant. Such results have also been recorded by Khedkar and Roy (1999) [10] in dehydrated mango slices.

The decrease in mean total sugars of osmotically preserve fruits from 38.46 to 36.89 per cent was observed with the advancement in storage period which might be due to the utilization of sugars in non-enzymatic browning reactions. The decrease in total sugar content in dehydrated products during storage was also observed by Sagar and Khurdiya (2012) [16] in dehydrated mango slices. A negligible effect of packaging on mean total sugars content of osmotically preserve fruits was observed. However, the lowest mean total sugars content was observed in osmotically preserve fruits packed in polyethylene packages which might be due to higher moisture content in osmotically preserve fruits products packed in polyethylene packages which favour faster non-enzymatic reaction during storage. Sharma *et al*. (2016) [20] also observed similar trend for total sugars content in dehydrated apple products packed in different packages.

The ascorbic acid content of osmotically preserve fruits followed a decreasing trend from 5.00 to 4.13 mg/100 g during six months of storage which was mostly due to its oxidation with the passage of time and its role as a substrate in non-enzymatic browning reactions (Mehta *et al*., 1994) [13]. It was also observed that the osmotically preserve fruits packed in aluminium laminated packages retained maximum (4.77 mg/100 g) mean ascorbic acid content, whereas, osmotically preserve fruits packed in polyethylene packages had minimum (4.37 mg/100g) mean ascorbic acid content. The osmotically preserve fruits packed in aluminium laminated packages showed highest retention of ascorbic acid content, while, in polyethylene pouches there was maximum loss during six months of storage period which might be attributed to maintenance of lower moisture content in laminated pouches thereby permitting less degradation of ascorbic acid. Similar evidences have been reported by Tripathi *et al*. (2016) [22] in dehydrated aonla.

The mean sensory scores for colour of osmotically preserve fruits during storage period of six month showed gradual decrease from 8.48 to 6.95 (Table 2). Among packages, laminated packages retained maximum (7.95) mean sensory colour score, while, polyethylene packed preserve fruits retained minimum (6.94) colour score during six month of storage. The change in colour was significantly higher in polyethylene and shrink wrapped osmotically preserve fruits and aluminium laminated packages had minimum loss in colour. The decrease in mean sensory score for colour during storage was observed which might be due to occurrence of non-enzymatic browning reactions and oxidation of ascorbic acid to dehydrosascorbic acid and tannins to gallic acid. Similar findings have been reported in different varieties of apricot (Sharma *et al*., 2014) [18].

The average sensory score for taste decreased from initial level of 6.22 to 5.17 after six months of storage (Table 2). However, on the basis of different packaging materials, the mean sensory scores of taste were found to be higher (5.70) in osmotically preserve fruits packed in aluminium laminated packages, whereas lowest (5.54) mean scores were recorded in polyethylene packed osmotically preserve fruits during six months of storage period. During storage, the mean sensory score for taste showed decreasing trend from initial to six months irrespective of packaging, whereas osmotically preserve fruits packed in laminated packages had minimum loss in taste during storage.

The mean texture score on 9 point hedonic scale was found to decrease gradually from 6.45 to 5.52 during six months of storage. On the other hand, the mean texture scores of osmotically preserve karonda fruits packed in different packaging materials varied from 5.79 to 6.15 with the highest score in aluminium laminated packages and lowest in the products packed in polyethylene packages (Table 2). The mean values of texture followed a decreasing trend from initial to six month of storage and samples packed in aluminium laminated packages maintained best texture.

The sensory scores for flavour of osmotically preserve karonda fruits followed decreasing trend from 8.23 to 6.69 for the mean scores during six months of storage (Table 2). Among packages, aluminium laminated packages retained maximum (7.74) mean sensory score for flavour while, polyethylene packed osmotically preserve fruits retained minimum (7.42) flavour score during six month of storage.

The overall acceptability mean scores during storage period of six months declined from an initial value of 7.05 to 5.88 after six months of storage period (Table 2). However, among packages, the mean overall acceptability scores for aluminium laminated osmotically preserve karonda fruits were found to be higher (6.60), while, polyethylene packed and shrink wrapped packages exhibited mean scores of 6.09 and 6.40, respectively. A general trend was observed in reduction of mean sensory scores during storage period which might be attributed to change in chemical composition of osmotically preserve fruits, change in sugar-acid blend and loss of aromatic compounds due to oxidation. Slight change in the texture upon storage was probably due to the degradation of pectic substances during storage. Similar reduction in sensory scores during storage has been reported by Sagar *et al*. (2008) [17] in dehydrated ripe mango slices. However, the lower mean sensory scores observed in osmotically preserve karonda fruits products packed in polyethylene packages which might be due to higher moisture absorption and gas permeability characteristics of the polyethylene, thereby affecting texture and colour of the packed products. The sensory scores were significantly higher in osmotically preserve karonda products packed in aluminium laminated packages which might be due to impermeable nature of laminated packages. Similar evidences have also been made by Ahmed and Choudhary (1999) [2] in osmotically dehydrated papaya.

From the present study it can be concluded that osmotically preserve karonda fruits can successfully be stored at refrigerated conditions after packing in aluminium laminated packaging material for a period of six months without any considerable loss in sensory as well as nutritional quality. The successful transfer of such technology after pilot scale testing may open new avenues for the processing industry for the efficient utilization of this fruit which is otherwise being less utilized in our country. This may also attract entrepreneurship and may help the youth getting self-employment.

Table 1: Effect of different packaging materials on moisture content, titratable acidity, reducing sugar, total sugar and ascorbic acid of osmotically preserve karonda fruits during storage

Storage Intervals (months)	Polyethylene pouches	Aluminium Laminated pouches	Shrink wrapped	Mean
		Moisture (%)		
0	11.32	11.32	11.32	11.32
2	13.46	11.08	12.84	12.46
4	13.52	11.08	13.25	12.61
6	13.68	11.08	13.33	12.70
Mean	12.99	11.14	12.68	
$CD_{0.05}$	Treatment = 0.16 Storage = 0.19 Treatment x Storage = 0.33			
		Titratable acidity (%)		
0	5.82	5.82	5.82	5.82
2	5.75	5.80	5.78	5.78
4	5.67	5.77	5.72	5.72
6	5.60	5.75	5.62	5.66
Mean	5.71	5.78	5.73	
$CD_{0.05}$	Treatment = 0.03 Storage = 0.04 Treatment x Storage = 0.09			

		Reducing sugar (%)		
0	9.25	9.25	9.25	9.25
2	9.98	10.02	10.28	10.09
4	10.20	10.17	10.34	10.24
6	10.07	11.01	10.35	10.48
Mean	9.87	10.11	10.03	
$CD_{0.05}$	Treatment = NS Storage = 0.56 Treatment x Storage = NS			
		Total sugar (%)		
0	38.46	38.46	38.46	38.46
2	36.84	37.74	36.92	37.17
4	36.66	37.35	36.82	36.94
6	36.59	37.30	36.79	36.89
Mean	37.14	37.71	37.25	
$CD_{0.05}$	Treatment = NS Storage = 0.63 Treatment x Storage = NS			
		Ascorbic acid (mg/100g)		
0	5.00	5.00	5.00	5.00
2	4.50	4.80	4.55	4.62
4	4.20	4.80	4.28	4.43
6	3.80	4.50	4.10	4.13
Mean	4.37	4.77	4.48	
$CD_{0.05}$	Treatment = 0.13 Storage = 0.15 Treatment x Storage = 0.32			

Table 2: Effect of different packaging materials on colour, taste, texture, flavour and overall acceptability of osmotically preserve karonda fruits during storage

Storage Intervals (months)	Polyethylene pouches	Aluminium Laminated pouches	Shrink wrapped	Mean
		Colour		
0	8.48	8.48	8.48	8.48
2	6.88	7.84	7.56	7.43
4	6.23	7.82	7.23	7.09
6	6.17	7.66	7.02	6.95
Mean	6.94	7.95	7.57	
$CD_{0.05}$	Treatment = 0.16 Storage = 0.18 Treatment x Storage = 0.31			
		Taste		
0	6.22	6.22	6.22	6.22
2	5.56	5.84	5.55	5.65
4	5.36	5.45	5.42	5.41
6	5.02	5.28	5.22	5.17
Mean	5.54	5.70	5.60	
$CD_{0.05}$	Treatment = 0.19 Storage = 0.23 Treatment x Storage = 0.44			
		Texture		
0	6.45	6.45	6.45	6.45
2	5.94	6.28	6.14	6.12
4	5.53	6.08	5.86	5.82
6	5.23	5.78	5.55	5.52
Mean	5.79	6.15	6.00	
$CD_{0.05}$	Treatment = 0.17 Storage = 0.19 Treatment x Storage = 0.38			
		Flavour		
0	8.23	8.23	8.23	8.23
2	7.82	8.04	7.92	7.93
4	7.14	7.77	7.33	7.41
6	6.50	6.93	6.65	6.69
Mean	7.42	7.74	7.53	
$CD_{0.05}$	Treatment = 0.11 Storage = 0.12 Treatment x Storage = 0.25			
		Overall acceptability		
0	7.05	7.05	7.05	7.05
2	6.13	6.65	6.43	6.40
4	5.71	6.45	6.17	6.11
6	5.47	6.24	5.93	5.88
Mean	6.09	6.60	6.40	
$CD_{0.05}$	Treatment = 0.10 Storage = 0.12 Treatment x Storage = 0.23			

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