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STUDIES ON MODIFIED ATMOSPHERIC PACKAGING ON SHELF LIFE AND QUALITY OF SAPOTA (*MANILKARA ZAPOTA* L) cv. KALIPATTI

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Abstract

The sapota fruits cv. Kalipatti packed in different packaging materials under study were stored at 15^{O}C for 15 and 30 days and then transferred to room temperature. It was found that the physiological loss in weight (PLW) and rotting percentage of fruits increased with increase storage period regardless of packaging material and storage condition. There was an increase followed by subsequent decrease in TSS and total sugar content with corresponding decrease in acidity during storage condition irrespective of packaging material. The fruits can be stored up to 21 days where packed in polypropylene bags of 100 guage with 0.1% perforation stored at 15^{O}C for 15 days (under cold chamber) and then transferred to room temperature (6 days).

Key words : Sapota, MAP, polypropylene bags, cold storage, perforation.

Introduction

Sapota is the fifth popular crop, among the fruits in both production and consumption next to mango, banana, citrus and grape. In India, the total area under sapota crop is estimated to be 70,000 ha with a production of 71,000 tonnes (www.indiabudget.nic.in). The post harvest losses are high in tropical countries particularly in India and it ranges between 25-30% for fruits like sapota (Salunkhe and Desai, 1984). When fresh fruits or vegetables are packed with polymeric films, the atmospheric composition within the package is altered by the respiration process of the commodity and by gas diffusion through the packages.

Thus, the storage life of the produce is increased (Little and Taylor, 1982). Modified atmosphere packaging (MAP) and vacuum packaging using polyethylene bags generally minimizes weight loss, respiration, delay softening and thereby extend the storage life.

Materials and Methods

Fruits of sapota cv. Kalipatti were obtained from sapota orchard located at Agricultural Research Institute, Rajendranagar, Hyderabad (A.P.), India; were used in the present investigation. An experiment was carried out at Fruit Research Station, Sangareddy, Andhra Pradesh to study the effect of packaging materials on increasing shelf life and quality of sapota cv. Kalipatti. The experimental design was laid out in FCRD (Factorial Completely Randomized Black Design) and each treatment was replicated 3 times. The best combination of packaging treatments was identified and the fruits from these treatments were shade dried and sealed in polypropylene bags of 100, 150 guage with (0.1%) and without perforation. Treatments consists of five packaging materials such as; fruits packed in polypropylene bag of 100 guage without perforation ($\mathbf{T_1}$), 100 guage with 0.1% perforation ($\mathbf{T_2}$), 150 guage without perforation ($\mathbf{T_3}$), 150 guage with 0.1% perforation ($\mathbf{T_4}$) and without any packaging material ($\mathbf{T_5}$) control. The fruits packed in the above stated packaging treatments were kept for storage at 15^{O}C for 15 (D_1) and 30 days (D_2) and then transferred to room temperature. The observation on physiological loss in weight (%), shelf-life (days) was measured from the day of harvest till the softening of fruits. The data collected for the individual stages of treatments were analysed under FCRD as suggested by Panse and Sukhatme (1985). The total soluble solids were determined with the help of hand

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Table 1 : Effect of packaging treatments on physical characters of sapota during stored at 15°C for 15 and 30 days and then transferred to room temperature.

Treatment	Physiological loss in weight (%)				Firmness(Kg/cm^2)				Spoilage (%)				Shelf life (days)
	1stday	3rdday	Mean	6thday	1stday	3rdday	Mean	6thday	1stday	3rdday	Mean	6thday	
T_1D_1	1.2	10.98	1.59	3.40	3.20	1.40	2.30	0.95	20.00	35.00	27.50	53.00	4.81
T_2D_1	1.60	2.30	1.95	2.50	4.30	2.50	3.40	1.00	12.00	27.0	109.50	49.00	5.80
T_3D_1	1.35	2.06	1.70	3.71	3.40	1.04	2.22	0.80	19.00	30.00	24.50	56.00	4.50
T_4D_1	1.50	2.60	2.05	2.85	3.60	1.90	2.75	0.75	18.00	32.00	25.00	54.00	5.00
T_5D_1	2.50	4.30	3.40	*	1.30	0.10	0.70	*	40.00	50.00	45.00	*	1.20
T_1D_2	3.83	5.10	4.46	*	0.10	0.04	0.07	*	40.00	45.00	42.50	*	2.45
T_2D_2	5.25	6.20	5.72	*	0.02	0.01	0.01	*	35.00	44.00	39.50	*	4.16
T_3D_2	4.10	5.70	4.90	*	0.03	0.02	0.02	*	38.00	50.00	42.50	*	1.80
T_4D_2	6.33	6.50	6.41	*	0.01	0.01	0.01	*	39.00	48.00	43.50	*	3.37
T_5D_2	8.20	9.10	8.66	*	0.01	0.01	0.01	*	42.00	51.00	46.50	*	1.20
Mean	3.58	4.58			1.59	0.70			30.30	41.20			3.42
S.Em±	0.83	0.46			0.11	0.06			1.19	1.50			0.17
CD at 0.05	1.77	0.97			0.23	0.14			2.48	3.14			0.35

T_1: Fruits packed in polypropylene bags of 100 guage without perforation, **T_2**: Fruits packed in polypropylene bags of 100 guage with 0.1% perforation, **T_3**: Fruits packed in polypropylene bags of 150 guage without perforation, **T_4**: Fruits packed in polypropylene bags of 150 guage with 0.1% perforation, **T_5**: Control (Fruit without any packaging), **D_1**: Fruits stored at 15°C for 15 days and then transferred to room temperature, **D_2**: Fruits stored at 15°C for 30 days and then transferred to room temperature, *: Fruits are totally spoiled.

refractrometer in Brix by Ranganna (1986). The acidity of fruits was determined by AOAC (1978) method expressed in terms of percentage titrabl acidity. The total sugars were determined by the method given by Lane and Eyon from Ranganna (1986).

Results and Discussion

Different packaging treatments significantly influenced the physical and quality characters of the sapota fruits. Moisture loss through transpiration during storage affects the saleable weight and eventually the fruit becomes unmarketable as a result of wilting or shrinking. PLW was continuous phenomena during storage due to moisture loss (Salunkhe and Desai, 1984).

The physiological loss in weight indicates the progress of ripening in climacteric fruit. Higher the PLW more the ripening. In the present investigation, the PLW of sapota fruit was found to increase with increase in storage period irrespective of packaging material and storage conditions. The decrease in weight loss could be due moisture loss as reported by Rao and Rao (1979) in banana and Sanjay (1996) in sapota.

The fruits stored at 15°C for 15 days recorded significantly minimum PLW when compare to the fruit stored at 15°C for 30 days on first, third and sixth day of transfer to room temperature irrespective of the packaging material (table 1). The PLW of climacteric fruits increase with progression of ripening (Ingle *et al*., 1981) and higher PLW in fruits stored at 15°C for 30 days indicate that the ripening process has initiated at low temperature storage and hastened at room temperature. The fruits packed in 100 or 150 guage polypropylene bags without perforation has recorded significantly lower PLW on initial and 3rd day (ripe stage) after transfer to normal room temperature, irrespective of days of storage at 15°C. This could be due to low rate of respiration and transpiration. Kumbhar and Desai (1986) also reported similar reduction in PLW of sapota packed in polyethylene bags. The reduced rate of moisture loss in fruits packed in polythene bags (Philipose and Sathiamoorthy, 1993) has resulted in minimal PLW in polypropylene bags without perforation when compared to control.

In the present investigation, the firmness of sapota fruits was found to be decreased with increase in storage period irrespective of

Table 2 : Effect of packaging treatments on chemical characters of sapota during stored at 15^{O}C for 15 and 30 days and then transferred to room temperature.

Treatment	Total Soluble solids (B°)				Acidity (%)				Reducing Sugars (%)				Total Sugars (%)				Sugar-acid ratio			
	1stday	3rdday	Mean	6thday	1stday	3rdday	Mean	6thday	1stday	3rdday	Mean	6thday	1stday	3rdday	Mean	6thday	1stday	3rdday	Mean	6thday
T_1D_1	18.84	20.08	19.46	18.58	12.50	0.16	0.22	0.12	5.40	6.20	5.80	5.881	0.11	11.75	10.93	9.90	74.28	120.32	97.30	165.51
T_2D_1	18.63	20.33	19.48	19.74	0.28	0.14	0.21	0.16	5.70	8.50	7.10	6.20	10.06	11.20	10.63	10.50	80.59	145.05	112.82	185.83
T_3D_1	18.45	20.30	19.37	18.75	0.29	0.20	0.24	0.11	5.60	7.00	6.30	6.10	10.70	11.50	11.10	9.107	5.30	108.81	92.05	122.15
T_4D_1	18.53	20.11	19.32	18.30	0.26	0.19	0.22	0.14	5.60	8.13	6.86	6.15	10.30	11.45	10.87	9.60	81.40	18.21	99.80	137.10
T_5D_1	18.17	20.84	19.50	*	0.24	0.16	0.20	*	5.80	7.00	6.40	*	8.90	9.10	9.00	*	71.90	145.90	108.90	*
T_1D_2	21.56	18.50	20.03	*	0.14	0.10	0.12	*	7.20	6.20	6.70	*	10.00	8.70	9.35	*	164.00	185.00	174.50	*
T_2D_2	20.39	18.40	19.39	*	0.37	0.01	0.19	*	9.30	7.15	8.22	*	12.20	11.50	11.85	*	192.00	192.40	192.20	*
T_3D_2	20.39	19.20	19.79	*	0.15	0.12	0.13	*	8.50	7.20	7.85	*	11.05	10.10	10.57	*	154.00	160.00	157.00	*
T_4D_2	21.50	18.00	19.75	*	0.16	0.08	0.12	*	8.70	6.60	7.65	*	9.33	8.45	8.89	*	180.00	185.00	182.50	*
T_5D_2	20.67	17.60	19.13	*	0.16	0.05	0.10	*	8.08	6.40	7.20	*	9.20	8.10	8.66	*	217.00	220.35	218.67	*
Mean	19.71	17.57	*	0.23	0.12	6.99	6.39	9.26	9.37	9.26	9.37									
S.Em±	1.03	0.83	0.04	0.04	0.26	0.60	0.34	0.45	1.41	0.05										
CD at (0.05)	*	1.86	0.08	0.09	0.54	1.25	0.71	0.95	2.94	0.11										

T_1: Fruits packed in polypropylene bags of 100 guage without perforation, **T_2**: Fruits packed in polypropylene bags of 100 guage with 0.1% perforation,
T_3: Fruits packed in polypropylene bags of 150 guage without perforation, **T_4**: Fruits packed in polypropylene bags of 150 guage with 0.1% perforation,
T_5: Control (Fruit without any packaging), **D_1**: Fruits stored at 15^{O}C for 15 days and then transferred to room temperature, **D_2**: Fruits stored at 15^{O}C for 30 days and then transferred to room temperature, *****: Fruits are totally spoiled.

packaging material. This may be due to changes in the amount of pectin materials cementing the cell walls and the hydrolysis of starch, hemicellulose in the fruit (Leopold, 1964). Further the firmness indicates the progression of ripening in climacteric fruits.

Storage for 15 days recorded significantly higher firmness compare to 30 days on first, third day and sixth day of transfer to room temperature irrespective of the packaging material (table 1). Gautam and Chundawat (1990) reported that the firmness of climacteric fruits decrease with progression of ripening. Hence, the decrease in firmness in sapota fruits after 30 days of storage indicate the hastening and progression of ripening process. The fruit packed in 100 gauge polypropylene bags with 0.1% perforation has recorded significantly higher firmness irrespective of storage duration compared to all other treatments after transfer to normal temperature. The maintenance of higher firmness in polypropylene bags could be due to low rate of respiration and transpiration. Polythene bags helps in arresting the moisture loss and maintain turgidity tolerance. These findings are in agreement with that of Kumbhar and Desai (1986).

The fruits stored at 15^{O}C for 15 days recorded significant lower spoilage when compare to fruit stored at 15^{O}C for 30 days on first, third day and sixth day of transfer to room temperature irrespective of the packaging material (table 1). The spoilage of sapota fruit was found to be increased with increase in storage period in all the treatments. Higher the spoilage, more the ripening in sapota (Gautam and Chundawat, 1990). Fruits packed in 100 guage polypropylene bags with 0.1% perforation have recorded significantly lower spoilage on all days of storage after transfer to normal temperature, irrespective of days of storage at low temperature. This may be due to limited exposure of fruits to micro flora and atmospheric oxygen (Singh, 1980). High spoilage of fruits in perforated polypropylene bags than in un-perforated polypropylene bags can be attributed to accumulation of moisture which leads to fungal growth (Philipose and Sathiamoorthy, 1993).

Maximum shelf life was observed in fruits stored at 15^{O}C for 15 days than for 30 days (table 1). This could be due to initiation of ripening process in the latter. Prolonged storage at 15^{O}C temperature initiated and subsequently hastened the ripening

process in fruits which might have resulted in low firmness, high spoilage and low shelf life in fruits stored at 15°C for 30 days. Further the fruits packed in polypropylene bags has recorded significantly highest shelf life after transfer to room temperature from 15°C when compared to unpacked control. This could be attributed to modified atmosphere created by accumulation of CO_2, depletion of O_2 and maintenance of high humidity inside the polypropylene bags (Magdaline *et al.*, 2001). Further maximum shelf life in fruits packed with polypropylene bags of 100 guage with 0.1% perforation stored at 15°C for 15 days and then transferred to room could be attributed to low levels of O_2 and increased CO_2 concentration which might have caused reduction in respiration rate and metabolic activity leading to prolonged shelf life (Sharma *et al.,* 2002). The results were in close conformity with the finding of Kumbhar and Desai (1986) and Sudha *et al.* (2007) in sapota. A total storability of 21 days (15 days at 15°C and 6 days at room temperature) was observed in fruits packed in polypropylene bags of 100 guage with 0.1% perforation.

The fruits stored for 15 days recorded significantly lower TSS when compare to the fruits stored at 15°C for 30 days on first, third and sixth day of transfer to room temperature irrespective of the packaging material (table 2). The TSS increased from initial day to 3rd day at room temperature in the fruits packed in different polypropylene packaging and stored at 15°C for 15 days. The increase in TSS during the initial stages may be attributed due to the conversion of starch and other polysaccharides into soluble forms of sugars (Satyan *et al*., 1992) indicating that the ripening process has started after transfer to room temperature in the fruits stored at 15°C for 15 days. The subsequent decrease in TSS from 3rd day to 6th day of storage is owing to the increased rate of respiration in later stages of storage (Mukerjee and Dutta, 1967) its faster utilization in oxidation process through Kreb's cycle (Singh and Mathur, 1980). Ripening is normally accompanied by increase in TSS in response to increase in ethylene production of fruits However, the TSS has decreased from the initial day to 3rd day of storage at room temperature in fruits stored at 15°C for 30 days irrespective of the packaging treatments. The TSS was significantly higher on the initial day and on 3rd day of storage at room temperature in the fruits stored at 15°C for 30 days and at 15°C for 15 day respectively indicating that the ripening process has already started in the fruit at low temperature. Hence, the fruits could not be stored beyond 3rd day of storage at room temperature packed in different polypropylene bags and stored at 15°C for 30 days.

Among the packaging treatments, there was a continuous decrease in acidity content of sapota fruit with the progresses of storage period (Barnell, 1941) and (Pool *et al*., 1972). This could be attributed to the conversion of acids, into sugar (Pool *et al*., 1972) and utilization of organic acids during respiration (Singh *et al*., 1954 a,b). Similar decrease in acidity content of sapota fruits with increase in storage period and utilization organic acid during respiration was also reported by Ingle *et al*. (1981) and Kumbhar and Desai (1986).

Conclusion

The data showed that fruits packed in 100 guage polypropylene bags with 0.1% perforation showed lower firmness, spoilage and it slowdown the ripening rate when compared with control and other treatments.

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