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Effect of modified atmospheric packaging on shelf life of custard apple CV. Balanagar

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Abstract
Custard apple being a climacteric fruit, has short life because of fast ripening followed by senescence accompanied with quality changes and decay loss. So, the experiment was under taken in Fruit research Station, Sangareddy during Rabi season by Completely Randomized Design using 8 different treatments ranging from T_1-Packing of fruits in polypropylene bag with 10 pores, T_2-Packing of fruits in polypropylene bag with 20 pores T_3-Packing of fruits in polypropylene bag with 30 pores, T_4-Packing of fruits in polypropylene bag with 40 pore, T_5-Packing of fruits in polypropylene bag with 50 pores, T_6 -Packing of fruits in polypropylene bag with 60 pores, T_7 -Packing of fruits in polypropylene bag without any pores and T_8-control (No packing) stored at low temperature (13 ºC±1.). The polypropylene bags with 20 pores under T2 recorded the significantly lowest physiological loss in weight than the control (T_8). Similarly TSS and Total sugars were significantly lower in fruits packed in polypropylene bags with 20 pores under T_2 than the control-T_8, indicating the delayed ripening and hence increasing the storage /shelf life of the fruits.

Keywords: Balanagar, physiological loss in weight (PLW), polypropylene bag, total soluble solids (TSS) and total sugars

Introduction
Custard apple (*Annona squamosa* Linn.) popular in the Deccan plateau is one of the most important fruit due to its nutritional and medicinal values. The fruits of Custard apple are very delicate and highly perishable. Being climacteric in nature, the biochemical changes in the fruit after harvest occur at a faster rate. The mature fruits after harvest ripen quickly and become excessively soft within 2 to 3 days at ambient condition and become unfit for consumption. The increase in shelf life of custard apple fruit would, therefore, be an advantage to the growers. It has several synonymous such as Sithaphal, Sharifa, Sugar apple, Sweet sop *etc.* and more than 70 species come under the genus *Annona* of which only six of them produces edible fruits. In India, custard apple is grown on marginal lands and hilly rocks with minimum inputs (Rajput, 1985) [10].

In India, custard apple is grown in Telangana, Andhra Pradesh, Assam, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, and Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal states. Besides India, it is common in China, Philippines and Cuba and has a commercial importance in Egypt and Central Africa. The plants are hardy and drought resistant and can thrive well on marginal and neglected soils (Rajput, 1985) [10]. Custard apple is a climacteric fruit and starts ripening soon after detachment from the tree (Wills *et al.*, 2001). It is highly perishable fruit with short shelf life of 1 to2 days after ripening. The steady increase in area under custard apple has enhanced the fruit flow into the markets which most of the time leads to glut in the markets (Jalikop, 2006) [7]. The lack of information on the post harvest handling of this highly perishable fruit has resulted in huge losses. Extension of shelf life in custard apple even for a day or two will go a long way in increasing the shelf life and thus making it much easier to handle the fruit. The practices reported by Salunkhe and Kadam (1995) [12] and Reddy (2000) [11] suggest that the fruits of custard apple after harvesting are either loaded directly or packed in bamboo baskets with paddy straw or leaves of custard apple as cushioning material and transported to markets.

Modified atmosphere packaging (MAP) is intended to create an appropriate gaseous atmosphere around a commodity packed in film packages to enhance shelf life and conserve the quality of packed produce (Deepak Raj Rai *et al.*, 2002) [3]. Therefore, it is necessary to investigate the proper method of packaging to enhance the shelf life and conserve the quality of produce.

Material and Methods

In the present investigation, seven packaging (MAP) materials having different number of pores and one control treatment without using any packaging material tested for Cv. Balanagar and Hybrid Atemoya X Balanagar were tried. Lab Experiment was laid in completely randomized block design after replicating thrice. In each treatment 6 units containing 4 fruits were tested and observations were recorded at 4 days interval for Total sugars, Total soluble solids and Physiological loss in weight. Statistical analysis was carried out in Windostat 8.5 for recording correlation in period span with Total sugars, Total soluble solids and PLW and modified atmospheric packaging (MAP). The usais of the treatment were T_1-Packing of fruits in polypropylene bag with 10 pores, T_2-Packing of fruits in polypropylene bag with 20 pores, T_3-Packing of fruits in polypropylene bag with 30 pores, T_4-Packing of fruits in polypropylene bag with 40 pores, T_5-Packing of fruits in polypropylene bag with 50 pores, T_6-Packing of fruits in polypropylene bag with 60 pores, T_7-Packing of fruits in polypropylene bag without any pores and T_8-control (No packing).

Results and Discussion

Physiological loss in weight (%): Data presented in Table-1 revealed that Polypropylene bag with 20 pores (T_2) recorded significantly lowest PLW but same was at with treatment (T_1) having polypropylene bag with 10 pores. Treatment (T_8) with no packaging material recorded significantly highest PLW which was at par with polypropylene bag with 60 pores. In the present investigation, the physiological loss in weight in cultivar Balanagar indicates the progress of ripening in climacteric fruits, higher the PLW, more the ripening (Ingale *et al*., 1982) [6]. Among the MAP treatments, the lowest PLW was recorded in polypropylene bags with 20 pores. This may have been resulted from restricted availability of oxygen and CO_2 accumulation and consequently reduction in respiration leading to less moisture loss (Heining, 1975) [5]. Polyethylene bagging extremely reduced weight loss from the 'Neang' sugarapple fruits stored at 130 C and 95% RH (Chunprasert *et al*., 2006) [2].

Table 1: Effect of modified atmosphere packaging on physiological loss in weight (%) of custard apple fruits cv. Balanagar at low temperature (13 ºC±1).

Treatments	Days				Mean
	4	8	12	16	
T_1-Polypropylene bag with 10 pores	0.36	0.80	1.12	1.78	1.01^{c}
T_2-Polypropylene bag with 20 pores	0.31	0.76	1.11	1.72	0.97^{c}
T_3-Polypropylene bag with 30 pores	0.30	0.82	1.34	2.13	1.15^{b}
T_4-Polypropylene bag with 40 pores	0.30	0.95	1.39	2.95	1.40^{b}
T_5-Polypropylene bag with 50 pores	0.44	1.09	1.48	2.19	1.30^{b}
T_6-Polypropylene bag with 60 pores	0.51	1.02	2.19	4.01	1.93^{a}
T_7-Polypropylene bag without pores	0.50	0.96	1.51	1.88	1.21^{b}
T_8-Control	0.45	1.06	2.41	4.36	2.07 ^{a}
Mean	0.40^{A}	0.93^{B}	1.57 ^{C}	2.63 ^{D}	

	CD at (0.05)	S.Em ±
Factor A (Days)	0.17	0.06
Factor B (Treatments)	0.25	0.08
For A x B	0.50	0.17

Total soluble solids (TSS %)

Observations on Total Soluble Solids for Balanagar cultivar presented in Table-2 showed significant difference in TSS tried in Polypropylene bag with different number of pores. Control (T_8) treatment recorded significantly higher TSS followed by treatment with Polypropylene bag having 20 pores (T_2). Polypropylene bag without pores recorded significantly lowest TSS. Significant differences were observed in spoilage of custard apple fruits due to storage period. The TSS increased progressively from '0' day (18.97) to 16th day (27.42) of storage period. The interaction between treatments and storage period on TSS of custard apple fruits was significant. On '0'day of storage highest TSS was recorded in polypropylene bags with 60 pores (T6) (21.00). From 4th day to 12th days of storage highest TSS was recorded in control (T_8) (22.00, 28.60and 27.80) respectively. On 16th day of storage highest TSS was recorded in polypropylene bags with 20 pores (T_2) (28.80). From 8th day to 16th days of storage lowest TSS was recorded in polypropylene bags without pores (T_7) (20.40, 22.00 and 23.00) respectively. In the present investigation, it was observed that the TSS of custard apple fruits initially increased with increase in storage period. The increase in TSS might be due to the hydrolysis of polysaccharides like starch, cellulose and pectin that remain resent in the fruit. Soluble solids rise concomitantly with the respiratory increase in annonaceous fruits and reach a maximum after the onset of second respiratory rise (Wills *et al*., 1984; Tsay and Wu, 1989 and Martinez *et al*., 1993) [9]. Among the MAP treatments, the higher TSS was recorded in control followed by polypropylene bags with 20pores. The total soluble solids of climacteric fruits increase with progressive of ripening (Kumbhar and Desai, 1986 and Willis *et al*., 1983) [8]. Similar results were observed by Gautam and Neeraja (2005) [4] in mango and Borkar *et al*. (2008) [1] in banana. Similar results were observed by Waskar and Nikam (1998) in sapota.

Table 2: Effect of modified atmosphere packaging on total soluble solids (˚Brix) of custard apple fruits cv. Balanagar at low temperature (13 ºC±1).

Treatments	Days					Mean
	0	4	8	12	16	
T_1-Polypropylene bag with 10 pores	16.80	18.20	21.00	26.00	28.00	22.00^{g}
T_2-Polypropylene bag with 20 pores	19.20	21.20	24.50	26.80	28.80	24.10^{b}
T_3-Polypropylene bag with 30 pores	18.80	20.20	25.60	25.00	28.20	23.56^{d}
T_4-Polypropylene bag with 40 pores	20.20	20.80	22.00	24.20	28.00	23.04^{f}
T_5-Polypropylene bag with 50 pores	19.60	21.00	23.80	24.00	28.60	23.40^{e}
T_6-Polypropylene bag with 60 pores	21.00	21.60	22.60	26.00	27.80	23.80^{c}
T_7-Polypropylene bag without pores	18.50	21.00	20.40	22.00	23.00	20.99^{h}
T_8-Control	17.60	22.00	28.60	27.80	27.00	24.60^{a}
Mean	18.97^{A}	20.75^{B}	23.56^{C}	25.22^{D}	27.42^{E}	

	CD at (0.05)	S.Em ±
Factor A (Days)	0.06	0.02
Factor (Treatments)	0.07	0.02
For A x B	0.16	0.05

Total sugars (%): The data enunciated on total sugars of custard apple fruits cv. Balanagar packed in polypropylene bags and stored at low temperature are presented in Table 3. There were significant differences among the treatments with respect to total sugars. Significantly highest total sugars were recorded in control (T_5) (19.20), which is at par with polypropylene bags with 40 pores (T_4) (19.12).Significantly lowest total sugars was recorded in polypropylene bags with 30 pores (T_3) (17.51), which is onpar with polypropylene bags with 60 pores (T_6) (17.42) and polypropylene bags with 20 pores (T_2) (17.30).Significant differences were observed in total sugars of custard apple fruits due to storage period. The total sugars increased progressively from '0' day (9.38) to 16th day (23.41) of storage period. The interaction between treatments and storage period on total sugars of custard apple fruits was significant. On 12th day and 16th day of storage highest total sugars was recorded in polypropylene bags with 40 pores (T_4) (25.51and 25.88) respectively. On '0' day and 4th day of storage lowest total sugars was recorded in polypropylene bags with30 pores (T_3) (8.86 and 14.53) respectively. On 12th day and 16th day of storage

Table 3: Effect of modified atmosphere packaging on total sugars (%) of custard apple fruits cv. Balanagar at low temperature (13 ºC±1)

Treatments	Days					Mean
	0	4	8	12	16	
T_1-Polypropylene bag with 10 pores	10.24	16.89	20.16	21.55	22.32	18.23^{c}
T_2-Polypropylene bag with 20 pores	9.19	15.43	17.86	21.19	22.87	17.30^{d}
T_3-Polypropylene bag with 30 pores	8.86	14.53	18.94	21.19	24.04	17.51^{d}
T_4-Polypropylene bag with 40 pores	9.26	16.02	18.94	25.51	25.88	19.12^{a}
T_5-Polypropylene bag with 50 pores	9.47	16.89	17.86	24.04	25.00	18.65^{b}
T_6-Polypropylene bag with 60 pores	9.26	18.38	18.38	19.53	21.55	17.42^{d}
T_7-Polypropylene bag without pores	9.19	19.84	19.84	21.19	21.55	18.32^{c}
T_8-Control	9.61	18.38	20.83	23.15	24.04	19.20^{a}
Mean	9.38^{A}	17.05^{B}	19.10^{C}	22.17^{D}	23.41^{E}	

	CD at (0.05)	S.Em ±
Factor A (Days)	0.18	0.06
Factor (Treatments)	0.23	0.08
For A x B	0.533	0.18

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