Int.J.Curr.Microbiol.App.Sci (2021) *10*(02): 3175-3180

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 10 Number 02 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1002.348

Shelf Life Enhancement of Custard Apple (*Annona squamosa* L.) under Sub-Tropical Conditions of Garhwal Hills

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Keywords

Custard apple, Physiological loss in weight (PLW), Polypropylene bag

Article Info

Accepted:
22 January 2021
Available Online:
10 February 2021

A B S T R A C T

An experiment was conducted at Horticultural Research Centre, Chauras, HNB Garhwal University, Srinagar Garhwal, Uttarakhand, India during autumn season 2017. The present investigation on improvement of shelf life of custard apple (*Annona squamosa* L.)cv. Balanagar was conducted with treatment having polypropylene bags with different number of holes. The experimental results showed that significantly lowest physiological loss in weight (1.27%) was recorded under the treatment (T_3) having 24 holes in polypropylene bag while highest physiological loss in weight (2.42%) was noted with the treatment (T_8). Significantly highest TSS (25.98^o Brix) was estimated in polypropylene bags with 24 holes (T_3) treatment and lowest TSS (20.78^o Brix) were recorded under control (T_8). The highest total sugar (20.59%) was found in the treatment (T_3) whereas treatment T_8showed the lowest total sugar (16.66%).

Introduction

Custard apple (*Annona squamosa* L.) is a climacteric fruit, semi deciduous, exotic subtropical fruit, highly perishable in nature and consumed in many countries throughout the world. Hence, it is mostly utilized or preferred for fresh market. Due to its climacteric nature, it ripens fast and spoiled easily (Manica, 1994). It belongs to the family Annonaceae, is believed to be introduced in India from tropical South America (Beerh, 1972), and is widely distributed throughout the tropical and sub-tropical regions. 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. Custard apple is the rich source of nutrients but it has short storage life and

having a great demand in the market. In India, custard apple is grown on marginal lands and hilly rocks with minimum inputs (Rajput, 1985). It is grown in Andhra Pradesh, Assam, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharastra, 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). 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 to 2 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). 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 practice as reported by Salunkhe and Kadam (1995) and Reddy (2000) 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 (Rai *et al.,* 2002). Therefore, it is necessary to investigate the proper method of packaging to enhance the shelf life and conserve the quality of produce.

Materials and Methods

In the present investigation, packaging material (Polypropylene Bag) is having different number of holes and control treatment without using any packaging material examined for custard apple cv. Balanagar. Experiment was laid in completely randomized block design with three replications and eight treatments in the Post-Harvest Technology Laboratory of Department of Horticulture, H. N. B. G. U. Srinagar Garhwal Uttarakhand. In each treatment, 5 fruits were tested and observations were recorded at 4 days interval for physiological loss in weight, total soluble solids and total sugars. The experiment comprises of 08 treatments namely,T_1-Packing of fruits in polypropylene bag with 08holes, T_2- Packing of fruits in polypropylene bag with 16holes, T_3-Packing of fruits in polypropylene bag with 24holes, T_4- Packing of fruits in polypropylene bag with 32holes, T_5 - Packing of fruits in polypropylene bag with 40holes, T_6 - Packing of fruits in polypropylene bag with 48holes, T_7 - Packing of fruits in polypropylene bag without any hole and T_8 -control (without polypropylene bag).

Results and Discussion

Physiological loss in weight (%)

Data presented in table 1 and depicted in Fig. 1 revealed that polypropylene bag with 24holes (T_3) recorded significantly lowest PLW (1.27%). Treatment (T_8) without any packaging material recorded significantly highest PLW (2.42%). 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). Among the treatments, the lowest PLW was recorded in polypropylene bags with 24holes. This may have been resulted from restricted availability of oxygen and CO_2accumulation and consequently reduction in respiration leading to less moisture loss (Heining, 1975).

Total soluble solids (^{o}Brix)

Table 2 showed that total soluble solids (TSS) of custard apple fruits cv. Balanagar were significantly differing among the treatments (Fig. 2). Significantly highest TSS was recorded in polypropylene bags with 24 holes (T_3, 25.98). Significantly lowest TSS was recorded in without packaging (T_8, 20.78). Significant differences were observed in TSS of custard apple fruits due to storage period. The TSS increased progressively from '0' day (21.50) to 16th day (29.10) of storage period.

In the present investigation, it was observed that the TSS of custard apple fruits initially increased with increase in storage period. Soluble solids rise continuously 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). The increase in TSS during the initial stages may be attributed to the conversion of starch and other polysaccharides into soluble forms of sugars (Mukherjee and Dutta, 1967 and Satyan *et al.*, 1992). The increase in TSS was gradual in custard apple fruits stored at 15 ºC and 20 ºC (Prasanna *et al.*, 2000).

Total sugars (%)

The data on total sugars of custard apple fruits cv. Balanagar are presented in Table 3 and depicted in Fig. 3. Data showed there were significant differences among the treatments with respect to total sugars. Highest total sugar was recorded in polypropylene bags with 24 holes (T_3, 20.59), which was significant among the treatments; lowest total sugar was recorded in control (T_8, 16.66).Significant differences were observed in total sugars of custard apple fruits due to storage period.

On the basis of above findings, it may be concluded that the treatment T_3 (Polypropylene bag with 24 holes) is superior over other treatments for the improvement of the shelf life of custard apple under sub-tropical conditions of Garhwal hills.

Table.1 Effect of polypropylene bag on physiological loss in weight (%) of custard apple fruits

Treatments	Days				Mean
	4	8	12	16	
T_1-Polypropylene bag with 08 holes	0.66	1.10	1.42	2.08	1.31
T_2-Polypropylene bag with 16 holes	0.61	1.12	1.64	2.43	1.45
T_3-Polypropylene bag with 24 holes	0.60	1.06	1.41	2.02	1.27
T_4-Polypropylene bag with 32 holes	0.60	1.25	1.69	3.25	1.70
T_5-Polypropylene bag with 40 holes	0.74	1.36	1.78	2.49	1.60
T_6-Polypropylene bag with 48 holes	0.80	1.26	1.81	2.18	1.51
T_7-Polypropylene bag without holes	0.60	1.32	2.49	4.31	2.18
T_8-Control (without Polypropylene bag)	0.81	1.39	2.81	4.66	2.42
S.Em ±	**0.38**				
CD at (0.05)	**0.55**				

Table.2 Effect of polypropylene bag on total soluble solids (°Brix) of custard apple fruits

Treatments	Days					Mean
	0	4	8	12	16	
T_1-Polypropylene bag with 08 holes	18.80	18.50	22.30	24.50	27.30	22.28
T_2-Polypropylene bag with 16 holes	19.50	21.30	24.10	27.10	28.50	24.10
T_3-Polypropylene bag with 24 holes	21.50	22.30	28.90	28.10	29.10	25.98
T_4-Polypropylene bag with 32 holes	20.30	21.90	25.90	26.30	28.90	24.66
T_5-Polypropylene bag with 40 holes	19.90	21.50	24.80	26.30	28.30	24.16
T_6-Polypropylene bag with 48 holes	19.10	21.30	22.90	25.30	28.30	23.38
T_7-Polypropylene bag without holes	17.90	21.10	21.30	24.30	28.10	22.54
T_8-Control (without Polypropylene bag)	17.10	20.50	20.70	22.30	23.30	20.78
S.Em ±	**0.05**					
CD at (0.05)	**1.00**					

Table.3 Effect of polypropylene bag on total sugars (%) of custard apple fruits

Treatments	Days					Mean
	0	4	8	12	16	
T_1-Polypropylene bag with 08 holes	9.49	15.73	20.46	21.85	22.62	18.03
T_2-Polypropylene bag with 16 holes	9.77	16.91	17.89	21.49	24.34	18.08
T_3-Polypropylene bag with 24 holes	10.54	19.87	20.86	25.81	25.91	20.59
T_4-Polypropylene bag with 32 holes	9.81	18.68	19.87	24.34	25.30	19.60
T_5-Polypropylene bag with 40 holes	9.56	18.68	18.97	23.45	24.34	19.00
T_6-Polypropylene bag with 48 holes	9.56	16.92	18.97	21.49	22.90	17.96
T_7-Polypropylene bag without holes	9.49	16.32	18.68	21.49	21.85	17.57
T_8-Control (without Polypropylene bag)	8.89	14.83	17.89	19.83	21.85	16.66
S.Em ±	0.11					
CD at (0.05)	0.26					

Fig.1 Effect of polypropylene bag on physiological loss in weight (%) of custard apple fruits

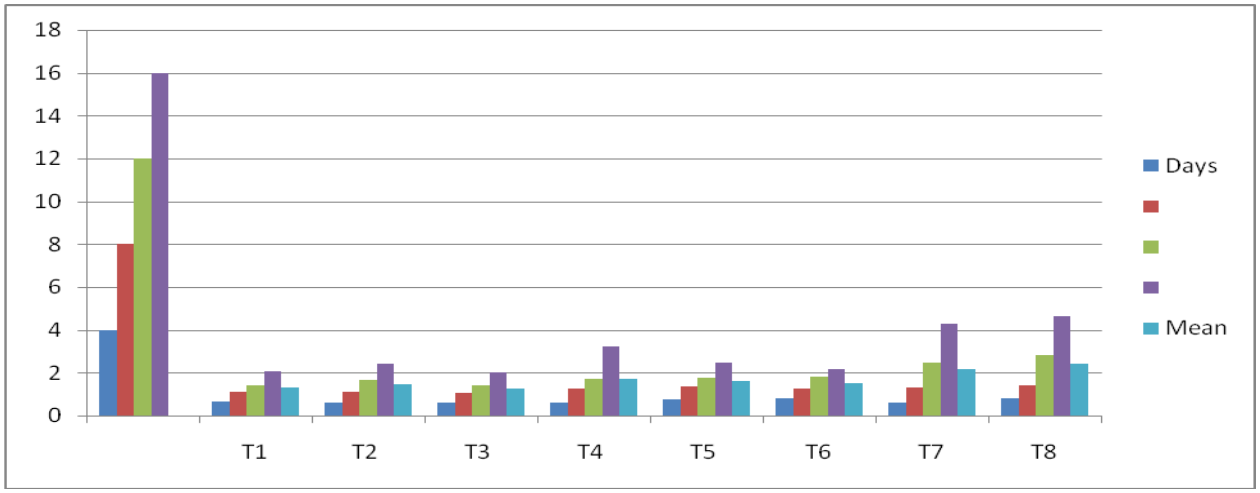


Fig.2 Effect of polypropylene bag on total soluble solids (^{o}Brix) of custard apple fruits

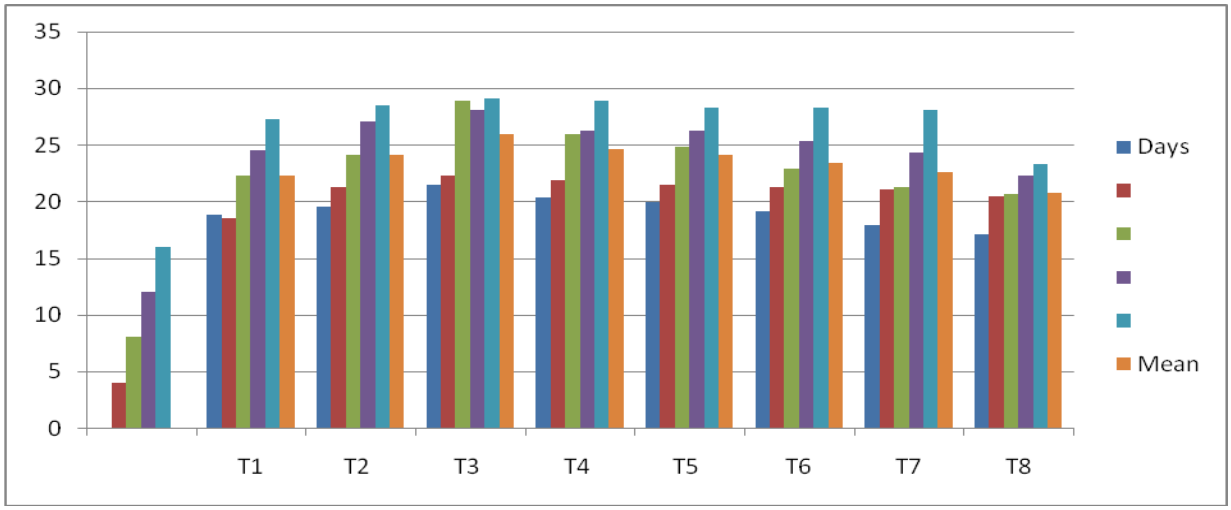
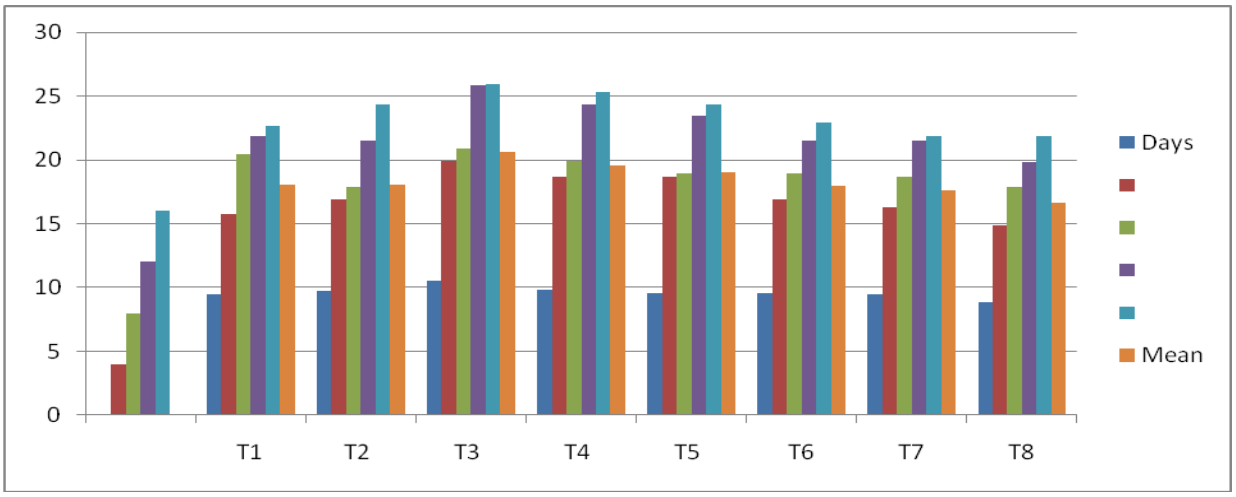


Fig.3 Effect of polypropylene bag on total sugars (%) of custard apple fruits



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How to cite this article:

Tanuja, D. K. Rana and Rathi, D. S. 2021. Shelf Life Enhancement of Custard Apple (*Annona squamosa* L.) under Sub-Tropical Conditions of Garhwal Hills. *Int.J.Curr.Microbiol.App.Sci.* 10(02): 3175-3180. doi: https://doi.org/10.20546/ijcmas.2021.1002.348