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Combined Effect of Gamma Irradiation and Post-Harvest Treatments on Quality and Shelf Life of Custard Apple (*Annona squamosa* L.) cv. Balanagar

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A B S T R A C T

Annona squamosa L. is a fruit native of India, which has become an important crop because of its tasty flavour, pulp content, nutritional value and antioxidant properties. The aim of this experiment was to evaluate the combined effect of gamma irradiation and post-harvest treatments on quality and shelf life of custard apple (*Annona squamosa* L.) at College of Horticulture, Rajendranagar, Hyderabad during 2017-18. It consists of 5 treatments *viz.*, T_1- 0.4 kGy + GA_3 @ 50 ppm, T_2-0.4 kGy + GA_3 @ 100 ppm, T_3-0.6 kGy + GA_3 @ 50 ppm, T_4- 0.6 kGy + GA_3 @ 100 ppm and T_5 – control and replicated 4 times in CRD. The fruits treated with combination of irradiation dose and post- harvest treatment T_1-0.40 kGy + GA_3 @ 50 ppm recorded lower PLW (3.16%), spoilage (21.45%), per cent ripening (44.64%), total soluble solids (24.67°B), brix-acid ratio (66.87), reducing sugars (11.69 %), total sugars (13.05%) and higher firmness (3.10 Kg/cm^2), titrable acidity (0.39 %), ascorbic acid (43.05 mg/100g). Highest shelf life (9.33) was recorded in fruits treated with T_1-0.40 kGy + GA_3 @ 50 ppm over control (5.00). Similarly highest organoleptic score (8.38) was obtained in fruits treated with T_1- 0.4 kGy + GA_3 @ 50 ppm.

Keywords

Gamma irradiation, Shelf life, Post-harvest, Quality

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Introduction

Custard apple (*Annona squamosa* L.) can be called as a fruit for delicacy of dry region due to its very sweet delicate flesh also known as sugar apple, belongs to family Annonaceae. The cultivar Balanagar is the most popular and widely grown in Telangana state. Fruits are mainly used for fresh consumption, generally being considered as a 'Fruit of poor people'. The large aggregate fruits are composed of peel, pulp and seeds. Pulp is cream coloured, custard-like, granular, and sweet with pleasant flavour and mild aroma. Fruits contain 45%

edible portion, 100g of which has a composition of moisture 70.5 g, carbohydrates 23.5 g, protein 1.6 g, fat 0.4 g, Ca17 mg, P 47 mg, iron 1.5 mg, thiamin 0.07 mg, riboflavin 0.17 mg, niacin 1.3 mg, vitamin 37 mg and gives 104 K calories of energy (Singh, 1995). Commercialization of sugar apple faces many problems because of its highly perishable nature. At room temperature, the post-harvest shelf life of fruit does not last more than three to four days. Short shelf life associated with inadequate handling, results in production loss and hinders sugar apple commercialization. Various viable technologies for improving shelf life and storage of horticultural commodities have been evolved during the post decades, which includes the use of fungicides, cold storage, controlled atmosphere storage, anti- transpirants, wax coatings, oil coatings, chemical coatings, edible coatings, growth retardants and different types of packaging materials etc., to increase the longevity of harvested fruits. But in spite of these available techniques, the percent post-harvest losses of fruits is still high.

Recently the irradiation technology is being used for improving shelf life of various fruits, vegetables and spices. Irradiated fruits or food material is being accepted in 60 countries. Gamma irradiation is a cold treatment that eliminates and inactivates the spoilage causing micro-organisms with no adverse effect on nutritional and sensory quality of fruits/foods. The treatment delays the processes of ripening, senescence and inactivates the micro-organisms. This technology has been adopted in most of the fruit crops like papaya, banana, guava, mango and sapota (Antaryami *et al.,* 2016) for enhancing the shelf life. Hence it is necessary to conduct comprehensive study for extending the shelf life of custard apple fruits under ambient conditions which in turn helps the grower to adopt the same at this level. Keeping this background in view, the present investigation was undertaken to study effect of irradiation in enhancing the shelf life and quality aspects of custard apple fruits.

Materials and Methods

Fruits used for experiments were procured from Fruit Research Station, SKLTSHU, Sangareddy, Medak district, Hyderabad at full mature stage but still firm. As maturity is judged by changing the fruit colour into light green, development of yellowish white colour between tubercles and initiation of cracking of skin between carpels. Gamma chamber 5000 supplied and installed by BRIT, DAE, Mumbai, at the Quality Control Laboratory, PJTSAU, was used for giving the irradiation treatments. Radiation field is provided by a set of stationary Cobalt-60 source placed in cylindrical cage followed by dipped in post-harvest treatments for 10 min. Treatment details are as follows.

Observations on the following physio-chemical characteristics were recorded everyday till the end of shelf life. Physiological loss in weight (PLW) was determined by recording the initial weight of the fruits on the day of initiating experiment and the weight of the fruits in each replication. A table top penetrometer was used to record the firmness of the fruits and obtained direct readings in Kg cm^{-2}. Browning of each fruit was scored using a 5 points hedonic scale given below (Ramma. 2004; Butta *et al.,* 1999). The number of fruits spoiled in a replication was counted and expressed in percentage. The shelf life of fruits was determined by recording the number of days the fruits remained in good condition during storage. The total soluble solids were determined by using ERMA hand refractometer and expressed as ° Brix (Ranganna, 1986). The titrable acidity was determined by titration method (Ranganna, 1986). Reducing non-reducing and total sugars were determined by the method of Lane and Eyon (AOAC, 1965). Ascorbic acid was estimated by Indophenol method (Ranganna, 1986). Finally, the organoleptic or the sensory evaluation of custard apple fruits were carried out by a panel of 5 semi-trained judges following hedonic rating system for characters like fruit appearance/ colour, aroma, texture and taste.

The design adopted is Completely Randomized Design with replications. The data were subjected to statistical analysis as per the procedure out lined by Panse and Sukhatme (1985).

Results and Discussion

Physiological Loss in Weight (PLW) (%)

The results obtained due to the combined effect of gamma irradiation and post-harvest treatments on physiological loss in weight of fruits which were differed significantly are furnished in the Table 1. Significantly lowest PLW (3.16) was recorded in T_1 - 0.4 kGy + GA_3 @ 50 ppm which was followed by T_2 - 0.4 kGy + GA_3 @ 100 ppm (3.18) and the highest PLW (3.41) was recorded in T_5 - Control. Interaction due to the combined effect of irradiation and post-harvest treatments at different days of storage was found to be significant.

Physiological loss in weight represents the weight loss due to modifications caused in membrane permeability, cellular integrity and pore size, transpiration and metabolic activity thereby affecting moisture loss to the atmosphere (Rastogi, 2005; Rastogi *et al.*, 2006). The results obtained in the present investigation are in close conformity with those of Zhang *et al.*, (2014) in Shatang Manderine, Jenjob *et al.*, (2017) in pineapple and Arundathi (2017) in papaya.

Percentage of ripening (%)

The data pertaining to the combined effect of gamma irradiation and post-harvest treatments on the per cent ripening of fruits which differed significantly are furnished in the Table 2. The lowest percent ripening (44.64) was observed in T_1 - 0.4 kGy + GA_3 @ 50 ppm followed by T_2 -0.4 kGy + GA_3@ 100 ppm (46.75) and the highest ripening (64.75) was observed inT_5-control. The delay in the ripening was due to decreased sensitivity to ripening action of ethylene and alteration in carbohydrate metabolism by regulating certain key enzymes, which interfere with production of ATP which is required for various synthetic processes during ripening (Udipi and Ghugre, 2010).Similar findings were confirmed by Arundathi (2017) in papaya and Jenjob *et al.*, (2017) in pineapple.

Shelf life (Days)

The data recorded on the combined effect of gamma irradiation and post-harvest treatments on the shelf life of fruits are furnished in the Table 3 and plate 1. The highest per cent increase of shelf life over control was observed in T_1 (0.4 kGy + GA_3 @50 ppm) followed by T_2 – 0.4 kGy + GA_3 @ 100 ppm (80.00%). However, minimum per cent increase (0.00) in shelf life was observed in T_5-control. The per cent increase of shelf life due to degradation of chlorophyll and increased enzymatic activitywere confirmed by Arundathi (2017) in papaya and Jenjob *et al.*, (2017) in pineapple.

Firmness (Kg cm^{-2})

The data pertaining to the combined effect of gamma irradiation and post-harvest treatments on firmness of fruits are furnished in the Table 4 and Plate 1. T_1- 0.4 kGy + GA_3 @ 50 ppm recorded the highest firmness (3.10) followed by T_2 - 0.4 kGy + GA_3 @ 100 ppm (2.92) and the lowest firmness (2.25) was observed in T_5 - control. Among the combination treatments, highest firmness was recorded in the fruits treated with GA_3 100 ppm+ 0.20 kGy. The delay in ripening of the treated fruits may lead to retarded degradation of starch, cellulose and hemicellulose resulted in increased firmness. (Akamine and Moy, 1983; Urbain 1986; Thomas, 1988, Sukumar Reddy, 2009).

Spoilage (%)

Lowest spoilage (21.45) was observed in T_1-0.40 kGy + GA_3 @ 50 ppm followed by T_2-0.4 kGy + GA_3 @ 100 ppm (22.37) and the highest spoilage (52.95) was observed in T_5 – control as mentioned in the below Table 5. Among the combination treatments the least spoilage was recorded in the fruits treated with GA_3 and benzyl adenine @ 100 ppm + 0.20 kGy.

The reduced spoilage may be due to decrease in microbial load and decrease in rate of respiration (Srivastava *et al.,* 1961). The Similar findings were confirmed by Arundathi (2017) in papaya and Jenjob *et al.,* (2017) in pineapple.

Total Soluble Solids (° Brix)

The data pertaining to the combined effect of gamma irradiation and post-harvest treatments on total soluble solids of fruits are furnished in the Table 6. T_1-0.4 kGy + GA_3 @ 50 ppm fruits recorded the lowest TSS (24.67) followed by T_2 - 0.4 kGy + GA_3 @ 100 ppm (24.97) and the highest TSS (25.92) was observed in T_5 - control. The reduced content of the TSS in the irradiated fruits might be due to delay in ripening and senescence or due to decrease in TSS under higher doses of gamma irradiation (Baghel *et al.,* 2005). The results obtained in the present investigation are in close conformity with those of Guimaraes *et al.,* (2013) in raspberries, (2010) and Hossain *et al.,* (2014) in guava, Ravikiran Reddy (2007) and Arundathi (2017) in papaya.

Titrable acidity (%)

Table 7 exhibits the data obtained on the combined effect of gamma irradiation and different post-harvest treatments on titrable acidity of fruits. T_1 - 0.4 kGy + GA_3 @ 50 ppm recorded the highest (0.39) titrable acidity which was on par with T_2 - 0.4 kGy + GA_3 @ 100 ppm (0.39) and the lowest titrable acidity (0.37) was observed in T_5 - control. The highest titrable acidity was observed with fruits treated with GA_3 (100 ppm) + 0.4 kGy irradiation. This may be due to less utilization of organic acids in respiration by antisenescene action of GA_3 which delays the ripening mechanism through reduced rate of starch degradation. This finding of the present study was in accordance with Sudha (2004) in sapota, Bhale Rao and Parmar (2011) and Macwan *et al.,* (2012) in banana.

Reducing Sugars (%)

The data pertaining to the combined effect of gamma irradiation and post-harvest treatments on reducing sugars of fruits are furnished in the Table 8. Fruits treated with T_1 - 0.4 kGy + GA_3 @ 50 ppm recorded the lowest reducing sugars (11.69) followed by T_2 - 0.4 kGy and GA_3 @ 100 ppm (11.78) and the highest reducing sugar (12.64) was observed in T_5 - control.

Total Sugars (%)

The data pertaining to the combined effect of gamma irradiation and post-harvest treatments on total sugars of fruits are furnished in the Table 9. Fruits treated with T_1- 0.4 kGy + GA_3 @ 50 ppm recorded the lowest total sugars (13.05) followed by T_2 -0.4 kGy + GA_3 @ 100 ppm (13.13) and the highest total sugars (13.91) was observed in T_5 - control fruits.

Table.1 Combined effect of irradiation and post-harvest treatments on physiological loss in weight (%) of fruits custard apple cv. Balanagar

S. No.	Treatments	PLW (%)						Mean
		Days After Storage						
		0	2	4	6	8	10	
01.	T_1	0.26	1.03	2.71	3.94	4.91	6.12	**3.16**
02.	T_2	0.27	1.04	2.73	3.96	4.94	6.14	**3.18**
03.	T_3	0.29	1.04	2.76	3.99	4.98	6.18	**3.21**
04.	T_4	0.30	1.06	2.78	3.99	4.99	6.19	**3.22**
05.	T_5	0.35	1.26	2.95	4.12	5.22	6.55	**3.41**
	Mean	**0.29**	**1.09**	**2.79**	**4.00**	**5.01**	**6.24**	**3.24**
		Treatments (T)		**Days (D)**		**TreatmentsX Days**		
	S.Em±	0.007		0.010		0.015		
	CD at 1%	0.015		0.022		0.032		

Table.2 Combined effect of irradiation and post-harvest treatments on per cent ripening (%) of fruits in custard apple cv. Balanagar

S. No.	Treatments	Per cent ripening (%)				Mean
		Days After Storage				
		4	6	8	10	
01.	T_1	22.00	34.56	52.00	70.00	**44.64**
02.	T_2	23.00	36.00	53.00	75.00	**46.75**
03.	T_3	25.00	40.00	55.00	76.00	**49.00**
04.	T_4	28.00	42.00	58.00	78.00	**51.50**
05.	T_5	43.00	50.00	73.00	93.00	**64.75**
	Mean	**28.20**	**40.51**	**58.20**	**78.40**	**51.32**
		Treatments (T)		**Days (D)**	**Treatments X Days**	
	S.Em±	1.22		0.62	0.45	
	CD at 1%	2.48		1.25	0.94	

Table.3 Combined effect of irradiation and post-harvest treatments on shelf life (days) of fruits in custard apple cv. Balanagar

S. No.	Treatments	Shelf life (days)	Per cent increase over control of shelf life.
01.	T_1	9.33	86.60
02.	T_2	9.00	80.00
03.	T_3	8.66	73.20
04.	T_4	8.33	66.60
05.	T_5	5.00	0.00
	Mean	**8.06**	**61.28**
	S.Em±	0.62	-
	CD at 1%	1.26	-

Table.4 Combined effect of irradiation and post-harvest treatments on firmness (Kg/ cm^2) of fruits in custard apple cv. Balanagar

S. No.	Treatments	Firmness (Kg/cm^2) Days After Storage						Mean
		0	2	4	6	8	10	
01.	T_1	5.30	4.65	3.60	2.70	1.30	1.05	**3.10**
02.	T_2	5.33	4.35	3.30	2.40	1.10	1.02	**2.92**
03.	T_3	5.28	4.15	3.10	2.20	0.90	0.95	**2.76**
04.	T_4	5.26	3.65	2.60	1.70	0.80	0.92	**2.49**
05.	T_5	5.22	3.45	2.40	1.40	0.60	0.45	**2.25**
	Mean	**5.28**	**4.05**	**3.00**	**2.08**	**0.94**	**0.88**	**2.70**
		Treatments (T)		**Days (D)**		**TreatmentsX Days**		
	S.Em±	0.033		0.020		0.014		
	CD at 1%	0.065		0.042		0.028		

Table.5 Combined effect of irradiation and post-harvest treatments on per cent spoilage (%) of fruits in custard apple cv. Balanagar

S. No.	Treatments	Per cent Spoilage (%) Days After Storage				Mean
		4	6	8	10	
01.	T_1	0.00	18.56	24.66	42.58	**21.45**
02.	T_2	0.00	19.45	25.60	44.43	**22.37**
03.	T_3	22.13	41.67	52.85	62.47	**44.78**
04.	T_4	23.12	42.54	56.46	69.80	**47.98**
05.	T_5	30.00	46.66	58.95	76.19	**52.95**
	Mean	**25.08**	**33.77**	**43.70**	**59.09**	**40.41**
		Treatments (T)		**Days (D)**		**Treatments X Days**
	S.Em±	0.010		0.016		0.023
	CD at 1%	0.021		0.032		0.048

Table.6 Combined effect of irradiation and post-harvest treatments on total soluble solids (^{o} brix) of fruits in custard apple cv. Balanagar

S. No.	Treatments	Total Soluble Solids (° Brix) Days After Storage						Mean
		0	2	4	6	8	10	
01	T_1	18.55	20.80	24.13	26.63	28.88	29.03	**24.67**
02	T_2	19.63	21.25	24.21	26.71	28.96	29.11	**24.97**
03	T_3	18.96	22.21	24.54	27.04	29.29	29.44	**25.25**
04	T_4	19.15	22.40	24.73	27.23	29.48	29.63	**25.44**
05	T_5	18.66	22.60	25.54	28.04	30.29	30.44	**25.92**
	Mean	**21.99**	**23.30**	**24.63**	**27.13**	**29.38**	**29.53**	**25.25**
		Treatments (T)		**Days (D)**		**Treatments X Days**		
	S.Em±	1.250		1.014		0.652		
	CD at 1%	2.458		2.026		NS		

Table.7 Combined effect of irradiation and post-harvest treatments on titrable acidity (%) of fruits in custard apple cv. Balanagar

S. No.	Treatments	Titrable acidity (%)						Mean
		Days After Storage						
		0	2	4	6	8	10	
01.	T_1	0.44	0.42	0.40	0.37	0.36	0.34	**0.39**
02.	T_2	0.44	0.42	0.40	0.37	0.36	0.34	**0.39**
03.	T_3	0.43	0.41	0.39	0.36	0.35	0.33	**0.38**
04.	T_4	0.43	0.41	0.39	0.36	0.35	0.33	**0.38**
05.	T_5	0.42	0.40	0.38	0.35	0.34	0.32	**0.37**
	Mean	**0.41**	**0.38**	**0.36**	**0.33**	**0.32**	**0.30**	**0.35**
		Treatments (T)		**Days (D)**		**TreatmentsX Days**		
	S.Em±	0.021		0.075		1.32		
	CD at 1%	0.044		0.145		NS		

Table.8 Combined effect of irradiation and post-harvest treatments on reducing sugars (%) of fruits in custard apple cv. Balanagar

S. No.	Treatments	Reducing Sugars (%)						Mean
		Days After Storage						
		0	2	4	6	8	10	
01.	T_1	10.28	10.69	11.37	11.75	12.89	13.25	**11.69**
02.	T_2	10.29	10.73	11.41	11.79	13.06	13.42	**11.78**
03.	T_3	10.30	10.78	11.46	11.84	13.19	13.55	**11.85**
04.	T_4	10.32	10.80	11.48	11.86	13.68	14.04	**12.03**
05.	T_5	10.33	11.41	12.09	12.47	14.29	14.65	**12.64**
	Mean	**10.30**	**10.88**	**11.56**	**11.94**	**13.42**	**13.78**	**11.98**
		Treatments (T)		**Days (D)**		**TreatmentsX Days**		
	S.Em±	0.405		0.812		0.014		
	CD at 1%	1.185		1.685		NS		

Table.9 Combined effect of irradiation and post-harvest treatments on total sugars (%) of fruits in custard apple cv. Balanagar

S. No.	Treatments	Total sugars (%)						Mean
		Days After Storage						
		0	2	4	6	8	10	
01.	T_1	11.48	11.94	12.68	13.13	14.35	14.73	**13.05**
02.	T_2	11.49	11.98	12.72	13.17	14.52	14.90	**13.13**
03.	T_3	11.51	12.04	12.78	13.23	14.66	15.04	**13.21**
04.	T_4	11.53	12.06	12.80	13.25	15.15	15.53	**13.39**
05.	T_5	11.55	12.68	13.42	13.87	15.77	16.15	**13.91**
	Mean	**11.51**	**12.14**	**12.88**	**13.33**	**14.89**	**15.27**	**13.34**
		Treatments (T)		**Days (D)**		**TreatmentsX Days**		
	S.Em±	0.320		0.685		1.12		
	CD at 1%	1.060		1.285		NS		

Table.10 Combined effect of irradiation and post-harvest treatments on ascorbic acid (mg/ 100 g) in fruits of custard apple cv. Balanagar

S. No.	Treatments	Ascorbic acid (mg/100g)						Mean
		Days After Storage						
		0	2	4	6	8	10	
01.	**T_1**	43.05	44.50	46.78	50.43	49.28	46.81	**43.05**
02.	**T_2**	42.75	44.20	46.48	50.13	48.98	46.51	**42.75**
03.	**T_3**	42.63	44.08	46.36	50.01	48.86	46.39	**42.63**
04.	**T_4**	42.47	43.92	46.20	49.85	48.70	46.23	**42.47**
05.	**T_5**	41.80	43.25	45.53	49.18	48.03	45.56	**41.80**
	Mean	**42.54**	**43.99**	**46.27**	**49.92**	**48.77**	**46.30**	**42.54**
		Treatments (T)		**Days (D)**		**TreatmentsX Days**		
	S.Em±	0.305		0.825		0.312		
	CD at 1%	0.621		1.638		NS		

Table.11 Combined effect of irradiation and post-harvest treatments on organoleptic evaluation of custard apple cv. Balanagar

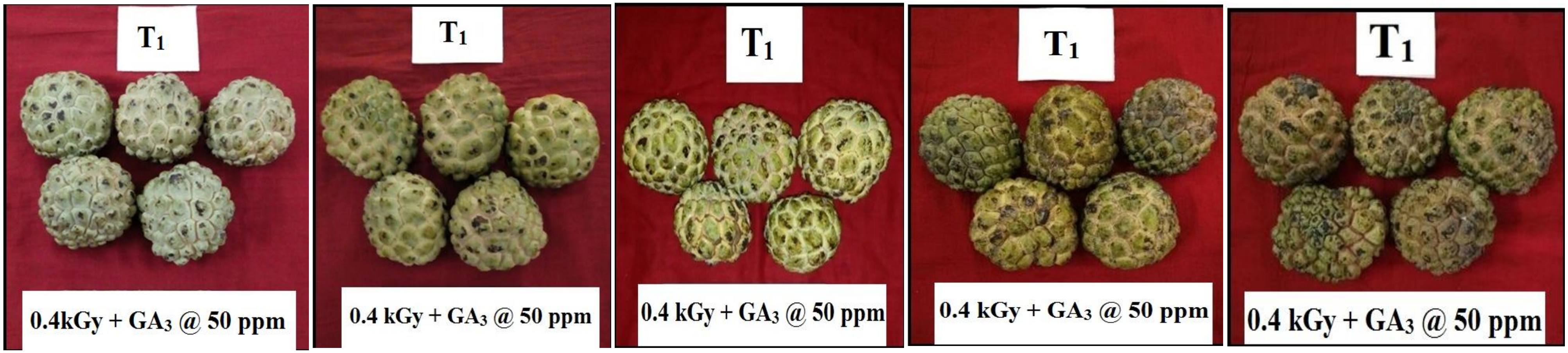
S. No.	Treatments	Organoleptic evaluation				
		Colour and appearance	Textur e	Taste	Flavour	Overall acceptability
01.	T_1	8.43	8.23	8.25	8.10	8.38
02.	T_2	8.13	7.83	8.03	7.75	8.15
03.	T_3	7.83	7.65	7.75	7.53	8.00
04.	T_4	7.40	7.43	7.65	7.33	7.63
05.	T_5	6.68	6.60	6.70	6.75	6.73
	Mean	**7.69**	**7.55**	**7.68**	**7.49**	**7.78**
	SE(m)	0.04	0.09	0.07	0.07	0.07
	CD at 1%	0.13	0.29	0.21	0.20	0.20

Score description: 9- Like extremely; 8- Like very much; 7- Like moderately; 6- Like slightly; 5- Neither like nor Dislike; 4 - Dislike slightly; 3- Dislike moderately; 2- Dislike very much; 1- Dislike extremely.

Treatment details

T_1	**0.40 kGy + GA_3 @ 50 ppm**
T_2	0.40 kGy + GA_3 @ 100 ppm.
T_3	0.60 kGy + GA_3 @ 50 ppm.
T_4	0.60 kGy + GA_3 @ 100 ppm.
T_5	Control

Plate.1 Images of custard apple fruits of best treatment (T_1–0.4kGy + GA_3@ 50 ppm having highest shelf life



2nd DAY OF STORAGE | **4th DAY OF STORAGE** | **6th DAY OF STORAGE** | **8th DAY OF STORAGE** | **10th DAY OF STORAGE**

The fruits treated with GA_3 (100 ppm) + 0.4 kGy irradiation recorded lowest reducing and total sugars at all the stages of observation. This may be due to slow hydrolysis of starch to sugars by antagonistic effect on autocatalytic biosynthesis of ethylene and inhibit the activity of α amylase, β amylase and starch phosphorylase and also due to maintaining the organic acid and acidity level results in low sugar content and higher starch in fruits at ripening (Deepak *et al.,* 2008).

Among the combination treatments, relatively lower sugars were recorded in the fruits treated with GA_3 and Benzyl Adenine @100 ppm + 0.20 kGy. This may be due to the inhibitory effect on destruction of sugars into simple compounds. These results ate in accordance with Sukumar Reddy (2009) in guava.

Irradiation of treatments in combination with GA_3 may also prevented deterioration by inhibiting fungal infection. Many post-harvest pathogens causes cellular damage by synthesizing enzymes affecting cell wall. Irradiation of fruits could have prevented the tissue damage and respiration resulting in increased total sugars. The similar results were agreement with that of Thomas and Janava (1975) in mango, Susheela *et al.,* (1997) in Pineapple and BrijBhushan *et al.,* (1998) in apple and Sukumar Reddy (2009) in guava.

Ascorbic acid (mg/100g)

Fruits treated with T_1 - 0.4 kGy + GA_3@ 50 ppm recorded the highest ascorbic acid (43.05) followed by T_2 -0.4 kGy + GA_3 @ 100 ppm (42.75) and the lowest ascorbic acid (41.80) was observed in T_5 - control fruits as shown in Table 10. The ascorbic acid content decreased during storage due to high rate of respiration and evapo-transpiration. The decreasing trend of ascorbic acid might have happened due to rapid conversion of ascorbic acid into dehydroascorbic acid in presence of enzyme ascorbinase (Bagel *et al.,* 2005). The results obtained in the present investigation are in close conformity with those of Guimaraes *et al.,* (2013) in raspberries, (2010) and Hossain *et al.,* (2014) in guava, Ravikiran Reddy (2007) and Arundathi (2017) in papaya.

Organoleptic quality

Results of combined effect of gamma irradiation and post-harvest treatments on organoleptic quality of custard apple (*Annona squamosa* L.) including colour and appearance, texture, taste, flavour and overall acceptability are presented in the Table 11. With respect to the colour and appearance the fruits treated with T_1-0.40 kGy + GA_3 @ 50 ppm (8.43) recorded highest score followed by T_2- 0.60 kGy + GA_3 @ 100ppm (8.13) treated fruits and lowest was observed in T_5-control (6.68) fruits. There is a significant difference among all the treatments. Score of texture was recorded highest in T_1- 0.40 kGy + GA_3 @ 50 ppm (8.25) treated fruits, followed by T_2-0.60 kGy + GA_3 @ 100 ppm (8.03) treated fruits and the lowest score was observed in T_5- control (6.70) fruits. There is a significant difference among all remaining treatments.

For taste highest score were recorded in T_1-0.40 kGy + GA_3 @ 50 ppm (8.23) treated fruits, followed by T_2-0.6 kGy + GA_3 @ 100 ppm (7.83) treated fruits and the lowest score was recorded by T_5-control (6.60) There is a significant difference among all remaining treatments. Score of flavour was recorded highest in T_1- 0.40 kGy + GA_3 @ 50 ppm (8.10) treated fruits, followed by T_2-0.60 kGy + GA_3 @ 100 ppm (7.75) treated fruits and the lowest score was recorded by T_5 - control (6.75) There is a significant difference among all remaining treatments. Highest score for overall acceptability was recorded in T_1-0.40 kGy + GA_3 @ 50 ppm (8.38) treated fruits followed by T_2- 0.60kGy + GA_3 @ 100 ppm (8.15) wrapped fruits and the lowest score was recorded by T_5-control (6.73). There is a significant difference among all remaining treatments. Among all the treatments the highest score in overall acceptability was recorded in fruits treated with T_1- 0.40 kGy + GA_3 @ 50 ppm (8.38) which is the first best treatment according to organoleptic evaluation, and followed by T_2- 0.60 kGy + GA_3 @ 100 ppm (8.15) treated fruits treatment is the second best among all treatments.

Post-harvest biochemical changes may influence the fruit flavour, taste, texture, and colour and hence these organoleptic parameters are crucial factors for consumer acceptability. In the present study, irradiation of fruits at 0.4 kGy followed by dipping fruits GA_3 @ 50 ppm received highest grade for flavour due to slow ripening of fruits and the fruits right stage for consumption on eight day of storage when they were tested for organoleptic quality. Besides it may also due to low disease infection, low weight loss, high total and reducing sugars through anti senescent and fungicidal activity. The results for organoleptic characters are in agreement with those reported by Kumar (1993) in mango, Rajkumar (2005) and Jancy (2006) in papaya, Sudha (2004) in Sapota and Machwan (2012) in banana.

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