The Pharma Innovation Journal 2022; 11(11): 1466-1471

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(11): 1466-1471

www.thepharmajournal.com
Received: 11-09-2022
Accepted: 15-10-2022

Thiripurasundhari S
Research Scholar, Department of Fruit Science, College of Horticulture, SKLTSHU, Rajendranagar, Telangana, India

Veena Joshi
Associate Professor, Department of Horticulture, College of Horticulture, SKLTSHU, Mojerla, Telangana, India

N Seenivasan
Professor and Controller of Examinations, Department of Horticulture, SKLTSHU, Mulugu, Siddipet, Telangana, India

D Vijaya
Professor, Department of Soil Science, SKLTSHU, Mulugu, Siddipet, Telangana, India

D Naga Harshitha
Assistant Professor, Department of Fruit Science, College of Horticulture, SKLTSHU, Rajendranagar, Telangana, India

Corresponding Author:
Thiripurasundhari S
Research Scholar, Department of Fruit Science, College of Horticulture, SKLTSHU, Rajendranagar, Telangana, India

Effect of packaging materials and ethylene absorbent on shelf life attributes of guava (*Psidium guajava* L.) cv. Arka Kiran

Thiripurasundhari S, Veena Joshi, N Seenivasan, D Vijaya and D Naga Harshitha

Abstract
Guava (*Psidium guajava* L.) which belongs to the family Myrtaceae (2n=22) is cultivated in tropical and subtropical regions of the world. Guava is a commercial crop grown in tropical India and well-known for its delectable flavour, taste and other sensory properties. Guava being a highly perishable fruit, undergoes rapid post-harvest ripening in few days under ambient conditions. The present investigation was carried out to study the effect of packaging materials and ethylene absorbant on shelf life attributes of guava cv. Arka Kiran at Post-harvest laboratory, College of Horticulture, SKLTSHU, Rajendranagar, Hyderabad. The freshly harvested guava fruits were packed in different packaging materials along with and without ethylene absorbants and stored in ambient (28 ± 2 ºC) and refrigerated (8 ± 1 ºC) storage conditions. The fruits packed in HDPE (High Density Polyethylene) 50 microns with ethylene absorbant and kept in refrigerated temperature was found to be best of all the treatments with a shelf life of 21.01 days followed by fruits stored in PP (Polypropylene) 50 microns with ethylene absorbant and refrigerated temperature with shelf life of 20.88 days.

Keywords: Guava, packaging material, ethylene absorbant, storage conditions, shelf life, HDPE

Introduction
Guava (*Psidium guajava* L.) is also known as 'apple of tropics' and 'poor man's apple' which originated from Tropical America and belongs to family Myrtaceae. Guava is a commercial crop grown in tropical India which is well-known for its delectable flavour, taste and other sensory properties. Guava is the fourth most important commercial fruit in area and production after mango, banana and citrus in India (Kiran *et al*., 2020) [12]. Guava crop cultivated in India with an area of 315 thousand hectares, production of 4916 thousand metric tons and productivity of 15.6 metric tons per hectare (NHB, 2021-22) [15]. In India, major guava producing states are Maharashtra, Bihar, Andhra Pradesh, Uttar Pradesh, Karnataka, Gujarat, Tamil Nadu and Telangana. Guava is highly demanding fruit year round for its fresh and processed produce and due to its tastiness and health-promoting qualities such as ascorbic acid (260 mg/100g) and dietary fiber (63.94 g/100 g) (Pedapati and Tiwari, 2014) [18].
Post-harvest quality conservation of guava is still a challenge in the production chain due to the minimized post-harvest life attributed to its rapid respiratory rate, quick loss of firmness and Prevalance of decay during storage (Forato *et al*., 2015) [7].
Having a climacteric fruit-typed respiration and ethylene peak during ripening, quality of guava fruit is rapidly degraded due to its high metabolic activities, respiration and transpiration rates, which persists at post-harvest and cause losses in texture and quality features throughout storage (Kanwal *et al*. 2016) [10]. Thus, high levels of post-harvest losses of guava can be overcome by proper harvesting, post-harvest handling, cold chain management and using proper packaging and storage technology.
Ethylene inhibition or its removal should be used to maintain post-harvest quality. Ethylene absorbants usually contain potassium permanganate (oxidizing agent), which oxidizes ethylene to acetaldehyde, which is then converted to acetic acid. Further oxidation of acetic acid releases water and carbon dioxide (Gaikwad *et al*., 2020) [8]. The packaging of fruits in polyethylene films which creates a modified environment that reduces dehydration and maintains freshness of the fruits (Kaur *et al*., 2013) [11]. High-density polyethylene (HDPE) is stronger, thicker, less flexible and more brittle than LDPE simultaneously better barrier to gases and moisture. Low-density polyethylene (LDPE) is softer and more flexible and has good moisture barrier.

LDPE has a low melting temperature, 105-115 °C, so it is a useful material for heat sealing (Jena *et al*., 2019) [9]. Polypropylene (PP) is also used as a packaging material of fruits. It is a good water vapour barrier and has higher melting temperature than polyethylene (Nath *et al*., 2012) [14]. In recent years, biodegradable non-plastic films have prospective to be used as packaging materials for fruits. Hence, use of ethylene absorbant and storing fruits in different packaging materials will postpone the untimely climacteric process (Yildirim *et al*., 2018) [22].

Materials and Methods

The experiment was carried out on Post-harvest Laboratory, College of Horticulture, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad during the year 2021- 2022. Guava fruits (cv. Arka Kiran) used for the research experiment were procured from orchard in Mojerla village, Mahabubnagar district, Telangana. The freshly harvested guava fruits were packed in different packaging materials along with and without ethylene absorbants (@ 5 g $KMnO_4$ per kg of fruit) and stored in ambient (28 ± 2 ºC) and refrigerated (8 ± 1ºC) storage conditions.

The experiment was conducted in two factor completely randomized design with three replications. Factor one includes nine treatments: P_1 - LDPE with ethylene absorbant, P_2 - LDPE without ethylene absorbant, P_3 - HDPE with ethylene absorbant, P_4 - HDPE without ethylene absorbant, P_5 - PP with ethylene absorbant, P_6 - PP without ethylene absorbant, P_7 - Biodegradable bags with ethylene absorbant, P_8 - Biodegradable bags without ethylene absorbant, P_9 - Control and factor two includes two storage conditions: S_1 - Ambient temperature and S_2 - Refrigerated temperature.

Physiological loss in weight (PLW) (%)

The initial weight of the fruit in each treatment was noted. The final weight was observed at every three days interval during the storage. The physiological loss in weight was expressed in percentage and calculated by using the following formula:

$$\text{PLW (\%)} = \frac{\text{Initial weight of the fruit} - \text{final weight of the fruit}}{\text{Initial weight of the fruit}} \times 100$$

Spoilage (%)

The number of fruits spoiled in each treatment was counted and expressed in percentage. Spoilage percentage was calculated by following formula:

$$\text{Spoilage (\%)} = \frac{\text{Number of spoiled fruits}}{\text{Total number of fruits}} \times 100$$

Shelf Life (days)

The number of days the fruits remained in good condition in storage was utilized to estimate the fruit's shelf life. In that particular treatment, the end of the shelf life was defined as the point at which more than 50% of the kept fruits became unfit for consumption and was expressed as a mean number of days (Padmaja and Bosco, 2014) [16].

Fruit firmness (kg/cm^2)

The firmness of the fruits was recorded by using a penetrometer which measures the penetration force and was expressed in terms of kg/cm^2.

Surface Colour Measurement (DA meter)

The surface colour of the fruit was measured by using DA meter which was developed by Prof. Costa's team from the University of Bologna. It is a tool that makes it possible to measure the amount of chlorophyll in a fruit due to its absorbent qualities. The DA is an index of the chlorophyll in fruit and as a consequence, of its ripeness state. This index loses its value as the fruit ripens, obtaining a very low value at the point at which the ripening is complete.

Results and Discussion

Physiological Loss in Weight (%)

Physiological loss in weight (%) of the fruits was increased during the storage conditions (Table 1). The constant loss of moisture through fruit transpiration and respiration could be the reason for increase in PLW during the storage conditions (Mir *et al*., 2018) [13].

Fruits stored in S_2 - refrigerated temperature was recorded considerably lower PLW (0.94%), (2.03%) and (3.07%) on 3rd, 6th and 9th day, while fruits kept in S_1 - ambient temperature had the highest PLW (3.51%), (6.15%) and (6.84%) on the 3rd, 6th and 9th day respectively. With respect to interactions, P_3S_2 - HDPE with ethylene absorbant + refrigerated temperature recorded least PLW (0.83%), (1.83%) and (2.43%) on 3rd, 6th and 9th day respectively.

Guava fruits stored under ambient temperature were discarded due to spoilage after 9th day of storage. The fruits stored in refrigerated temperature packed in HDPE with ethylene absorbant (P_3S_2) recorded significantly lowest PLW (3.58%), (4.64%), (5.81%) and (7.59%) on 12th, 15th, 18th and 21st day respectively.

Fruits packed in high density polyethylene (HDPE) with ethylene absorbant and stored in refrigerated temperature had recorded the minimum PLW. This might be due to the water loss reduction in fruits and lower accumulation of ethylene inside the packages (Silva *et al.* 2009) [21]. The results obtained are in close conformity with those results of Akhtar *et al*. (2012) [1] in loquat fruits.

Spoilage (%)

The synergistic impact of different packaging materials and storage conditions of guava (cv. Arka Kiran) fruits on spoilage (%) is presented in the table 2. Guava fruits stored in S_1 - ambient temperature packed in HDPE with ethylene absorbant (P_3S_1) recorded significantly minimum spoilage of (0.0%), (23.33%) and (31.67%) on 3rd, 6th and 9th day respectively whereas control fruits recorded maximum spoilage percentage.

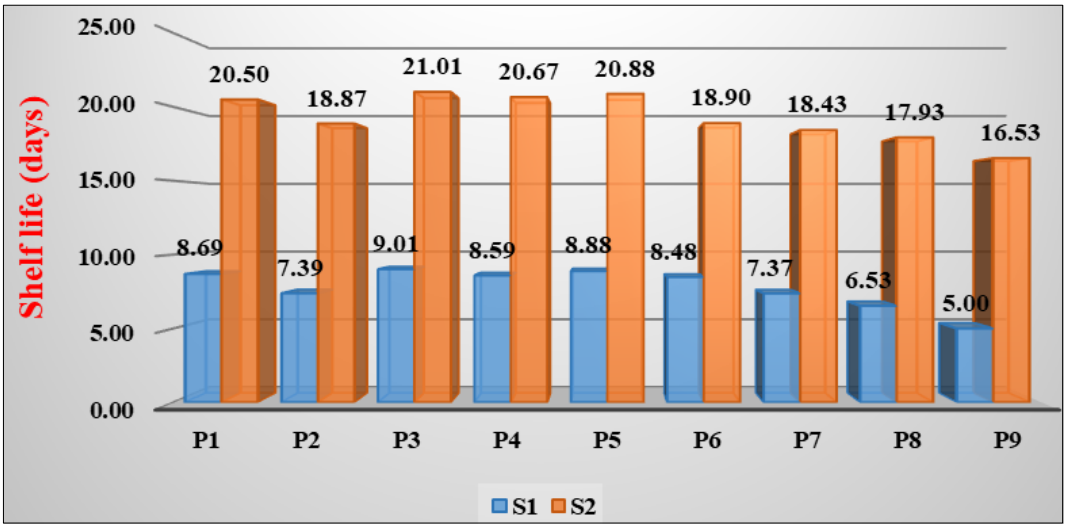
The fruits stored under ambient temperature were discarded due to spoilage after 9th day of storage, while in refrigerated conditions did not shown spoilage percent upto 9 days. The fruits stored in refrigerated temperature packed in HDPE with ethylene absorbant (P_3S_2) recorded significantly least spoilage of (6.67%), (16.67%) and (28.33%) on 15th, 18th and 21st day respectively.

Fruits packed in high density polyethylene (HDPE) with ethylene absorbant and stored in refrigerated temperature was observed the least spoilage percent. This might be due to reduced respiration, transpiration and ethylene production. The results are in conformity to the findings of Elzubeir *et al*. (2017) [6] in mango and Rammohan *et al*. (2017) [19] in banana fruits.

Shelf Life (days)

The synergistic impact of different packaging materials and storage conditions of guava (cv. Arka Kiran) fruits on shelf life (days) is presented in the fig. 1.

The highest shelf life (21.01 days) was observed in P_3S_2 - HDPE with ethylene absorbant + refrigerated temperature and it was found to be par with P_5S_2 - PP with ethylene absorbant + refrigerated temperature (20.88 days) and P_9S_1 (control + ambient temperature) was recorded least shelf life (5.00 days). The polyethylene bags and ethylene absorbants had maintained the quality of fruits during the storage conditions. The similar findings were reported by Ali *et al*. (2015) [2] in apricot and Pattar *et al*. (2021) [17] in jamun fruits.



P_1 - LDPE with ethylene absorbant; P_2 - LDPE without ethylene absorbant; P_3 - HDPE with ethylene absorbant; P_4 - HDPE without ethylene absorbant; P_5 - PP with ethylene absorbant; P_6 - PP without ethylene absorbant; P_7 - Biodegradable bags with ethylene absorbant; P_8 - Biodegradable bags without ethylene absorbant; P_9 - Control. S_1 - Ambient temperature; S_2 - Refrigerated temperature.

Fig 1: Effect of different packaging materials with ethylene absorbant on Shelf Life (days) of guava cv. Arka Kiran at different storage conditions

Firmness (kg/cm^2)

Firmness of guava fruits showed decreasing tendency with increase in storage period was given in the table 3. Reduction in fruit firmness during the storage was due to increased rates of respiration and ethylene evolution of fruits (Sharma *et al*., 2012) [20].

Fruits stored in S_2 - refrigerated temperature observed significantly higher levels of firmness (8.11, 7.69 and 7.26 kg/cm^2) on 3rd, 6th and 9th day whereas fruits kept in S_1 - ambient temperature had the lowest firmness (6.49, 5.35 and 4.79 kg/cm^2) on 3rd, 6th and 9th day respectively. In terms of interactions, P_3S_2 - HDPE with ethylene absorbant + refrigerated temperature recorded highest firmness (8.63, 8.23 and 7.93 kg/cm^2) on 3rd, 6th and 9th day respectively.

Guava fruits stored under ambient temperature were discarded due to spoilage after 9th day of storage. The fruits stored in Refrigerated temperature packed in HDPE with ethylene absorbant (P_3S_2) recorded significantly highest firmness (7.80, 6.87, 5.87 and 4.53 kg/cm^2) on 12th, 15th, 18th and 21st day respectively.

Fruits packed in high density polyethylene (HDPE) with ethylene absorbant and stored in refrigerated temperature had recorded the highest firmness. These polyethylene packaging materials and ethylene absorbant had reduced the water loss and fruit ripening during the storage. The similar findings were reported by Azene *et al*. (2011) [3] in papaya and Dhakal *et al*. (2021) [5] in banana fruits.

Surface Colour Measurement (DA meter)

The synergistic impact of different packaging materials and storage conditions of guava (cv. Arka Kiran) fruits on surface colour measurement is presented in the table 4.

With respect to storage conditions, maximum surface colour measurement was observed in S_2 - refrigerated temperature (1.98), (1.94) and (1.89) on 3rd, 6th and 9th day whereas minimum surface colour measurement was observed in S_1 - ambient temperature with (1.93), (1.83) and (1.75) on 3rd, 6th and 9th day respectively. Among interactions, P_3S_2 - HDPE with ethylene absorbant + refrigerated temperature recorded highest surface colour measurement (2.04), (2.01) and (1.97) on 3rd, 6th and 9th day respectively.

Guava fruits stored under ambient temperature were discarded due to spoilage after 9th day of storage. The fruits stored in refrigerated temperature packed in HDPE with ethylene absorbant (P_3S_2) recorded significantly highest surface colour measurement (1.92), (1.87), (1.80) and (1.75) on 12th, 15th, 18th and 21st day respectively.

Fruits packed in high density polyethylene (HDPE) with ethylene absorbant and stored in refrigerated temperature was observed the maximum surface colour. The results obtained are in close conformity with those results of Carrilo *et al*. (2003) [4] in pear fruits.

Table 1: Effect of different packaging materials with ethylene absorbant on Physiological Loss in Weight (%) of guava cv. Arka Kiran at different storage conditions

Physiological Loss in Weight (%)																	
	3rd day			6th day			9th day			12th day		15th day		18th day		21st day	
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
P_1	2.91	0.87	1.89	5.23	1.88	3.56	7.08	2.72	4.90	*	3.75	*	4.83	*	6.01	*	7.73
P_2	3.10	0.93	2.02	6.83	1.99	4.41	*	4.41	-	*	3.98	*	4.99	*	6.18	*	*
P_3	2.71	0.83	1.77	5.16	1.83	3.50	6.25	2.43	4.34	*	3.58	*	4.64	*	5.81	*	7.59
P_4	2.97	0.86	1.92	5.22	1.87	3.55	6.85	2.53	4.69	*	3.60	*	4.75	*	6.03	*	7.77
P_5	2.94	0.86	1.90	5.33	1.92	3.63	7.17	2.64	4.91	*	3.75	*	4.94	*	6.13	*	7.89
P_6	3.17	0.89	2.03	7.05	1.96	4.51	*	2.84	-	*	4.02	*	5.12	*	6.96	*	*
P_7	3.16	0.95	2.06	6.98	2.02	4.50	*	3.00	-	*	4.22	*	5.96	*	7.29	*	*
P_8	4.12	1.06	2.59	7.41	2.23	4.82	*	3.34	-	*	4.86	*	6.05	*	7.86	*	*
P_9	6.48	1.16	3.82	*	2.54	-	*	3.72	-	*	5.06	*	7.12	*	*	*	*
Mean	3.51	0.94		6.15	2.03		6.84	3.07		-	4.09	-	5.38	-	6.53	-	7.74

	3rd day		6th day		9th day		12th day		15th day		18th day		21st day	
	S.Em ±	CD at 5%	S.E m±	CD at 5%	S.E m±	CD at 5%	S.E m±	CD at 5%	S.E m±	CD at 5%	S.E m±	CD at 5%	S.E m±	CD at 5%
P	0.020	0.058	0.012	0.034	0.008	0.023	0.008	0.022	0.010	0.027	0.007	0.020	0.009	0.026
S	0.010	0.027	0.006	0.016	0.004	0.011	0.004	0.011	0.005	0.013	0.003	0.009	0.004	0.012
P x S	0.029	0.082	0.017	0.049	0.011	0.033	0.011	0.032	0.014	0.039	0.010	0.028	0.013	0.037

*- end of shelf life

P_1 - LDPE with ethylene absorbant; P_2 - LDPE without ethylene absorbant; P_3 - HDPE with ethylene absorbant;
P_4 - HDPE without ethylene absorbant; P_5 - PP with ethylene absorbant; P_6 - PP without ethylene absorbant;
P_7 - Biodegradable bags with ethylene absorbant; P_8 - Biodegradable bags without ethylene absorbant; P_9 - Control.
S_1 - Ambient temperature; S_2 - Refrigerated temperature.

Table 2: Effect of different packaging materials with ethylene absorbant on Spoilage (%) of guava cv. Arka Kiran at different storage conditions

Spoilage (%)																	
	3rd day			6th day			9th day			12th day		15th day		18th day		21st day	
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
P_1	0.00	0.00	0.00	26.67	0.00	13.33	33.33	0.00	16.67	*	0.00	*	8.33	*	18.33	*	33.33
P_2	5.00	0.00	2.50	31.67	0.00	15.83	*	0.00	0.00	*	6.67	*	11.67	*	23.33	*	*
P_3	0.00	0.00	0.00	23.33	0.00	11.67	31.67	0.00	15.83	*	0.00	*	6.67	*	16.67	*	28.33
P_4	0.00	0.00	0.00	26.67	0.00	13.33	36.67	0.00	18.33	*	0.00	*	10.00	*	21.67	*	35.00
P_5	0.00	0.00	0.00	25.00	0.00	12.50	38.33	0.00	19.17	*	0.00	*	8.33	*	21.67	*	36.67
P_6	6.67	0.00	3.33	28.33	0.00	14.17	*	0.00	-	*	8.33	*	11.67	*	23.33	*	*
P_7	6.67	0.00	3.33	31.67	0.00	15.83	*	0.00	-	*	8.33	*	16.67	*	28.33	*	*
P_8	8.33	0.00	4.17	36.67	0.00	18.33	*	0.00	-	*	10.00	*	16.67	*	36.67	*	*
P_9	21.67	0.00	10.83	*	0.00	0.00	*	0.00	-	*	11.67	*	28.33	*	*	*	*
Mean	5.37	0.00		28.75	0.00		35.00	0.00			5.00	-	13.15	-	23.75	-	33.33

	3rd day		6th day		9th day		12th day		15th day		18th day		21st day	
	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%
P	0.56	1.59	0.73	2.11	0.56	1.59	0.56	1.59	0.79	2.25	0.79	2.25	0.56	1.59
S	0.26	0.75	0.35	0.99	0.26	0.75	0.26	0.75	0.37	1.06	0.37	1.06	0.26	0.75
P x S	0.79	2.25	1.04	2.98	0.79	2.25	0.79	2.25	1.11	3.19	1.11	3.19	0.79	2.25

*- end of shelf life

P_1 - LDPE with ethylene absorbant; P_2 - LDPE without ethylene absorbant; P_3 - HDPE with ethylene absorbant;
P_4 - HDPE without ethylene absorbant; P_5 - PP with ethylene absorbant; P_6 - PP without ethylene absorbant;
P_7 - Biodegradable bags with ethylene absorbant; P_8 - Biodegradable bags without ethylene absorbant; P_9 - Control.
S_1 - Ambient temperature; S_2 - Refrigerated temperature

Table 3: Effect of different packaging materials with ethylene absorbant on Firmness (kg/cm^2) of guava cv. Arka Kiran at different storage conditions

Firmness (kg/cm^2)																	
	3rd day			6th day			9th day			12th day		15th day		18th day		21st day	
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
P_1	6.80	8.57	7.68	5.60	8.13	6.87	4.53	7.63	6.08	*	6.93	*	6.47	*	5.67	*	3.93
P_2	6.40	8.27	7.33	5.23	7.67	6.45	*	7.20	-	*	6.70	*	6.20	*	5.03	*	*
P_3	7.13	8.63	7.88	5.97	8.23	7.10	4.93	7.93	6.43	*	7.80	*	6.87	*	5.87	*	4.53
P_4	6.97	8.50	7.73	5.73	8.07	6.90	4.87	7.63	6.25	*	7.03	*	6.47	*	5.43	*	3.97
P_5	6.93	8.50	7.72	5.57	8.17	6.87	4.83	7.80	6.32	*	7.27	*	6.63	*	5.67	*	4.13
P_6	6.37	8.17	7.27	5.07	7.63	6.35	*	7.23	-	*	6.77	*	6.27	*	4.97	*	*
P_7	6.30	7.70	7.00	4.93	7.27	6.10	*	6.93	-	*	6.43	*	5.93	*	4.50	*	*
P_8	6.07	7.40	6.73	4.73	7.13	5.93	*	6.63	-	*	6.27	*	5.73	*	3.97	*	*

P_9	5.40	7.23	6.32	*	6.93	-	*	6.30	-	*	5.83	*	4.93	*	*	*	*	
Mean	6.49	8.11		5.35	7.69		4.79	7.26		-	6.78	-	6.17	-	5.14	-	4.14	
	3rd day		6th day		9th day		12th day		15th day		18th day		21st day					
	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%				
P	0.06	0.16	0.05	0.15	0.04	0.12	0.03	NS	0.04	0.11	0.03	0.09	0.02	0.07				
S	0.03	0.08	0.03	0.07	0.02	0.06	0.01	NS	0.02	0.05	0.01	0.04	0.01	0.03				
P x S	0.08	0.23	0.08	0.22	0.06	0.17	0.04	NS	0.06	0.16	0.04	0.12	0.03	0.10				

*- end of shelf life

P_1 - LDPE with ethylene absorbant; P_2 - LDPE without ethylene absorbant; P_3 - HDPE with ethylene absorbant;
P_4 - HDPE without ethylene absorbant; P_5 - PP with ethylene absorbant; P_6 - PP without ethylene absorbant;
P_7 - Biodegradable bags with ethylene absorbant; P_8 - Biodegradable bags without ethylene absorbant; P_9 - Control.
S_1 - Ambient temperature; S_2 - Refrigerated temperature

Table 4: Effect of different packaging materials with ethylene absorbant on Surface Colour Measurement (DA meter) of guava cv. Arka Kiran at different storage conditions

Surface Colour Measurement (DA meter)																	
	3rd day			6th day			9th day			12th day		15th day		18th day		21st day	
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
P_1	1.97	2.01	1.99	1.87	1.96	1.92	1.74	1.94	1.84	*	1.87	*	1.83	*	1.74	*	1.70
P_2	1.95	1.96	1.96	1.83	1.93	1.88	*	1.89	-	*	1.83	*	1.80	*	1.72	*	*
P_3	1.97	2.04	2.01	1.88	2.01	1.94	1.78	1.97	1.87	*	1.92	*	1.87	*	1.80	*	1.75
P_4	1.97	1.99	1.98	1.85	1.97	1.91	1.74	1.93	1.83	*	1.89	*	1.86	*	1.76	*	1.71
P_5	1.96	2.03	1.99	1.87	1.99	1.93	1.75	1.96	1.86	*	1.90	*	1.86	*	1.79	*	1.73
P_6	1.93	1.96	1.95	1.82	1.91	1.86	*	1.87	-	*	1.81	*	1.78	*	1.72	*	*
P_7	1.92	1.96	1.94	1.79	1.92	1.85	*	1.87	-	*	1.80	*	1.74	*	1.71	*	*
P_8	1.89	1.94	1.91	1.77	1.89	1.83	*	1.83	-	*	1.76	*	1.71	*	1.69	*	*
P_9	1.81	1.93	1.87	*	1.89	-	*	1.80	-	*	1.73	*	1.69	*	*	*	*
Mean	1.93	1.98		1.83	1.94		1.75	1.89		-	1.83	-	1.79	-	1.74	-	1.72

	3rd day		6th day		9th day		12th day		15th day		18th day		21st day	
	S.Em ±	CD at 5%	S.Em ±	CD at 5%	S.Em ±	CD at 5%	S.Em±	CD at 5%	S.Em ±	CD at 5%	S.Em ±	CD at 5%	S.Em ±	CD at 5%
P	0.005	NS	0.004	0.012	0.003	0.010	0.003	0.008	0.003	0.008	0.003	0.007	0.001	0.004
S	0.002	NS	0.002	0.006	0.002	0.005	0.001	0.004	0.001	0.004	0.001	0.003	0.001	0.002
P x S	0.007	NS	0.006	0.017	0.005	0.014	0.004	0.011	0.004	0.011	0.004	0.010	0.002	0.006

*- end of shelf life

P_1 - LDPE with ethylene absorbant; P_2 - LDPE without ethylene absorbant; P_3 - HDPE with ethylene absorbant;
P_4 - HDPE without ethylene absorbant; P_5 - PP with ethylene absorbant; P_6 - PP without ethylene absorbant;
P_7 - Biodegradable bags with ethylene absorbant; P_8 - Biodegradable bags without ethylene absorbant; P_9 - Control.
S_1 - Ambient temperature; S_2 - Refrigerated temperature

Conclusion

From this study it could be concluded that packaging materials with ethylene absorbant and different storage conditions effected the shelf life attributes of guava fruits. Among the packaging materials, HDPE (High Density Polyethylene) with ethylene absorbant is best followed by PP (Polypropylene) with ethylene absorbant. Among the storage conditions, guava fruits stored in S_2 - refrigerated temperature (8 ± 1 ºC) showed better results with increase in shelf life than S_1 - ambient temperature. With respect to interactions P_3S_2 - HDPE (High Density Polyethylene) 50 microns with ethylene absorbant + refrigerated temperature was best of all the treatments with a shelf life of 21.01 days followed by P_5S_2 - PP (Polypropylene) 50 microns with ethylene absorbant + refrigerated temperature with shelf life of 20.88 days.

Reference

1. Akhtar A, Abbasi NA, Hussain A, Bakhsh A. Preserving quality of loquat fruit during storage by modified atmosphere packaging. Pakistan Journal of Agricultural Sciences. 2012;49(4) 419-423.
2. Ali S, Masud T, Ali A, Abbasi KS, Hussain, S. Influence of packaging material and ethylene scavenger on biochemical composition and enzyme activity of apricot cv. Habi at ambient storage. Food Science and Quality Management. 2015;35:73-82.
3. Azene M, Workneh TS, Woldetsadik K. Effect of packaging materials and storage environment on postharvest quality of papaya fruit. Journal of food science and technology. 2011;51(6):1041-1055.
4. Carrillo-Lopez A, Cruz-Hernandez A, Guevara-Lara F, Paredes-Lopez O. Physico-chemical changes during ripening in storage of two varieties of prickly pear stored at 18 °C. Journal of food science and technology. 2003;40(5):461-464.
5. Dhakal S, Aryal S, Khana P, Basnet B, Srivastava A. Effect of $KMnO_4$ on shelf life and quality of banana (*Musa paradisiaca*). Fundamental and Applied Agriculture. 2021;6(3):225-231.
6. Elzubeir MM, Abu-Goukh ABA, Osman A. Effect of polyethylene film lining and potassium permanganate on quality and shelf-life of mango fruits. Journal of Environmental and Social Sciences. 2017;4(1):130-137.
7. Forato LA, Britto D, Rizzo JS, Gastaldi TA, Assis OB. Effect of cashew gum-carboxymethyl cellulose edible coatings in extending the shelf-life of fresh and cut guavas. Food Packaging and Shelf Life. 2015;5:68-74.
8. Gaikwad KK, Singh S, Negi YS. Ethylene scavengers for active packaging of fresh food produce. Environmental Chemistry Letters. 2020;18(2):269-284.

9. Jena S, Goyal RK, Rana MK, Mishra A, Bishnoi A, Nayak SR. Evaluation of different packaging films on shelf life and qualitative attributes of pomegranate fruit cv. Mridula under ambient environment. International Journal of Current Microbiology and Applied Sciences. 2019;8(5):1542-1550.
10. Kanwal N, Randhawa MA, Zafar I. A review of production, losses and processing technologies of guava. Asian Journal of Agriculture and Food Sciences. 2016;4(2):96-101.
11. Kaur K, Dhillon WS, Mahajan BV. Effect of different packaging materials and storage intervals on physical and biochemical characteristics of pear. Journal of Food Science and Technology. 2013;50(1):147-152.
12. Kiran R, Singh N, Kumar R, Dongariyal A, Jat ML, Pratap T. Effect of wrapping material on quality parameters of guava (*Psidium guajava* L.) fruits during storage. Journal of Pharmacognosy and Phytochemistry. 2020;9(5):2924-2927.
13. Mir A, Monika S, Bandral JD. Effect of active packaging on quality and shelf life of peach fruits. The Pharma Innovation Journal. 2018;7(4):1076-1082.
14. Nath A, Deka BC, Singh A, Patel RK, Paul D, Misra LK, Ojha H. Extension of shelf life of pear fruits using different packaging materials. Journal of Food Science and Technology. 2012;49(5):556-563.
15. National Horticultural Board Database. Ministry of Agriculture and Farmers Welfare, Government of India, Gurgoan, India; c2021-22.
16. Padmaja N, Bosco SJD. Preservation of jujube fruits by edible Aloe vera gel coating to maintain quality and safety. Indian Journal of Scientific Research and Technology. 2014;2(3):79-88.
17. Pattar A, Laxman KDK, Naik N, Jholgikar P, Koulagi S, Naika MB. Effect of different packaging materials and storage condition on quality of jamun (*Syzygium cuminii*) fruits. Journal of Pharmacognosy and Phytochemistry. 2021;10(1):928-932.
18. Pedapat A, Tiwari RB. Effect of different osmotic pretreatments on weight loss, yield and moisture loss in osmotically dehydrated guava. Journal of Agri Search 2014; 1(1):49-54.
19. Rammohan K, Reddy PK, Vanajalatha K, Kumar Annepu S, Rao AM. Standardization of packing material gauge and ventilation levels to minimize the post-harvest losses in banana cv. Grand Naine at ambient storage conditions. International Journal of Current Microbiology and Applied Science. 2017;6(7):2344-2351.
20. Sharma S, Sharma RR, Pal RK, Jhalegar MJ, Singh J, Srivastav M, Dhiman MR. Ethylene absorbents influence fruit firmness and activity of enzymes involved in fruit softening of Japanese plum (*Prunus salicina*) cv. Santa Rosa. Fruits. 2012;67(4):257-266.
21. Silva DFP, Salomao LCC, Siqueira DLD, Cecon PR, Rocha A. Potassium permanganate effects in postharvest conservation of the papaya cultivar Sunrise Golden. Pesquisa Agropecuaria Brasileira. 2009;44(7):669-675.
22. Yildirim S, Rocker B, Pettersen MK, Nilsen N, Ayhan Z, Rutkaite R. Active packaging applications for food. Comprehensive Reviews in Food Science and Food Safety. 2018;17(1):165-199.