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Effect of HDPE and LDPE packaging materials on physiological parameters of guava cv khaja

Soudamalla Nagaraju and AK Banik

Abstract
Guava (*Psidium guajava* L.), having 2n=22, belongs to the family Myrtaceae and is native of Mexico. Guava has limited storage potential at ambient conditions, which leads to glut in market and poor return to the growers. Moreover, over ripe fruit at ambient conditions lead to lot of wastage and economic losses. Post-harvest losses can be minimized by adopting proper post-harvest handling practices and better understanding of biochemical control of fruit ripening. Postharvest life of fruits and vegetables can be extended by using LDPE and HDPE films these films are commonly used to minimize weight loss, reduce abrasion, damage and delay. fruit ripening in view of above information an experiment is proposed to be conducted with following objectives,1) To increase the post-harvest life of guava fruits under ambient condition.2) To study the effect of packaging materials on and quality and shelf life of guava fruits. The experiment on “Some aspects post-harvest handling of guava cv. Khaja as influenced by packaging materials” was conducted during the period of December 2015-January 2016 in the department of Post-Harvest Technology of Horticultural Crops, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Nadia, to study the effect of treatments on quality of guava fruits. The cultivar of guava Khaja was harvested at mature but unripe stage. The guava fruit was packed in different microns of LDPE packages (1% LDPE+$KMNO_4$, 2% LDPE+$Kmno_4$ non purporated LDPE and control HDPE packages (1% HDPE+$KMNO_4$, 2% HDPE+$Kmno_4$ non purporated HDPE and control packaging. All treatments were kept in ambient condition. The fruits were examined for physiological loss in weight (PLW), shelf-life, and organoleptic quality. The treatments which not only extended the shelf life and increased marketable fruits but also reduced the post –harvest losses without adversely affecting the fruit quality of guava. These treatments are found obviously easy for practical application for extending the shelf life of guava.

Keywords: HDPE, LDPE, physiological, guava cv khaja

Introduction

Guava (*Psidium guajava* L.), having 2n=22, belongs to the family Myrtaceae and is native of Mexico (Decandolle, 1904), while Persglove (1968) opined that it is originated in Brazil. It is a perennial tree of tropics and subtropics offering great economic potential (Pathak and Ojha, 1993). It is commercially cultivated in Pakistan, Bangladesh, India, Thailand, Mexico, Brazil, USA and several other tropical and subtropical countries of the world (Watson and Dallwitz, 2007). In India guava grown in an area of 268 thousand hectors with the production of 3668 thousand MT production (Anonymous, 2014) [8]. It is the fifth most widely grown fruit crops in India and the major producing states are Bihar, Andhra Pradesh, Utter Pradesh, Maharashtra, West Bengal, Karnataka, Gujarat and Madhya Pradesh. Guava is the third most important fruit crop of West Bengal state besides mango and Guava. In West Bengal about 25 cultivars are reported to grow in different districts, important among these are Lucknow-49, Allahabad Safeda, Dudhe Khaja, Gole Khaja, Kabli, Baruipur, Chittidar, Harijha. In West Bengal guava cultivated in an area of 14.4 thousand ha with 186thousand MT production (Anonymous, 2014) [8].

Guava fruits are rich in high-profile nutrients. With its unique flavor, taste, and health-promoting qualities, the fruit easily fits in the new functional foods category, often called “Super-fruits”. Guava fruit contain Carbohydrates 14.3 gm. Protein 2.55 gm. Calcium 8 mg, Vitamin-C 228 mg, Vitamin-A 624 IU, Lycopene 5204µg, Energy 68 Kcal, and anti-oxidant property 496 mg/100 gram fruit.

Guava has limited storage potential at ambient conditions, which leads to glut in market and poor return to the growers. Moreover, overripe fruit at ambient conditions lead to lot of wastage and economic losses.

The low temperature in winter months interferes with growth and developmental process of fruits leading to irregular supply or availability of guava fruits in the market (Mahajan *et al.*, 10). Therefore, guava fruits are required to be managed appropriately from November to March in order to get a regulated market supply. This can be attained with judicious use of post-harvest treatment, followed by storage at appropriate temperature and relative humidity. Various attempts have been made to extend the storage life of guava with use of various chemicals and packaging materials (Hiwale and Singh, 7; Mahajan and Singh, 9). Among these, the use of packaging materials for storage is always preferred because it is free from any harmful residual effects on human health. Polyethylene film creates a modified atmosphere within the packaging, thereby reducing the transpirational losses and respiration rate. The packaging of guava fruits in polyethylene film minimizes the post-harvest losses and chilling injury and therefore ensures better quality of fruits during cold storage. Hence, the present studies were planned to standardize the technology for storage of surplus fruit in cold storage with the use of different packaging materials.
Postharvest losses can be minimized by adopting proper postharvest handling practices and better understanding of biochemical control of fruit ripening. Postharvest life of fruits and vegetables can be extended by using HDPE & LDPE with different perforation films are commonly used to minimize weight loss, reduce abrasion, damage and delay fruit ripening.

Materials and Methods

The present experiment entitled "Some aspects of Post-Harvest Technology of Guava" was conducted with the objectives to optimize the shelf life and quality y of Guava during storage. The details of location, material used and methods were adopted for experiment described in this chapter. The experiment details and techniques employed are as follows:

Experimental details

Location

The experiment was conducted in laboratory of Post-Harvest Technology of Horticultural crops, Faculty y of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur du ring 2015 -16. Two different varieties of Guava viz khaja. Were collected from Guava research plot of All India Coordinated Research Project (AICRP) on tropical fruits at Mondouri.

Site of experiment

The Experiment on packaging with ethylene absorbent and post-harvest treatment on Guava cv khaja was carried out under the laboratory conditions in the department of Post-Harvest Technology of Horticultural Crops, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal during 2016, which is located approximately at 22.58 ^{0} N latitude, 88.32 ^{0} E longitude having an average altitude of. 75m from the sea level.

Harvesting

Harvesting of fruits was done in the earl y morning hours. After harvest, the matured Guava fruits of uniform size and shape, free from mechanical damage, bruises and fungal or insect attack were selected and immediately y transported to laboratory.

Washing

Washing of fruits was done in tap water & then in distilled water containing 50 ppm of chlorine (CaCl 2) to reduce the microbial load, after that kept under fan for surface drying at room temperature.

Environmental parameter

The place from where fruits were taken comes under subtropical humid region. The average temperature ranges from 20. 5 ^{O} C –30. 98 ^{O} C during the month of October to December.

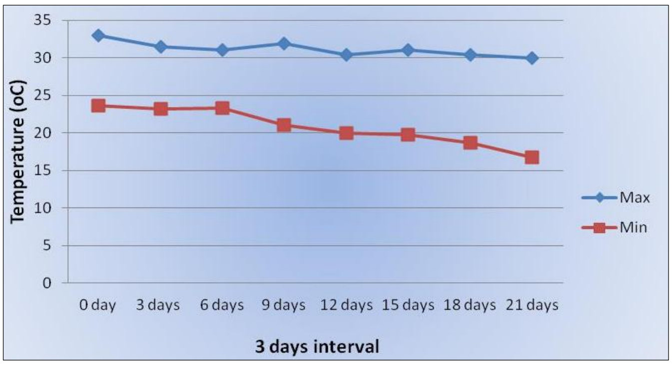
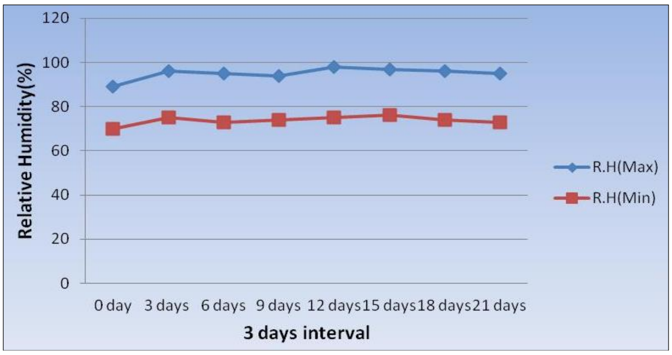


Fig 1: Graphical representation of temperature during storage of Guava



Source: Department of Agro - meteorology and physics, BCKV

Fig 2: Graphical representation of Relative humidity (%) during storage of Guava

Effect of packaging and ethylene absorbent on quality and shelf life of Guava CV Khaja

Guava fruits cv. Khaja was harvested at properly matured but unripe stage and brought to the laboratory for post-harvest study. The hands were separated from the bunch, washed and kept under fan for surface drying. Guava fruits after proper surface drying. Guava fruits after proper surface drying were packed with different packaging materials *viz*. Low Density Pol yethylene (LDPE) and High density polythene (HDPE) with varying amount of perforation i.e. 1%, 2% and no perforation and one ethylene absorbent sachets was placed in each bag @4gm KMnO 4 /Kg of fruit). Fruits without packaging and ethylene absorbent were kept as control for comparison. 10 fruits were placed in each polyethylene bag and constituted one replication.

Treatments Details

T1: HDPE (1%perforation) + KMnO4
T2: HDPE (2%perforation) + KMnO4
T3: HDPE (Non perforation) + KMnO4
T4: LDPE (1%perforation) + KMnO4
T5: LDPE (2%perforation) + KMnO4
T6: LDPE (Non perforation) + KMnO4
T7: Control (without packaging and ethylene absorbent)

Design of experiment: CRD (Completely Randomized Design)
No. of treatments: 7
Repetition of treatments: 3
Varieties of Fruits: Guava cv.-Khaja
Observations recorded for storage of Guava
Physical parameters
P L W (%)
Shelf life (days)
Ripening (%)

Oraganoleptic evolutions of fruits
C o l o u r
F l a v o r
Texture

Methodology adopted for storage of Guava Observations recorded
Physical characters
Physiological loss in weight (PLW-%): Initially before treatment at matured green stage, fruit weight is taken placing single fruit on digital weight box using the unit gram. Physiological loss in weight was calculated on weight basis at three days intervals and expressed in percent (%) (Siddiqui, 2008).

$$PLW\ (\%) = \frac{\text{Initial weight (gm)} - \text{Final weight (gm)}}{\text{Initial weight (gm)}} X\ 100$$

Shelf life (Days): When fruits showed symptoms of over ripening by shriveling and over-softening, that duration was considered as the optimum shelf life of fruit and expressed in days

Sensory evaluation: Quality parameters like colour, flavour over-all acceptability were assessed by means of sensory evaluation. A panel of judges who scored on a ten-point scale assessed the quality parameter. Ten members did the evaluation to avoid biasness, if any, in the first assessment (Amerine *et al.*, 1965). Colour, flavour and overall acceptability were assessed based on the hedonic scale (Ranganna, 1991).

Sensory evaluation: 1-9 Hedonic scale suggested by Ranganna (1991) was followed. Details of the scale are given in table 1.

Table 1: (1-9) Hedonic Scale

Acceptability of quality parameters	Score
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

Statistical analysis
The analysis of the data obtained in experiment was analyzed by Completely Randomized Design method. Standard error (S.Em ±) and the critical difference (P= 0.05) for all effects were calculated (Gomez and Gomez, 1984) [26].

Preparation method of ethylene absorbent
Ethylene absorbents (permanganate-Silica gel) were prepared by mixing 120 ml 0.1M $KMno_4$ with 100 gm of 16 - mesh silica gel. Saturated solution of potassium permanganate was poured into dried silica gel and left for 30 minutes. The absorbent mixture was dried at 110^O C for 16 hours. The absorbent mixture was packed in muslin cloth bags. The absorbent was used at the rate of 4gm/kg of fruits.

Results and Discussion
Effect of packaging and ethylene absorbent on quality and shelf life of Guava fruits cv. Khaja
Physiological loss in weight (%)
The effects of different packaging and ethylene absorbent on PLW of Marta man in ambient condition is being presented in Table-1. There is statistically significant difference in PLW among different treatments during storage except in zero day where data was non-significant.
It can be seen that in general, weight losses increased considerably in all the treatments with progress of storage period but control fruits recommended higher PLW throughout the storage period. Whereas fruits packed in un-perforated LDPE recommended minimum PLW throughout the storage period. On 12^{th} day maximum PLW was observed in control fruits (10.37%) and minimum was recorded in Un-perforated HDPE (0.67%), followed by un-perforated LDPE (1.31%) after which fruits deteriorates in un-perforated HDPE and control. Whereas least PLW was observed in un-perforated LDPE with a loss of 1.38 on the 15^{th} day of storage. There was a significant variation in PLW of different treatments. The PLW was found to increase steadily during entire period of storage which is due to continuous respiration and transpiration after harvest and during storage. Thompson (2001) reported that weight loss of fruits in polyethylene bags was far low than from unpackaged fruits.
This result was also in accordance with that of Nair *et al.* (1992) [45] who reported that, after harvest fruit lost weight due to water loss. Stover and Simmonds (1987) [50] also observed that Guava fruits lost weight due to respiration and transpiration as a result of which the appearance, textural and nutritional qualities of the fruit were negatively affected.
The reduced weight loss in the plastic bag could be attributed to the reduction in respiration and transpiration rate while the increased weight loss in non-packaged fruits could be due to faster respiration and transpiration of the fruits. It can be concluded that reduced O2 and increased CO2 within the packaging films decreased the respiration rate of Guava fruit. Nair *et al.* (1992) [45] observed similar results in their experiments on packaging. In the present study, among different packaging materials, T3 (un-perforated HDPE) Along with T6 (un-perforated LDPE) most effective treatments in reducing PLW compared to the loss associated with control fruits during the storage period under ambient condition. The result was similar to findings of Hailu *et al.* (2014) [29] who reported the reduction in weight loss was higher in Guava fruits that were packaged in high density polythene bags than the weight loss from low density polyethylene bags. HDPE bag was found to prevent the weight loss by about 1% more than LDPE bags. This could be attributed to the permeability difference between the two plastic films for water vapor and gases as well (Thompson, 2001). Borkar *et al*. (2008) [14] reported the minimum weight loss with non-perforated HDPE (250 gauge) with ethylene absorbent. Similar result were recorded by Visalakshi *et al.* (2012). This result was also in line with the finding of Akhtar *et al*. (2012) [5] who reported in loquat fruits during storage that the HDPE and LDPE treatments with perforations had more weight losses compared to non-perforated HDPE and LDPE.

Table 1: Effect of packaging and ethylene absorbent on the PLW (%) of Guava fruits c v Khaja

	Treatment	Days				
		3	6	9	12	15
T1	1% perforated HDPE+$KMnO_4$	1.91	2.22	2.43	2.56	2.7
T_2	2% perforated HDPE+ $KMnO_4$	0.94	1.56	3.22	4.63	4.8
T_3	Un-perforated HDPE+ $KMnO_4$	0.04	0.34	0.62	0.67	-
T4	1% perforated LDPE+$KMnO_4$	0.33	1.65	2.89	3.85	3.92
T_5	2% perforated LDPE+$KMnO_4$	0.63	1.57	2.57	3.95	3.99
T_6	Un-perforated LDPE+ $KMnO_4$	0.29	0.63	1.20	1.31	1.38
T_7	Control(no packaging)	1.32	3.64	6.60	10.37	-
	SE. m (+)	0.013	0.045	0.043	0.037	0.035
	CD (0.05%)	0.038	0.136	0.13	0.113	0.121

Shelf life

The effect on total shelf life of Khaja Guava fruits that were given various treatments are represented in table -2. There is a statistically significant difference among the shelf life of fruits of various treatments

Table 2: Effect of packaging and ethylene absorbent on shelf life of Guava fruits cv. Khaja

	Treatment	Shelf life(days)
T1	1% perforated HDPE+KMnO4	16.17
T_2	2% perforated HDPE+ KMnO4	15.25
T3	Un-perforated HDPE+ KMnO4	13.55
T4	1% perforated LDPE+KMnO4	17.18
T_5	2% perforated LDPE+KMnO4	16.23
T6	Un-perforated LDPE+ KMnO4	18.35
T_7	Control(no packaging)	12.13
	SE. m (+)	0.101
	CD (0.05%)	0.306

As can be seen from table longest shelf life 18 days was observed in un-perforated LDPE (T6) followed by 1% perforated LDPE (17 days).

The shortest shelf life was seen in T7 (control) which deteriorated after 12^{th} days of storage. In general, un-perforated LDPE extends the shelf life by 6 days over control.

The shelf life of Guava fruits that were stored in un-perforated LDPE had a longer storage life. The result were similar with Karpuravalli Guava fruits which were stored in unvented polybags at low temperature could significantly increase the green life up to 19 days as observed by Narayana *et al.*(2002). Borkar *et al.* (2008) [14] reported that the shelf life of Guava was extended to 15 days with non- perforated HDPE (250 gauge) and ethylene absorbent. This was also supported by Visalakshi *et al.* (2012) who found that packaging of Guava cv. Khaja in 500 gauge polythene bags without ventilation recorded an extended shelf life up to 18 days as against only 8 days in control. Corroborative results were obtained by Hailu, *et al.* (2012) [30] who concluded that packaging of Guava fruit in polyethylene bags had the longer shelf life and maintained the chemical qualities of the Guava

Fruit ripening (%)

Results on the packaging of Guava with ethylene absorbent on ripening of fruits cv. Khaja are presented in table-3 Packaging of Guava with ethylene absorbent markly delayed the onset of ripening as compared to control. However, the increase had been at a reduced rate in all the packaged fruits as compared to control. Untreated fruits showed 100% ripening on 10^{th} day whereas treated fruit showed after 12^{th} days of storage under ambient condition. In general un-perforated LDPE recorded minimum ripe fruit percentage (90%) on 15 days of storage. The higher percentage of ripe fruit (100%) was recorded in control (without packaging and ethylene absorbent) during each interval of storage period up to 12 days after which samples deteriorates.

Table 3: Effect of packaging and ethylene absorbent on Ripening of Guava fruits cv. Khaja

	Treatment	Days			
		6	9	12	15
T_1	1% perforated HDPE+$KMnO_4$	30	55	85	98
T2	2% perforated HDPE+ $KMnO_4$	35	60	90	100
T3	Un-perforated HDPE+ $KMnO_4$	49	85	100	-
T_4	1% perforated LDPE+$KMnO_4$	25	55	80.3	95.3
T_5	2% perforated LDPE+$KMnO_4$	30	60	85.3	100
T_6	Un-perforated LDPE+ $KMnO_4$	20	50	75.3	90
T7	Control(no packaging)	65	89	100	-
	SEm(+)	1.294	0.634	0.35	0.436
	CD (0.05%)	3.924	1.922	1.061	1.324

Ripe fruit percentage was slowed down by un-perforated LDPE. The results were similar with Ben-Yenonshuna (1985) [12] who reported that packaging of climacteric fruits in low density polyethylene bags delay ripening and softening. The reduced ripe fruit percentage in the plastic films could be attributed to the reduction in respiration and transpiration rate while the increased weight loss in non-packaged fruits could be due to faster respiration and transpiration of the fruits. Similar results were obtained by Hailu *et al.* (2012) [30].

The sensory score for colour of fruits as affected by various treatments are given in table-4.which also shows a significant difference among all the treatments.

The sensory score for colour increased gradually during period of storage. The highest sensory score for colour (8.5) was observed in T5 (2% perforated LDPE) at about 12^{th} day of storage. Treatment T3 (un-perforated HDPE) had minimum sensory score for colour (7.7) on 12^{th} day.

Sensory score for flavor

The sensory score for flavour of fruits as affected by various treatments are given in table- 4. Which also shows a significant difference among all the treatments.

The sensory score for flavour increased gradually storage period progress. The highest sensory score for flavour (8.7) was observed in T5 (2% perforated LDPE) at about 12^{th} day of storage. Treatment T7 (control) had minimum sensory score for flavour (6.93) on 12^{th} day.

4 Overall Sensory score

The Overall Sensory score of fruits as affected by various treatments are given in table -4 which also shows a significant difference among all the treatments.

The overall sensory score of all fruits as affected by various treatments showed an increasing trend. Treatment T5 (2% perforated LDPE) was able to retain much of its overall quality and recorded a highest overall score of 17.43 on 12^{th} day of storage.

Treatment T3 (un-perforated HDPE) had minimum sensory overall score of 14.8 on 12^{th} day of storage.

Table 4: Effect of packaging and ethylene absorbent on Sensory score of Guava fruits cv. Khaja

Treatment	Colour(10)			Flavor(10)			Overall(20)		
	6 days	9 days	12 days	6 days	9 days	12 days	6 days	9 days	12 days
T_1	6.4	7.6	8.06	5.76	6.46	7.63	12.16	14.0	15.7
T_2	7.4	7.9	8.4	6.6	7.16	8.23	14	15.0	16.6
T_3	6.2	7.5	7.7	4.8	5.8	7.1	11	13.3	14.8
T_4	6.8	7.3	8.13	6.16	6.8	7.83	12.9	14.1	15.9
T_5	7.2	8.16	8.7	7	7.46	8.73	14.2	15.6	17.4
T_6	6.43	7.6	7.9	5.43	6.2	7.2	11.8	13.8	15.1
T7	7.5	8.6	8.1	7.86	8.33	6.93	15.3Z	16.9	15.0
SE. m (+	0.045	0.061	0.062	0.12	0.087	0.098	0.165	0.148	0.16
CD (0.05%)	0.137	0.184	0.188	0.363	0.262	0.298	0.5	0.446	0.486

Packaging material had significant effect on the change in peel colour and flavour of Guava fruits during the storage period of 12^{th} days under ambient conditions (Table 4). Guava packaged using plastic films (LDPE and HDPE) developed excellent type of colour and flavour whereas fruits kept in the control showed dull type of colour. This might be due to lower percentage of relative humidity in the storage room.

Among treatments, the highest scoring for sensory evaluation was seen in T5 (2% perforated LDPE). Similar result was also reported by Ahmad *et al*. (2006) [4] that Guavas stored at lower O2 levels were slightly greener than those which were stored at higher O2 levels. The loss of green colour is due to chlorophyll degradation, the results were in conformity with Hailu *et al.* (2014) [29] who reported a highest value for sensory evaluation in LDPE compare to HDPE. These findings are in line with and supported by Pongener *et al.* (2010) in peach fruits.

In T3 (un-perforated HDPE) treatment recorded the least sensory which can be mainly attributed to the low fruit quality of fruits that render it unacceptable for consumption (Lakshmana *et al*., 2013) [36].

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