Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2021; 10(1): 928-932
Received: 27-10-2020
Accepted: 25-12-2020

**Archana Pattar**
Ph.D. Scholar, Department of Post-Harvest Technology, Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka, India

**Dr. Laxman Kukanoor**
Professor of Post-Harvest Technology and Head, HEEU, RHREC, Kumbhapur farm, Dharwad, Karnataka, India

**Dr. K Ramachandra Naik**
Professor and Head, Department of Post-Harvest Technology, Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka, India

**Dr. Nagesh Naik**
Professor and Head, Department of Fruit Science, College of Horticulture, Sirsi, Karnataka, India

**Dr. Praveen Jholgikar**
Associate Professor, Department of Fruit Science, College of Horticulture, Bidar, Karnataka, India

**Dr. Sumangala Koulagi**
Assistant Professor Department of Plant Pathology, Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka, India

**Dr. Mahantesha BN Naika**
Assistant Professor, Department of Crop improvement and biotechnology, Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka, India

**Corresponding Author:**
**Archana Pattar**
Ph.D. Scholar, Department of Post-Harvest Technology, Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka, India

# Effect of different packaging materials and storage condition on quality of jamun (*Syzygium cuminii* Skeels) fruits

**Archana Pattar, Dr. Laxman Kukanoor, Dr. K Ramachandra Naik, Dr. Nagesh Naik, Dr. Praveen Jholgikar, Dr. Sumangala Koulagi and Dr. Mahantesha BN Naika**

## Abstract
The Effect of different packaging materials on the storage life and quality of jamun fruits were investigated. Fruits of jamun were harvested at firm ripe and divided into requisite lots for further handling. First was packed in packaging materials *viz*., Poly ethylene (100 gauge), Poly ethylene (150 gauge), Poly propylene (100 gauge), Poly propylene (150 gauge), Punnet Box, CFB box and Bamboo basket The observations on various physico-chemical quality attributes of fruits were recorded at different storage intervals. During storage fruits packed in Poly ethylene (150 gauge) were found to reduce significantly the respiration rate, rotting percentage and minimum loss of titratable acidity Fruits packed in Poly ethylene (150 gauge) with maximum shelf life of 6 days at ambient storage and 12 days at cold storage respectively.

**Keywords:** Jamun, packaging material, storage, temperature, quality

## Introduction
Jamun (*Syzygium cuminii* Skeels) is an evergreen tropical tree which belongs to family ‘Myrtaceae’. It is commonly known as java plum, jambul, jamun, black plum, faux pistachier, Indian blackberry, doowet, jamboo and jambolan. Jamun is native to the subtropical Himalayas, India, Sri Lanka, Malaysia and Australia. Its fruits are delicious and have great importance in folk medicine (Ayyanar and Subash, 2012) [2]. India is the second largest producer of the fruits in the world. World production of Jamun is estimated to 13.5 million tones, out of which 15.40 per cent is contributed by India. India ranks second in production of Jamun in the world. Maharashtra state is the largest Jamun producer (Savitha, 2018) [10].
Jamun fruits exhibits non climacteric pattern of respiration hence they have very short shelf life after harvest and that is one of the major drawbacks for long distance transport and marketing. Physiological and biochemical processes such as respiration and transpiration continue after harvesting as the fruits are living entity even after the detachment from mother plant. The quality of Jamun is greatly deteriorated between its harvesting and consumption so there is a considerable wastage of this fruit. Jamun is mainly grown for consumption as a table fruit. Jamun fruits are normally packed in bamboo baskets using leaves as liner for transport to local market and can be stored only for 2-3 days under ambient conditions. Hence, greater attention should be required to utilize the fruits by extending the shelf life after harvest by various postharvest treatments with proper packaging.

## Material and Methods
Jamun fruits were procured from Horticulture Department, Hidkal Dam, Belgaum district of Karnataka. Fruits were harvested manually and packed in plastic crates and brought to the laboratory immediately for further experimentation. Fruits of uniform size, shape, free from any visible damage and decay, were manually selected for the experiment to maintain the uniformity. Further the fruits were washed in clean water to remove the dirt and they were air dried under electric fan.

## Fruits packaging and storage
Fruit samples with sachets containing iron powder (1g/Kg of fruits) were packed in different packaging materials. The packed samples were stored at ambient conditions and cold storage and observations were recorded at an interval of 2 days.

## Treatment details
### Factor 1: Packaging material
- $PE_1$ - Poly ethylene (150 gauge)
- $PE_2$ - Poly ethylene (200 gauge)

- $PP_1$ - Poly propylene (150 gauge)
- $PP_2$ - Poly propylene (200 gauge)
- PUN - Punnet box (500g)
- CFB - CFB box (500g)
- BB - Bamboo basket (500g) – control

**Factor 2: Storage environment**

- $E_1$ - Low temperature storage (10-12 °C)
- $E_2$ - Room temperature

**Treatment details**

$PE_1E_1$ Poly ethylene (150 gauge) + Low temperature storage (10-12 °C)
$PE_1E_2$ Poly ethylene (150 gauge) + Room temperature
$PE_2E_1$ Poly ethylene (200 gauge) + Low temperature storage (10-12 °C)
$PE_2E_2$ Poly ethylene (200 gauge) + Room temperature
$PP_1E_1$ Poly propylene (150 gauge) + Low temperature storage (10-12 °C)
$PP_1E_2$ Poly propylene (150 gauge) + Room temperature
$PP_2E_1$ Poly propylene (200 gauge) + Low temperature storage (10-12 °C)
$PP_2E_2$ Poly propylene (200 gauge) + Room temperature
$PUNE_1$ Punnet box (500g) + Low temperature storage (10-12 °C)
$PUNE_2$ Punnet box (500g)+ Room temperature
$CFBE_1$ CFB box (500g) + Low temperature storage (10-12 °C)
$CFBE_2$ CFB box (500g) + Room temperature
BB $E_1$ Bamboo basket + Low temperature storage (10-12 °C)
BB $E_2$ Bamboo basket + Room temperature

**Rate of respiration (ml $CO_2$/kg/h)**

The rate of respiration was measured by static method using gas analyzer. Known quantities of fruits were sealed hermetically in a 330 ml plastic container having a provision for hole and closed with septum for 1 h at ambient temperature. The syringe was inserted into the head space of the container to estimate the $CO_2$ release by the fruits.

$$\text{Rate of respiration (ml } CO_2\text{/kg/hr)} = \frac{CO_2 \text{ Concentration X Volume of the container}}{100 \text{ X weight of the fruit (kg) X Time (h)}}$$

**Rotting (%)**

The percentage fruits decay was calculated by using the following formula:

$$\text{Rotting Percentage (\%)} = \frac{\text{Weight of the rotted fruits}}{\text{Initial weight of the fruits}} \text{ X 100}$$

**Total titratable acidity (%)**

The acidity was determined by diluting the pulp extracted from five grams of sample and filtered through muslin cloth and made up to known volume with distilled water (100 ml). From this, five ml of aliquot was taken and titrated against standard NaOH (0.1 N) using a phenolphthalein indicator. The appearance of light pink colour was recorded as the end point. The values were expressed in terms of tartaric acid per cent of the fruits (Anon., 1984).’

**Shelf-life (Days)**

Shelf-life of jamun fruits were recorded throughout the experimental period under ambient storage condition. As and when the fruits lost their marketability, the shelf-life was recorded (in days) until the end of the experimental period.

**Results and Discussion**

**Respiration rate (ml $CO_2$/kg/h)**

The results on respiration rate suggested an increasing trend and registered significant differences throughout the storage periods in all the treatments. The results on the effect of storage temperature, packaging and their interactions on respiration rate during storage are presented in the Table 1. With regard to the effect of storage temperature, it was evident that respiration rate was significantly influenced by storage temperature. The fruits stored at cold storage condition recorded significantly minimum respiration rate in (30.40, 31.69 and 33.45ml $CO_2$/ kg/h) compared to those stored in ambient condition (37.61, 38.38 and 47.55) at 2, 4 and 6 DAS respectively. The packaging played a major role in reducing the respiration rate during storage as evident from the data. The fruits packed in 150 gauge polyethylene bags showed minimum respiration rate (24.66, 26.22 and 27.52 ml $CO_2$/kg/h) whereas maximum respiration rate was observed in fruits packed in bamboo baskets (37.25, 38.75 and 52.78 ml $CO_2$/kg/h) at 2, 4 and 6 DAS respectively. The interaction effect of storage temperature and packaging revealed that significantly minimum (23.66, 25.66 and 26.37 ml $CO_2$/kg/h) respiration rate is observed in treatment $PE_1$ (150 gauge polyethylene stored in cold storage condition). The maximum respiration rate was observed in fruits packed in bamboo baskets stored in ambient condition (39.40, 40.93 and 67.66 ml $CO_2$/ kg/h) at 2, 4 and 6 DAS respectively. Jamun fruits stored under room temperature were discarded due to spoilage after $6^{th}$ day of storage. The fruits stored in cold storage packed in 150 gauge polyethylene bags recorded significantly minimum $PE_1$ (26.14, 29.33, 30.47 and 35.32 ml $CO_2$/ kg/ h) respiration rate. The maximum respiration rate was observed in fruits packed in bamboo baskets (38.89, 42.29, 49.34 and 59.210 ml $CO_2$/kg/h) at 8, 10, 12 and 14 DAS respectively.

**Table 1:** Effect of packaging materials on respiration rate (ml $CO_2$ /kg/h) of jamun fruits under different storage conditions

| Treatments | Days after storage | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | | | 4 | | | 6 | | | **8 | 10 | 12 | 14 |
| | $S_1$ | $S_2$ | Mean (P) | $S_1$ | $S_2$ | Mean (P) | $S_1$ | $S_2$ | Mean (P) | $S_1$ | $S_1$ | $S_1$ | $S_1$ |
| $PE_1$ | 23.66 | 25.66 | 24.66 | 25.66 | 26.77 | 26.22 | 26.37 | 28.66 | 27.52 | 26.40 | 29.33 | 30.47 | 35.32 |
| $PE_2$ | 28.66 | 36.66 | 32.66 | 30.66 | 38.72 | 34.69 | 31.80 | 39.67 | 35.74 | 33.09 | 33.74 | 35.31 | 39.31 |
| $PP_1$ | 30.58 | 41.12 | 35.85 | 31.50 | 42.88 | 37.19 | 33.50 | 45.96 | 39.73 | 34.87 | 38.69 | 44.68 | 47.23 |
| $PP_2$ | 30.00 | 48.80 | 39.40 | 30.62 | 45.80 | 38.21 | 33.63 | 49.42 | 41.52 | 36.65 | 39.56 | 40.49 | 55.88 |
| PUN | 31.42 | 32.21 | 31.82 | 32.75 | 32.89 | 32.82 | 35.45 | 45.96 | 40.71 | 36.59 | 38.83 | 39.58 | 43.26 |
| CFB | 33.34 | 39.40 | 36.37 | 34.10 | 40.71 | 37.40 | 35.53 | 55.52 | 45.52 | 38.64 | 39.27 | 44.75 | 48.59 |
| BB | 35.11 | 39.40 | 37.25 | 36.56 | 40.93 | 38.75 | 37.90 | 67.66 | 52.78 | 38.89 | 42.29 | 49.34 | 59.21 |
| Mean (S) | 30.40 | 37.61 | | 31.69 | 38.38 | | 33.45 | 47.55 | | 34.98 | 37.38 | 40.66 | 46.97 |
| For comparing means of | S. Em± | | C.D. @ 1% | S. Em± | | C.D. @ 1% | S. Em± | | C.D. @ 1% | 0.15 | 0.11 | 0.01 | 0.01 |
| P | 0.182 | | 0.53 | 0.655 | | 1.90 | 0.136 | | 0.39 | 0.65 | 0.47 | 0.04 | 0.04 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S | 0.097 | 0.28 | 0.35 | 1.01 | 0.073 | 0.21 | | | | |
| P x S | 0.257 | 0.75 | 0.926 | 2.69 | 0.193 | 0.56 | | | | |

*Initial value of respiration rate was 23.00 ml $CO_2$ /kg/h
** Jamun fruits stored under room temperature ($S_2$) were discarded due to spoilage after 6th day of storage
NS – Non significant
$PE_1$ - Poly ethylene (150 gauge)
$PE_2$ - Poly ethylene (200 gauge)
$PP_1$ - Poly propylene (150 gauge)
$PP_2$ - Poly propylene (200 gauge)
PUN - Punnet Box (500g)
CFB - CFB box (500g)
BB - Bamboo basket (500g) – Control
$S_1$- Low temperature
$S_2$- Room temperature

Rate of respiration gradually increased during storage in all the treatments irrespective of the storage temperatures and packages. Control fruits showed highest respiratory rate at ambient temperature irrespective of the packaging materials. At cold storage, a significant difference was observed with respect to the incremental change in respiratory rate among the different packaging materials. The rise in respiratory rate was found to be very rapid in control irrespective of storage temperature whereas fruits packed in LDPE bags exhibited a slow and gradual rise in respiratory rate during the storage period. The control fruits showed higher respiratory rate due to the direct interaction with the atmosphere where the chances of gaseous exchange was more. Also as the fruit underwent various other physiological changes like loss in moisture and microbial infection this might have induced faster respiratory activity. The lower respiratory rate is probably due to least incidence of spoilage. The lowest respiratory activity in LDPE with oxygen scavenger might be due to its lower oxygen transmission rate.

**Rotting (%)**

The data on percent of rotting indicated and significant different and recorded an increasing trend throughout the storage of jamun fruits in all the treatments. The results on the effect of storage temperature, packaging and their interactions on rotting during storage are presented in the Table 2. With regard to the effect of storage temperature, it was evident that rotting was significantly influenced by storage temperature. The fruits stored at cold storage condition recorded significantly minimum rotting in (16.59, 19.59 and 22.59 %) compared to those stored in ambient condition (18.37, 23.37 and 28.37%) at 2, 4 and 6 DAS respectively. The packaging played a major role in reducing the rotting during storage as evident from the data. The fruits packed in 150 gauge polyethylene bags showed minimum rotting (15.90, 19.90 and 23.90) and on par with $PE_2$, whereas maximum rotting was observed in fruits packed in bamboo baskets (21.14, 25.14 and 29.14%) at 2, 4 and 6 DAS respectively. The interaction effect of storage temperature and packaging revealed that significantly minimum (15.65, 18.65 and 21.65%) rotting is observed in treatment $PE_1$ (150gauge polyethylene) which is on par with $PE_2$. The maximum rotting was observed in fruits packed in bamboo baskets (24.97, 29.97 and 34.97%) at 2, 4 and 6 DAS respectively. Jamun fruits stored under room temperature were discarded due to spoilage after 6th day of storage. The fruits stored in cold storage packed in 150 gauge polyethylene bags recorded significantly minimum $PE_1$ (24.40, 24.65, 27.30 and 27.85%) rotting, which is on par with $PE_2$ The maximum per cent rotting was observed in fruits packed in bamboo baskets (26.07, 26.32, 28.97 and 29.52%) at 8, 10, 12 and 14 DAS respectively

**Table 2:** Effect of packaging materials on rotting (%) of jamun fruits under different storage conditions

| Treatments | Days after storage | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | | | 4 | | | 6 | | | **8 | 10 | 12 | 14 |
| | $S_1$ | $S_2$ | Mean (P) | $S_1$ | $S_2$ | Mean (P) | $S_1$ | $S_2$ | Mean (P) | $S_1$ | $S_1$ | $S_1$ | $S_1$ |
| $PE_1$ | 15.65 | 16.16 | 15.90 | 18.65 | 21.16 | 19.90 | 21.65 | 26.16 | 23.90 | 24.40 | 24.65 | 27.30 | 27.85 |
| $PE_2$ | 15.70 | 16.24 | 15.97 | 18.70 | 21.24 | 19.97 | 21.70 | 26.24 | 23.97 | 24.45 | 24.70 | 27.35 | 27.90 |
| $PP_1$ | 17.06 | 17.99 | 17.52 | 20.06 | 22.99 | 21.52 | 23.06 | 27.99 | 25.52 | 25.81 | 26.06 | 28.71 | 29.26 |
| $PP_2$ | 16.42 | 18.42 | 17.42 | 19.42 | 23.42 | 21.42 | 22.42 | 28.42 | 25.42 | 25.17 | 25.42 | 28.07 | 28.62 |
| PUN | 16.90 | 17.56 | 17.23 | 19.90 | 22.56 | 21.23 | 22.90 | 27.56 | 25.23 | 25.65 | 25.90 | 28.55 | 29.10 |
| CFB | 17.11 | 17.29 | 17.20 | 20.11 | 22.29 | 21.20 | 23.11 | 27.29 | 25.20 | 25.86 | 26.11 | 28.76 | 29.31 |
| BB | 17.32 | 24.97 | 21.14 | 20.32 | 29.97 | 25.14 | 23.32 | 34.97 | 29.14 | 26.07 | 26.32 | 28.97 | 29.52 |
| **Mean (S)** | 16.59 | 18.37 | | 19.59 | 23.37 | | 22.59 | 28.37 | | 25.34 | 25.59 | 28.24 | 28.79 |
| For comparing means of | S.Em± | C.D. @ 1% | | S.Em± | C.D. @ 1% | | S.Em± | C.D. @ 1% | | 0.15 | 0.15 | 0.15 | 0.15 |
| P | 0.126 | 0.36 | | 0.126 | 0.36 | | 0.126 | 0.36 | | | | | |
| S | 0.067 | 0.19 | | 0.067 | 0.19 | | 0.067 | 0.19 | | 0.64 | 0.64 | 0.64 | 0.64 |
| P x S | 0.178 | 0.51 | | 0.178 | 0.51 | | 0.178 | 0.51 | | | | | |

** Jamun fruits stored under room temperature ($S_2$) were discarded due to spoilage after 6th day of storage
$PE_1$ - Poly ethylene (150 gauge)
$PE_2$ - Poly ethylene (200 gauge)
$PP_1$ - Poly propylene (150 gauge)
$PP_2$ - Poly propylene (200 gauge)
PUN - Punnet Box (500g)
CFB - CFB box (500g)
BB - Bamboo basket (500g) – Control
$S_1$- Low temperature
$S_2$- Room temperature

Spoilage of Jamun fruits was observed on 2 DAS at all the temperatures irrespective of the packages and it showed a sharp increase throughout the storage period. It was least at low temperature and maximum at ambient temperature irrespective to packaging. Among the packaging materials LDPE although found better, as there was ventilation in the packages, no heat liberated during the respiration remained in the packages and so it caused less spoilage upon storage irrespective of the packaging materials and temperatures. It is evident from the properties of packaging materials that LDPE had low water vapor transmission rate compared to other packaging materials. The lower spoilage in fruits packed in LDPE may also be due to the accumulation of $CO_2$ within the polyethylene bags and its preservative effects (Hardenburg, 1956) [6]. The reduced spoilage by using active packaging technology has earlier been reported by Lazan *et al.* (1993) [8] in papaya fruit, Szczerbanik *et al.* (2005) [14] in Japanese pear, Reddy *et al.* (2008) [9] in acid lime and Bhutia *et al.* (2011) [3]

in sapota. Hence, more exchange of water vapor in LDPE has probably resulted in maintaining a low water activity leading to less incidence of rotting. In Poly propylene higher percentage of rotting was probably due to poor $CO_2$ transmission rate compared to LDPE. Different type of packaging materials have different properties which lead to difference in quality of the fresh produce stored in them.

### Titratable acidity (%)

The titrable acidity decreases as the storage period increases in all the treatments (Table 3). The fruits stored at cold storage condition showed non-significant at 2 DAS and at 4$^{th}$ and 6$^{th}$ DAS recorded significantly maximum titrable acidity (0.72 and 0.69%), whereas fruits stored in ambient condition recorded significantly minimum titrable acidity (0.71, 0.64 and 0.62%) at 2, 4 and 6 DAS respectively. The fruits packed in 200 gauge polyethylene bags showed maximum titrable acidity $PE_2$(0.77, 0.76 and 0.75%) which was on par with $PE_1$ (at 4 and 6 DAS) whereas minimum titrable acidity was observed in fruits packed in bamboo baskets (0.71,0.64 and 0.61%) at 2, 4 and 6 DAS respectively. The interaction effect of storage temperature and packaging was found non-significant at 2, 4 and 6 DAS respectively. Jamun fruits stored under room temperature were discarded due to spoilage after 8$^{th}$ day of storage. The fruits stored in cold storage packed in 200 gauge polyethylene bags recorded significantly maximum $PE_2$ (0.70, 0.68, 0.65 and 0.56%) titrable acidity. The minimum titrable acidity was observed in fruits packed in bamboo baskets (0.55, 0.52, 0.38 and 0.31%) at 8, 10, 12 and 14DAS respectively.

**Table 3:** Effect of packaging materials on titratable acidity (%) of jamun fruits under different storage conditions

| Treatments | Days after storage | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | | | 4 | | | 6 | | | **8 | 10 | 12 | 14 |
| | $S_1$ | $S_2$ | Mean (P) | $S_1$ | $S_2$ | Mean (P) | $S_1$ | $S_2$ | Mean (P) | $S_1$ | $S_1$ | $S_1$ | $S_1$ |
| $PE_1$ | 0.79 | 0.70 | 0.74 | 0.78 | 0.69 | 0.73 | 0.76 | 0.69 | 0.72 | 0.67 | 0.54 | 0.47 | 0.47 |
| $PE_2$ | 0.80 | 0.75 | 0.77 | 0.79 | 0.74 | 0.76 | 0.77 | 0.73 | 0.75 | 0.70 | 0.68 | 0.65 | 0.56 |
| $PP_1$ | 0.78 | 0.71 | 0.74 | 0.74 | 0.60 | 0.67 | 0.72 | 0.56 | 0.64 | 0.63 | 0.56 | 0.51 | 0.33 |
| $PP_2$ | 0.77 | 0.69 | 0.73 | 0.67 | 0.61 | 0.64 | 0.65 | 0.60 | 0.62 | 0.59 | 0.49 | 0.38 | 0.24 |
| PUN | 0.75 | 0.72 | 0.73 | 0.68 | 0.63 | 0.65 | 0.66 | 0.59 | 0.62 | 0.62 | 0.54 | 0.46 | 0.41 |
| CFB | 0.78 | 0.72 | 0.75 | 0.71 | 0.65 | 0.68 | 0.68 | 0.60 | 0.64 | 0.58 | 0.54 | 0.46 | 0.51 |
| BB | 0.73 | 0.69 | 0.71 | 0.67 | 0.62 | 0.64 | 0.64 | 0.59 | 0.61 | 0.55 | 0.52 | 0.38 | 0.31 |
| Mean (S) | 0.77 | 0.71 | | 0.72 | 0.64 | | 0.69 | 0.62 | | 0.62 | 0.55 | 0.44 | 0.40 |
| For comparing means of | S.Em± | C.D. @ 1% | | S.Em± | C.D. @ 1% | | S.Em± | C.D. @ 1% | | 0.01 | 0.01 | 0.02 | 0.02 |
| P | 0.015 | NS | | 0.019 | 0.05 | | 0.019 | 0.05 | | | | | |
| S | 0.008 | 0.02 | | 0.01 | 0.03 | | 0.01 | 0.03 | | 0.04 | 0.07 | 0.09 | 0.10 |
| P x S | 0.021 | NS | | 0.027 | NS | | 0.027 | NS | | | | | |

*Initial value of titratable acidity was 1.30%

** Jamun fruits stored under room temperature ($S_2$) were discarded due to spoilage after 6$^{th}$ day of storage

NS – Non significant

$PE_1$ - Poly ethylene (150 gauge)
$PE_2$ - Poly ethylene (200 gauge)
$PP_1$ - Poly propylene (150 gauge)
$PP_2$ - Poly propylene (200 gauge)
PUN - Punnet Box (500g)
CFB - CFB box (500g)
BB - Bamboo basket (500g) – Control
$S_1$- Low temperature
$S_2$- Room temperature

The decrease in titratable acidity in all the treatments during storage irrespective of the storage conditions might be associated with their utilization as a substrate during respiration. Similar decrease in organic acids was reported by Weichman (1986). Bhattarai and Gautam (2006) stated that the fruit might utilize the acids during storage resulting in decrease in the acidity. Ramana *et al.* (1979) substantiated the same that the change in total titratable acids during storage was mainly due to metabolic activities of the living tissues which further depletes the organic acids. At low temperature, in LDPE maximum retention of acidity was observed than stored at ambient temperature. LDPE bags may have created conditions which delayed fruit senescence and therefore might have enabled the fruits to retain higher acidity levels. The slower decline in titratable acids content of fruits packed with sachets containing iron powder is due to delaying in senescence. The lowest mean titratable acidity was recorded in the control fruits, which can be described to the unhindered high metabolic activities occurring in them, resulting in the utilization of organic acids as respiratory substrates during storage. The present findings are in accordance with the findings of Collum *et al*. (1992) [5] in mango, Illeperuma and Jayasuriya (2002) [7] in mango, Sharma and Singh (2010) [11] in apple, Bron and Jacomino (2006) [4] in papaya, Silva *et al*. (2012) [12] in custard apple, Sood *et al*. (2012) [13] in strawberry and Teka (2013) [15] in tomato fruit and many other workers.

### Shelf life (Days)

The data on shelf life of jamun fruits as influenced by treatments and storage conditions are presented in Table 4.Under ambient storage, maximum shelf life of 6 days was recorded in $PE_1$ (150 gauge polyethylene) followed by $PE_2$ (200 gauge polyethylene) for 5.5 days. The least shelf life was recorded in bamboo baskets (4.0 days). However, under low temperature maximum shelf life of 12 days was recorded again in $PE_1$ (150gauge polyethylene) followed by $PE_2$ (200 gauge polyethylene) for 10.0 days and least shelf life in bamboo baskets (5 days). $PE_1$ (150gauge polyethylene) was found to be superior treatment for extension of shelf life both under ambient and cold storage.

**Table 4:** Effect of packaging materials on shelf life of jamun fruits under different storage conditions

| Treatments | Shelf life (Days) | |
|---|---|---|
| | **Low temperature** | **Room temperature** |
| $PE_1$ - Poly ethylene (150 gauge) | 12 | 6 |
| $PE_2$ - Poly ethylene (200 gauge) | 10 | 5.5 |
| $PP_1$ - Poly propylene (150 gauge) | 7 | 4.5 |
| $PP_2$ - Poly propylene (200 gauge) | 7 | 4.5 |
| PUN - Punnet Box (500g) | 9 | 4.5 |
| CFB - CFB box (500g) | 8 | 5 |
| BB - Bamboo basket (500g) – Control | 5 | 3.5 |
| Mean | 8.28 | 4.78 |
| S.Em± | 0.15 | 0.16 |
| C.D. @ 1% | 0.66 | 0.70 |

## References


1. Anonymous. Official Methods of Analysis, 14th edition, Sidney Williams, (Eds) Association official Analytical Virginia 1984, P424-462.
2. Ayyanar M, Subash P. *Syzygium cumini* (L) Skeels: A review of its phytochemical constituents and traditional uses. Asian Pac. J Trop. Biomed 2012, P240-246.
3. Bhutia Pal, RK W, Sen S, Jha SK. Response of different maturity stages of sapota (*Manilkara achras* Mill.) cv. Kallipatti to in-package ethylene absorbent. J Food Sci. Technol 2011;48(6):763-768.
4. Bron HV, Jacomino AP. Ripening and quality of Golden papaya fruit harvested at different maturity stages. Braz. J Plant Physiol 2006;18:389-396.
5. Collum TG, Aquino S, Miller WR, Donald RF. Individual shrink film wrapping of mangoes. Proceedings of the Florida State Horticultural Society 1992;105:103-105.
6. Hardenburg RE. Polythene file box lineary for reducing weight losses and shriveling of Golden Delicious apples in storage. Proc. Am. Soc. Horti. Sci 1956;67:82-90.
7. Illeperuma CK, Jayasuriya P. Prolonged storage of ‘karuthacolomban’ mango by modified atmosphere packaging at low temperature. J Horti. Sci. Biotechnol 2002;77(2):153-157.
8. Lazan H, Ali ZM, Selamat MK. The underlying biochemistry of the effect of modified atmosphere and storage temperature on firmness decrease in papaya. Acta Hortic 1993;343:141-147.
9. Reddy VB, Madhavi GB, Reddy DB, Reddy VC, Srinu B 1993. Effect of different packing materials on the shelf life and quality of acid lime (*Citrus aurantifolia* Swingla.) at room temperature. J Dairying, Foods and Home Sci 2008;27(3, 4):216-220.
10. Savitha. Development and nutritional analysis of pearl millet based Jamun (*Syzygium cumini* L.) seeds incorporated value added products. M.Sc. (Agri) Thesis, CCS, Haryana Agri. Univ., Hisar (India) 2018.
11. Sharma RR, Singh D. Effect of different packaging materials on shelf-life and quality of apple during storage. Indian J Hort 2010;66(2):245-248.
12. Silva AVC, Muniz EN, Rangel JHA, Yaguiu P, Souza JPB, Carnelossi MAG. Quality of Custard Apple (*Annona squamosa* L.) in relation to packaging and storage period. Acta Hortic 2012;934:287-294.
13. Sood M, Kaul RK, Sood P. Improving strawberry fruit storability by application of postharvest chemical treatments. Appl. Biol. Res 2012;14(2):125-130.
14. Szczerbanik MJJE, Best DJ, Scott K, Paton J. Effects of polyethylene bags, ethylene absorbent and 1-methylcyclopropene on the storage of Japanese pears. J Horti. Sci. Biotech 2005;80(2):162-166.
15. Teka TA. Analysis of the effect of maturity stage on the postharvest biochemical quality characteristics of tomato (*Lycopersicon esculentum* mill.) fruit. Int. Res. J Pharm. Appl. Sci 2013;3(5):180-186.