



Evaluation of polyfilm for shelf-life extension of mango (*Mangifera indica*) cv. Dashehari

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ABSTRACT

Present study reports the impact of polyfilm having ethylene absorbing property for study on ripening behavior of mango (*Mangifera indica* L.) cv. Dashehari. The fruits stored in open condition decomposed after 10 days of storage but the fruits stored in polyfilm remained fresh even after 14 days of storage with low physiological weight loss (15%) and acceptable for marketing on the basis of their higher firmness (0.8 kg/cm²) and TSS (18.69°Brix). There was a marginal difference in carotenoids, phenol content and antioxidant values in both the conditions. The level of polygalacturonase activity retarded from 0.146 to 0.095 U/ml in polybag, while it increased from 0.146 to 0.268 U/ml in fruits stored under open condition. Thus polybag is effective in prolonging the shelf-life of mango fruits by way of its ability to maintain fruit firmness and delaying the ripening process.

Key words: Mango, Microbial counts, Polybag, Post-harvest physiology, Polygalacturonase

Mango (*Mangifera indica* L.) is one of the most popular subtropical fruit. India is the largest producer of mangoes in the world and Dashehari grown in northern belt is considered to be the choicest mango cultivar, as they are delicious in taste and aroma and a very high pulp to stone ratio. Due to its climacteric nature, mangoes become perishable after few days of harvest owing to faster ripening process and it is the major constraint in its export. The ripening in mango is characterized by the sharp increase in ethylene production. This is followed by a series of biochemical changes leading to ethylene production, increased respiration, chlorophyll degradation, development of carotenoids, enzymatic breakdown of polysaccharides into simpler compounds leading to tissue softening. (Herianus *et al.* 2003). Progression in ripening brings about degradation of cell wall component along with structural changes (Zaharah *et al.* 2013). Major constraints and problems associated with post-harvest handling of fruits like mango are short shelf-life and lack of appropriate post-harvest technologies for storage. A treatment, which can inhibit the rapid softening in fruits after harvest, is of paramount importance to increase the shelf-life. Several chemicals have been reported to play an important role in retarding ripening and enhancing its shelf-life (Zheng *et al.* 2007) but most of them are not eco-

friendly and not acceptable to the consumers. However, research and development in packaging materials and technology over the past decades has confirmed that polymeric films modify the atmosphere within the bag and thereby, extend the shelf-life of mango without any hazardous effect on environment. Not much work has been conducted to study the utility of MA (modified atmosphere) film bag in extending the shelf-life of fruits under different climatic conditions. These films can maintain mango fruit quality by way of delayed ripening and enhanced shelf-life due to increased CO₂ and decreased O₂ levels. On this background, the study was under taken to investigate the ability of polybag film having ethylene absorbing properties to delay Dashehari mango fruit ripening as well as prolong the shelf-life along with associated physiological and ripening having enzymatic changes at different storage period.

MATERIALS AND METHODS

Fruits of mango cv. Dashehari having uniform size were harvested at fully mature green stage from the orchard of ICAR-Central Institute for Subtropical Horticulture, Rehmankhara, Lucknow located at 26.54°N latitude, 80.45°E longitude and 127 m above mean sea level (msl). Fruits were washed under running tap water followed by three times rinsing in double distilled water and then air dried for experimental use and were further treated with the fungicide captan (0.2%) for 5 minutes. The fruits were divided into two lots, which were given one of the following two treatments: (1) control (2) modified atmosphere fresh poly bag (MAP) having capacity of 10 kg and dimension 90 × 90 cm. Seven such bags were used for storing the fruits and

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withdrawn were made from each bag at days 2, 4, 6, 8, 10, 12 and 14. Each treatment containing 10 kg of fruit (about 21 fruits) with three replications and stored at room temperature (27-30°C) and 85.0% RH until the fruits were become not acceptable for marketing. The total soluble solids, firmness and pH were recorded by using hand Refractometer (Erma Japan), penetrometer (Mc cotmick C, USA) and standard procedure using fresh pulp respectively. The shelf-life of mango fruit was calculated by counting the days from treatment till marketable condition i.e. up to the stage when they remained acceptable for marketing on the basis of firmness and physical condition of fruits.

The total phenol content of pulp was estimated by adopting the method of Bray and Thorpe (1954) and the mean values were expressed in mg/g f.wt. Ascorbic acid was estimated by 2,6-dichlorophenol-indophenol visual titration method as described by Ranganna (1979) and its content was expressed by mg/100 g of fresh fruit pulp. The total antioxidant value in term of FRAP assay was performed as described by (Benzie and Strain 1996). The experiment was conducted at 37°C, and at pH 3.6 with a blank sample in parallel. In this assay, reductants (antioxidants) in the sample reduce Fe (III)/tripyrindyltriazine complex to the blue ferrous form, with an increase in absorbance at 593 nm. The final results were expressed (mg AEAC/g f.wt.) as ascorbic acid equivalence antioxidant capacity (AEAC). Carotenoid estimation was done by the using the method of (Arnon 1949). Absorbance was measured at 510 and 480nm using a Double beam UV-VIS Spectrophotometer (Decibel, USA). The final results were expressed µg/g fresh weight of tissue.

The surface microbial counts were taken as per methods detailed by Swanson *et al.* (1992). Polygalacturonase (PG) activity was determined through the methodology described

and modified by (Garg and Ashfaque 2010). One unit of PG activity was defined as the quantity of enzyme necessary to produce one micromole (µm) of galacturonic acid per minute. Data represent the mean and standard error mean and experimental design was completely randomized. Data were further subjected to analysis of variance and means were compared using least significance difference (LSD) at the $P < 0.05$ level.

RESULTS AND DISCUSSION

The shelf-life of mango fruit gradually decreased with increasing storage period as indicated by gradual cumulative weight loss of fruits. However, the physiological weight loss (PLW) of fruit was considerably more pronounced in open condition as compared to polybag treatment. Under ambient condition significant PLW started in fruit from the 2nd day of storage and loss up to 26% and 35% was observed at 6th and 10th day, respectively, and the fruits were hardly found acceptable for the marketing and all fruits were decomposed on 12th day of storage (Fig 1). On the other hand, the fruit weight loss of poly bag treatment was not significant up to 12th day of storage as exhibited by 1 and 2% loss in weight at 10-12 day, respectively. The fruits kept in the bags were found to be acceptable for marketing up to this period and quality started deteriorating only after 14 days of storage (Table 1 and 2). The TSS, firmness and acidity in terms of pH of the fruits were measured on 0 days and different days of stored fruits. Mango fruit ripening has been related to gradual decrease in firmness, increased TSS and lower acidity with increasing physiological weight loss (Kalra and Tandon 1983). In the present investigation a similar trend was obtained, particularly in control fruits (Table 3). However, higher firmness, lower TSS, higher acidity and lower physiological

Table 1 Effect of polybags on weight loss of different period of storage in mango cv. Dashehari

Treatment	Weight (kg)								Total weight loss (%)*
	Days after storage								
	0	2	4	6	8	10	12	14	
Polybag	5.0	5.0	5.0	5.0	5.0	4.95 ± 0.18	4.9 ± 0.11	4.25 ± 0.17	15.0
Control	5.0	4.8 ± 0.21	4.65 ± 0.22	3.7 ± 0.12	3.35 ± 0.22	3.25 ± 0.15	(decomposed)		35.0
CD (P=0.05)		0.11	0.41	0.23	0.12	0.78			1.21

*Percentage (%) weight loss between 0 and last day.

Table 2 Effect of polybags on periodical percentage of cumulative weight loss of mango cv. Dashehari at different storage periods

Treatment	Physiological weight loss (%)							
	Days after Storage							
	0	2	4	6	8	10	12	14
Polybags	0	0	0	0	0	1.0 ± 0.005	2.0 ± 0.001	15.0 ± 1.35
Control	0	4.0 ± 0.12	7.0 ± 1.5	26 ± 2.5	33.0 ± 1.8	35.0 ± 5.6	decomposed	decomposed
CD (P=0.05)						0.45	0.56	

Table 3 Effect of polybags on biochemical attributes at different period of storage in mango cv. Dashehari

Days	Firmness (kg/cm ²)		TSS (°Brix)		Acidity (%)		pH		Ascorbic acid (mg/100g sample)		Carotenoid (µg/g fwt.)		Total Phenol (mg/g fwt.)		Total antioxidant value (mg AEAC/g fwt.)	
	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C
0	12.5±	11.8 ±	10.53 ±	10.53±	2.42±	2.20 ±	3.40 ±	3.66 ±	89.00 ±	81.00±	77.28±	77.53±	256.29±	250.12±	5.34±	5.00±
	1.2	0.41	0.45	0.45	0.08	0.16	0.45	0.08	10.00	5.00	4.56	6.11	5.2	3.2	0.56	0.41
2	10.3±	9.90 ±	12.56±	12.99±	2.12±	2.00 ±	3.86±	3.98±	81.00±	78.88±	77.31±	77.61±	250.11±	240.11±	5.66±	5.22±
	0.78	0.98	0.78	0.55	0.11	0.41	0.12	0.21	2.44	2.33	3.66	3.41	3.1	4.1	0.78	0.45
4	7.4 ±	7.11 ±	13.87±	15.11±	1.78±	1.45 ±	3.97±	4.11±	74.22±	73.11±	77.56±	77.79±	232.11±	225.11±	5.89±	5.46±
	1.2	0.74	0.56	0.78	0.09	0.11	0.11	0.18	3.11	2.41	3.56	5.22	8.6	6.1	0.78	0.63
6	5.21±	4.65 ±	15.08±	17.78±	1.51±	1.22 ±	4.07±	4.65±	70.08±	72.10±	78.11±	78.08±	200.11±	208.11±	6.01±	5.71±
	0.56	0.52	0.41	0.41	0.07	0.07	0.23	0.22	4.11	1.22	5.66	4.11	9.1	7.4	0.81	0.52
8	4.01±	2.48 ±	16.11±	18.78±	1.11±	0.89 ±	4.22±	5.00±	68.41±	70.41±	78.41±	78.33±	195.21±	191.11±	6.23±	5.89±
	0.23	0.56	0.85	0.35	0.07	0.07	0.21	0.41	1.22	2.11	7.11	6.23	6.5	6.1	0.74	0.66
10	2.11±	0.15±	17.69±	19.90±	0.88±	0.56±	4.41±	5.50±	63.00±	68.00±	78.99±	78.56±	190.81±	182.36±	6.41±	6.11±
	0.41	0.04	0.37	0.30	0.05	0.08	0.20	0.046	5.00	6.00	4.56	5.11	7.1	6.4	0.81	0.71
12	1.41±	NIL*	18.01 ±	NIL*	0.59±	NIL*	4.41±	NIL*	52.32 ±	NIL*	79.00±	NIL*	181.22±	NIL*	6.55±	NIL*
	0.23		0.41		0.04		0.11		1.85		5.23		5.6		0.78	
14	0.8 ±	NIL*	18.69 ±	NIL*	0.36±	NIL*	4.42±	NIL*	39.70±	NIL*	79.22±	NIL*	160.11±	NIL*	6.69±	NIL*
	0.08		0.29		0.04		0.29		2.10		7.11		8.1			
CD (P=0.05)	0.63	1.12	0.78	1.11	1.23	0.89	1.02	1.08	0.87	0.63	0.78	0.96	1.01	1.22	0.89	1.21

T : Treatment (Polybags), C : Control, *Decomposed.

Table 4 Effect of polybags on microbial population in pulp at different storage period in mango cv. Dashehari

Treatment	Bacteria (cell/g)								Yeast and mould (cfu/g)							
	0	2	4	6	8	10	12	14	0	2	4	6	8	10	12	14
Polybag	2.52x 10 ²	2.68x 10 ²	2.72x 10 ²	2.91x 10 ²	3.01x 10 ²	3.11x 10 ²	3.25x 10 ²	3.32x 10 ²	2.91x 10 ²	3.09x 10 ²	3.21x 10 ²	3.45x 10 ²	3.66x 10 ²	3.72x 10 ²	3.81x 10 ²	3.87x 10 ²
Control	2.52x 10 ²	2.71x 10 ²	3.21x 10 ²	3.69x 10 ²	4.00x 10 ²	4.45x 10 ²	NIL*	NIL*	2.91x 10 ²	3.22x 10 ²	3.35x 10 ²	3.52x 10 ²	3.66 x 10 ²	3.70x 10 ²	NIL*	NIL*
CD (P=0.05)	0.78	0.95	0.74	0.65	0.78	0.78			0.84	0.77	0.92	0.89	0.91	1.01		

*Decomposed.

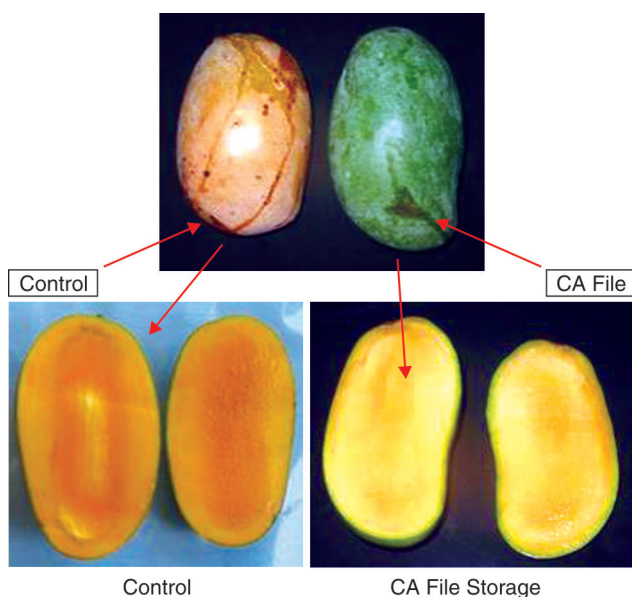


Fig 1 Mango fruits after 10 days of storage in control and CA film condition.

weight loss was observed in polybags stored fruits compared to control during same period of storage which indicated more shelf-life than in the fruits kept in open condition. There was marginal difference in carotenoids, phenol content and FRAPS values up to 8th day of storage in both condition (Table 3); however, subsequent increase in total phenol and FRAP value were recorded in polybag fruit. Their content was not detected significantly in later storage period in control fruits. The data pertaining to the Polygalacturonase (PG) activity measured clearly showed that its activity gradually increased in control fruits from 0.146 to 0.268 U/ml up to 10 days of storage, while in poly bag stored fruits its activity exhibited decreasing trend from 0.146 U/ml to 0.095 U/ml during the storage period. The ripening is characterized by the sharp increase in ethylene production, which triggered PG activity resulting softening of cell wall tissue in control whereas, in polybag ethylene production was inhibited resulting in lower PG activity and delay the ripening process. The change in firmness during ripening is generally attributed to changes in the activity of cell wall degradation enzymes. Thus the lower activity of PG in polybags stored fruits could be related to firmer fruits with low CPLW at different period of storage. It is

Table 5 Effect of polybags on changes in polygalacturonase enzyme (PG) activity in mango cv. Dashehari

Treatment	Polygalacturonase (U/ml)							
	0	2	4	6	8	10	12	14
Polybag	0.146	0.122	0.115	0.106	0.101	0.099	0.097	0.095
Control	0.146	0.174	0.199	0.214	0.241	0.268	NIL	NIL*
CD at 5% (P=0.05)	0.41	0.52	0.88	0.78	0.92	0.86		

*Decomposed.

also fact that fruit with high rates of ethylene production soften and ripen faster than the fruits are kept in antiethylene system (polybag). Thus fruits kept in modified atmosphere fresh polybag (MAP) were unable to develop an ethylene rise because of inhibition of auto-catalytic production of ethylene in fruits (Abdi *et al.* 1998) and the fruits did not exhibit marked changes in firmness up to certain stage of storage. The surface microbial load in terms of bacterial, yeast and mould growth was also lower after 14th day (3.3×10^2 cell/g bacteria and 3.87×10^2 cfu/g yeast and mould) in the fruit kept in poly bag as compared to control after 10th day (4.45×10^2 cell/g bacteria and 3.7×10^2 cfu/g yeast and mould) after last day of storage (Table 4). The present findings therefore, suggest that such polybags are useful for enhancing the shelf-life of fruits of mango particularly Dashehari cultivar having less shelf-life, with more commercial value in subtropical region as compared to other commercial cultivars of mango.

Thus it is concluded that polybag may be useful for enhancing the shelf-life of mango fruit particularly cultivar Dashehari for enhancing the marketability period of fruits.

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