Plant Archives Vol. 25, No. 1, 2025 pp. 1597-1605 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.1.235

EFFECT OF SKIN COATINGS ON IMMATURE MANGO (*MANGIFERA INDICA* L.) CV. SARIK HEINOU IN MANIPUR, INDIA

Ram Preet Singh[1], Linthoingambi Ningombam[2], Dupati Ashok Kumar[1], Md. Rizwanullah[1], Ng. Piloo[3], Shweta Yadav[4*] and Damini Ngute Tamin[5]

[1]Department of Fruit Science, College of Horticulture and Forestry, Central Agricultural University, Pasighat - 791 102, Arunachal Pradesh, India.

[2]Department of Agricultural Sciences, Arunachal University of Studies Namsai - 792 103, Arunachal Pradesh, India.

[3]Department of Horticulture, College of Agriculture, Central Agricultural University Manipur - 795 004, Imphal West, India.

[4]Department of Vegetable Science, College of Horticulture, Banda University of Agriculture & Technology, Banda - 210 001, Uttar Pradesh, India.

[5]Department of HAMP, Mizoram University, Tanhril, Aizawl - 796 004, Mizoram, India.

*Corresponding author E-mail : shwetayadav.skb@gmail.com

(Date of Receiving-31-01-2025; Date of Acceptance-04-04-2025)

ABSTRACT

The present study evaluated the effect of different coatings, including paraffin wax, aloe vera gel, castor oil, coconut oil, mustard oil, palm oil, and cling film, on the postharvest quality and shelf life of mango fruits. The results indicated that cling film and paraffin wax were most effective in minimizing physiological weight loss (PLW), reducing spoilage and maintaining fruit color, peel, flesh, and stone weight. These coatings significantly influenced key quality parameters such as total soluble solids (TSS), acidity, TSS: acidity ratio, reducing sugar, and total sugar. Cling film and paraffin wax coatings slowed down ripening by reducing respiration rates, delaying chlorophyll degradation, and retaining fruit firmness, leading to an extended shelf life of 12–15 days with good marketability and sensory attributes. The findings suggest that these coatings can be an effective postharvest treatment for enhancing mango storage life while maintaining fruit quality.

Key words : Mango, Postharvest coatings, Shelf life, Physiological weight loss, Fruit quality.

Introduction

Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae and originated in the Indo-Burma region (Subramanyam *et al*., 1975). It is one of the choicest fruits in the world (Joshi *et al*., 2013) and is also one of the most preferential fruit crops of the tropical and subtropical regions of the world for human consumption (Vasugi *et al*., 2012). Due to its importance, luscious flavour and taste, *M. indica* is often named “King of fruits”. Its social and economic impact are the most relevant in developing and emerging countries, where mango is a high-valued component in the diet, rich in vitamins and minerals (Ribeiro *et al*., 2007). Mango fruits are very delicious with an excellent flavour, attractive fragrance and rich in carbohydrates, proteins, fats, minerals, and vitamins particularly vitamin A (beta carotene), vitamin B1, vitamin B2 and vitamin C (ascorbic acid). Being rich in bioactive compounds, consumption of mango can provide excellent source of antioxidants that helps to reduce the risk of certain forms of cancer, slow the aging process, improve lung function, and reduce complications associated with diabetes (Alam *et al*., 2016). Mango as an emerging tropical export fruit is produced in over 90 countries worldwide with a production of over 28.51 million metric tons. Asia accounts for approximately 77% of global mango production. America and Africa account for approximately 13% and 10%, respectively. Ethiopia has a diverse agro - ecology that can grow various fruit crops with a huge potential for mango production as well. More than 47 thousand hectares of land is under fruit crops in Ethiopia and

mangoes cover 12.61% of the fruit crop area. Mango is grown in India in tropical and subtropical regions from sea level to an altitude of 1500 meters. It is grown almost in all states of the country. One-fifth of the total fruit produced in the country is Mango next to Banana. Mango is cultivated in the largest area of 2,258 thousand hectares and the production is around 21,822 thousand MT, contributing 39 % of the total world production of mango (NHB, 2017-2018). Raw fruits of local varieties of Mango trees are used for preparing various traditional products like raw slices in brine, amchur, pickle, murabba, chutney, panhe (sherbet) etc. The wood is used as timber, and dried twigs are used for religious purposes. Mango kernel also contains about 8-10% good quality fat, which can beused for saponification. Its starch is used in the confectionery industry (Anonymous, 2013). Mango postharvest losses are still very significant. They are primarily due to harvesting fruit at improper maturity, mechanical damage caused during harvesting or improper field handling, sap burn, spongy tissue, lenticels discolouration, fruit softening, decay, chilling injury, and disease and pest damage, among others (Yahia, 1998). Nanda *et al*. (2012) revealed that 5.8-18.1% of fruits were lost during harvesting, postharvest activities, handling and storage. Quality losses often occur due to tight fruit packing, using improper transport and inadequate field handling. Fruit losses during export can vary dramatically depending on postharvest handling and export conditions, especially concerning rates of decay, pests and physiological breakdown. Despite a variety of uses, unfortunately, the post-harvest treatments of mango crops are minimal and there is very less processed product in some parts of North East India, especially in Manipur. In Manipur, despite its availability in abundance during the peak season, most of the local varieties have the tendency to get infested with insects and fails to ripen fully. As a result, to lessen and minimize the loss, it is necessary to preserve the immature mango by way of different post-harvest handling and processing techniques like proper processing and value addition, prolonging shelf life of immature mangoes by using different skin coatings and storage at optimum temperature and relative humidity, packaging treatments. Coating might be an important substance to prolong shelf life of mango by minimizing physiological processes and microbial decay. Paraffin and different types of oils like almond oil, olive oil, sesame oil, coconut oil and mustard oil etc., may be investigated to find out their effects on shelf life and quality of mango. Individual shrink wrapping, which may be considered as modified atmosphere packaging (MAP) for individual fruit, is used to enhance the storage life and maintain freshness of fruits and vegetables. This technique has been successfully used for non-climacteric fruits and vegetables like citrus, pomegranate, cucumber, capsicum, etc. mainly to prevent shrivelling and mass loss, without affecting the flavour (Ben-Yehoshua *et al*., 1983; Sonkar and Ladaniya, 1999; Sudhakar Rao *et al*., 2009; Nanda *et al.*, 2001; Dhall *et al*., 2012). Cling film the plastic packaging film has revolutionized the food industry by protecting and preserving the food. Cling film is very thin polyethylene film that adheres to the surface of fruit and serves as an extra covering. Film improved physico-chemical characteristics of Guava i.e., appearance, weight loss, total soluble solids, titrable acidity, ascorbic acid content and total sugars by retarding respiration and transpirational losses (Chandra and Kumar, 2012). Pure coconut oil as edible coating of fruits has gaining interest for its anti-senescence property by controlling respiration rate, transpiration rate and binding of the ethylene biosynthesis process. Coconut oil and liquid paraffin coating closed the opening of stomata and lenticels thereby, reducing the transpiration and respiration rate and also reduce microbial activity (Bisen *et al*., 2012). Hence, the present study "Effect of Skin Coatings on Immature Mango (*Mangifera indica* L.) cv. Sarik Heinou in Manipur" is undertaken with the following objectives: to study the shelf life of immature mango using coatings, to study the effectiveness of different coatings and to study the quality of immature mango during storage.

Materials and Methods

Collection of Raw Materials

Immature mango fruits (*Mangifera indica* L. *cv*. Sarik heinou) were harvested from the Horticulture Research Farm, CAU, Andro, Imphal East. The fruits were washed, surface dried, and sorted to remove bruised, diseased, or decayed samples.

The study was conducted in the Laboratory of the Department of Horticulture, College of Agriculture, Iroisemba, CAU, Manipur. The experiment followed a Completely Randomized Design (CRD) with eight different coating treatments. Each treatment was replicated three times, making a total of 24 samples. The eight different treatment details are T_1 (Castor oil), T_2 (Palm oil), T_3 (Coconut oil), T_4 (Mustard oil), T_5 (Aloe vera gel), T_6 (Paraffin wax), T_7 (Cling film) and T_8 (Control).

Methodology

The experimental procedure began with the selection and harvesting of immature mango fruits, followed by washing and sorting to remove any bruised, diseased, or

decayed fruits. After ensuring cleanliness, different coating treatments were applied to the selected fruits. The coated fruits were then stored under ambient conditions, and regular observations were recorded to assess their physical and biochemical parameters over time.

Observations recorded

The study assessed both physical and biochemical parameters of coated mangoes to evaluate their shelf life and quality. Physiological loss in weight (% PLW) was calculated as the percentage difference between the initial and final fruit weight. Specific gravity was determined by dividing the fruit's weight by the volume of displaced water. The peel, flesh and stone were separated and weighed individually to determine their respective proportions. Sensory quality was evaluated by a panel of judges using a 9-point hedonic scale, while fruit peel and flesh color were rated on a 5-point scale. Spoilage percentage was calculated as the ratio of spoiled fruits to the total number of fruits, and marketable fruit percentage was determined based on visual assessment.

Biochemical parameters included total soluble solids (TSS), measured using a hand refractometer and expressed in °Brix. Acidity percentage was determined through titration with NaOH, and the TSS: Acid ratio was calculated by dividing the TSS value by the acidity content. Total and reducing sugars were estimated using Lane and Eynon's titration method. Additionally, chlorophyll content was analyzed spectrophotometrically using an 80% acetone extract to determine changes in pigment composition over time.

Results and Discussion

The study evaluated the effect of different skin coatings on the shelf life and quality of immature mangoes (*Mangifera indica* L. cv. Sarik heinou) during storage. Various physical and biochemical parameters were analyzed, with data presented in Tables and Figures.

Effect on Physiological Loss in Weight (% PLW)

Physiological weight loss increased with storage duration across all treatments. Fruits coated with cling film (T_7) exhibited the least weight loss, recording 0.00%, 1.05%, 1.08% and 3.04% on the 0th, 5th, 10th, and 15th day, respectively. Conversely, uncoated fruits (T_8) showed the highest weight loss at 0.00%, 3.93%, 5.05% and 7.62%, respectively.

Coatings such as paraffin wax and cling film effectively minimized weight loss by reducing water loss and respiration, thereby extending fruit freshness. These findings align with studies by Attia (1995), Waskar and Gaikwad (2005) and Zafrul *et al.* (2020), which demonstrated that wax coatings slow weight loss and enhance shelf life. The reduced transpiration and respiration rates in coated fruits resulted in lower desiccation, supporting the benefits of edible coatings in postharvest preservation.

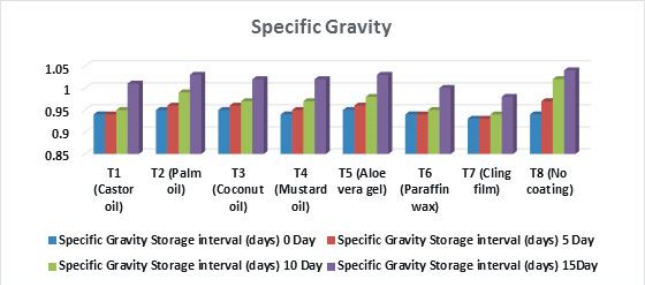

Fig. 1 : Effect of coating treatments on specific gravity (g/cm^3) of local mango during different days of storage.

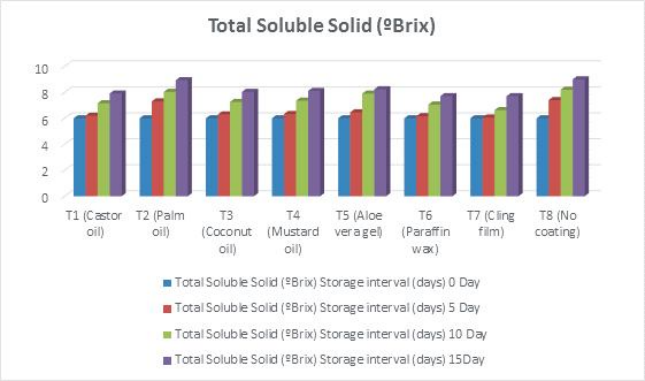

Fig. 2 : Effect of coating treatments on total soluble solids of local mango.

Effect on Specific Gravity (g/cm^3)

Specific gravity, an indicator of fruit quality, showed significant variations among treatments during storage. Fruits coated with cling film (T_7) recorded the lowest specific gravity at 0.93, 0.93, 0.94 and 0.98 g/cm^3 on the 0th, 5th, 10th and 15th days, respectively. In contrast, uncoated fruits (T_8) had the highest values at 0.94, 0.97, 1.02 and 1.04 g/cm^3.

A decline in specific gravity was observed across all coatings compared to the control, suggesting reduced water loss and slower degradation. These findings align with Sastry and Krishnamurthy (1975) and Nandini and Oommen (2002), who reported wide variations in mango cultivars' density, emphasizing the role of coatings in maintaining fruit quality during storage.

Effect on Peel, Flesh and Stone weight (g)

Significant variations were observed in peel, flesh, and stone weight across treatments during storage. Cling film-coated fruits (T_7) showed minimal changes, with peel weight increasing slightly (13.13 to 18.78 g), flesh weight

Table 1 : Effect of coating treatments on physiological loss in weight (%) of local mango during different days of storage.

Treatment	Physiological loss in weight (%)			
	Storage period (days)			
	0 Days	5 Days	10 Days	15 Days
T_1 (Castor oil)	0.00	9.07 (3.09)	18.37 (4.34)	30.44 (5.56)
T_2 (Palm oil)	0.00	13.03 (3.71)	26.03 (5.15)	47.06 (6.80)
T_3 (Coconut oil)	0.00	9.92 (3.22)	19.28 (4.44)	35.58 (5.98)
T_4 (Mustard oil)	0.00	10.33 (3.28)	20.40 (4.56)	42.71 (6.56)
T_5 (Aloe vera gel)	0.00	11.12 (3.40)	22.38 (4.77)	46.06 (6.82)
T_6 (Paraffin wax)	0.00	1.38 (1.48)	4.18 (2.15)	9.93 (3.20)
T_7 (Cling film)	0.00	0.61 (1.05)	3.05 (1.80)	9.48 (3.04)
T_8 (No coating)	0.00	14.99 (3.93)	29.82 (5.50)	57.81 (7.62)

Note: Value that is presented in bracket is the square root transformed value.

remaining stable (80.80 to 78.29 g) and stone weight increasing (7.64 to 14.81 g) over 15 days.

In contrast, uncoated fruits (T_8) exhibited higher peel weight change (11.93 to 14.81 g), greater flesh weight reduction (79.44 to 72.11 g) and lower stone weight (7.22 to 6.39 g). Coatings helped maintain fruit integrity by reducing weight loss. These findings align with Kundu and Ghosh (1992) and Singh *et al.* (2013), who reported variations in stone content across mango cultivars.

Effect on Sensory quality

Sensory quality ratings varied significantly across storage periods. Cling film-coated fruits (T_7) maintained the highest sensory quality scores (9.00 on day 0, decreasing to 6.60 by day 15), while uncoated fruits (T_8) showed the lowest scores (9.00 to 2.33).

Coatings helped retain fruit quality by preserving texture, color, and flavor, aligning with findings by Malundo *et al*. (1997) and Ragaert *et al.* (2004). Shrink-wrapped mangoes also showed superior sensory attributes (Sudhakar Rao and Shivashankara, 2015), and Yuen *et al*. (1993) reported that cling wrap significantly maintained mango appearance and taste up to 10 days.

Effect on Fruit Colour (Peel and Flesh)

Fruit colour changes during storage were influenced by coating treatments, with cling film-coated fruits (T7) showing the slowest colour change (peel: 1.00 to 3.10, flesh: 1.00 to 3.06) compared to uncoated fruits (T8), which exhibited the highest colour change (peel: 1.00 to 4.70, flesh: 1.00 to 4.80). Colour change is a key ripening indicator, linked to chlorophyll breakdown and carotenoid formation. Coatings delayed this process, as also observed by Thommohaway *et al*. (2007), Rao and Shivashankara (2015). Uncoated fruits ripened faster due to increased respiration and moisture loss, aligning with findings by Leopold (1964) and Leoseck (1950).

Effect of Coating Treatments on Flesh Colour of Local Mango

Fruits coated with pure coconut oil, liquid paraffin wax, and castor oil retained a light green colour for up to 18 days, enhancing market acceptability by delaying senescence and chlorophyll degradation. In contrast, mustard and sesame oil coatings led to dark brown discoloration due to skin injury and tissue softening (Bisen *et al*., 2012). Similar findings were reported by Dalal *et al.* (1987) in baramasi lemon, where mustard oil emulsion caused higher weight loss and changes in texture, flavour, and colour.

Effect on Spoilage (%)

Spoilage percentage increased with storage duration across all treatments. No spoilage was observed up to the 5th day. By the 10th day, paraffin wax (T_6) and cling film (T_7) had the lowest spoilage (0.70%), while castor oil (T_1), coconut oil (T_3) and mustard oil (T_4) recorded 2.63%. On the 15th day, cling film (T_7) showed the least spoilage (20.83%), whereas uncoated fruits (T_8) had the highest spoilage (49.33%). The deterioration was likely due to microbial growth and CO_2 accumulation, aligning

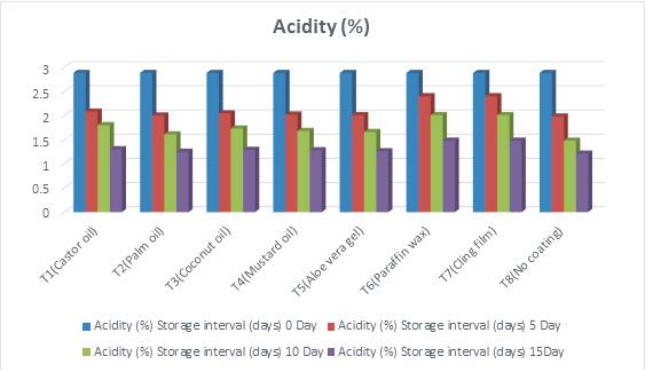

Fig. 3 : Effect of coating treatments on acidity of local mango.

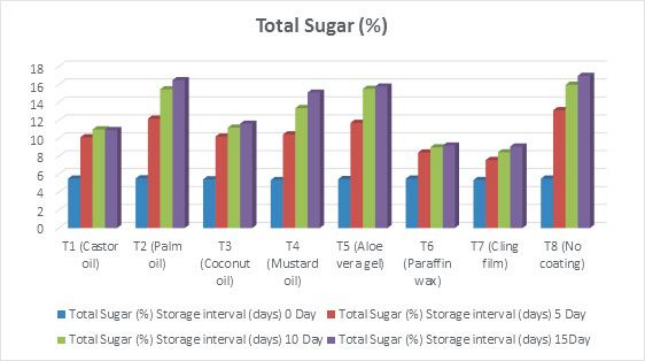

Fig. 4 : Effect of coating treatments on total sugar of local mango.

Table 2 : Effect of coating treatments on Peel weight (g), Flesh weight (%) and stone weight (%) of local mango during different days of storage.

Treatment	Peel weight (%)			
	Storage period (days)			
	0 Day	5 Days	10 Days	15 Days
T_1 (Castor oil)	12.58	14.97	16.25	16.19
T_2 (Palm oil)	12.06	14.63	15.11	15.23
T_3 (Coconut oil)	12.38	14.94	16.15	16.04
T_4 (Mustard oil)	12.36	14.80	15.75	15.96
T_5 (Aloe vera gel)	12.12	14.63	15.46	15.30
T_6 (Paraffin wax)	12.79	15.42	17.88	17.49
T_7 (Cling film)	13.13	15.99	18.78	18.78
T_8 (No coating)	11.93	13.80	14.95	14.81

Treatment	Flesh weight (%)			
	Storage period (days)			
	0 Day	5 Days	10 Days	15 Days
T_1 (Castor oil)	80.49	77.77	76.92	76.70
T_2 (Palm oil)	79.75	76.77	74.54	74.69
T_3 (Coconut oil)	80.20	77.71	76.09	76.06
T_4 (Mustard oil)	80.17	77.24	75.22	75.48
T_5 (Aloe vera gel)	79.97	77.23	74.94	74.93
T_6 (Paraffin wax)	80.56	78.01	76.59	77.29
T_7 (Cling film)	80.80	78.91	78.48	78.29
T_8 (No coating)	79.44	75.08	72.18	72.11

Treatment	Stone weight (%)			
	Storage period (days)			
	0 Day	5 Days	10 Days	15 Days
T_1 (Castor oil)	7.40	8.16	9.08	9.08
T_2 (Palm oil)	7.24	6.85	6.88	6.65
T_3 (Coconut oil)	7.39	8.13	8.94	9.01
T_4 (Mustard oil)	7.36	7.94	7.93	8.05
T_5 (Aloe vera gel)	7.33	7.26	6.91	6.84
T_6 (Paraffin wax)	7.44	8.57	9.18	9.09
T_7 (Cling film)	7.64	8.90	9.29	14.81
T_8 (No coating)	7.22	6.44	6.39	6.39

with findings by Paladines *et al.* (2014).

Spoilage is one of the prime problems in mango storage. Fruit contamination affects the produce quantity and quality (Tripathi and Dubey, 2004). *Aloe vera* gel is the one of common known coating material which is usually used to increase the storage life of various table fruits like mango (Castillo *et al*., 2006). Browning and dehydration of fruits during storage can be reduced by coating with *Aloe vera* gel (Martinez *et al*., 2006). Serano *et al*. (2006) reported about the properties like anti-flammatory, anti-bacterial and anti-fungal gels found in *Aloe vera* have contributed to long shelf-life of fresh fruits during storage.

Table 3 : Effect of coating treatments on sensory quality of local mango during different gays of storage.

Treatment	Sensory Quality			
	Storage period (days)			
	0 Day	5 Days	10 Days	15 Days
T_1 (Castor oil)	9.00	8.93	5.93	2.60
T_2 (Palm oil)	9.00	8.93	7.27	6.33
T_3 (Coconut oil)	9.00	8.60	6.67	5.87
T_4 (Mustard oil)	9.00	8.53	6.47	6.27
T_5 (Aloe vera gel)	9.00	8.67	6.27	6.40
T_6 (Paraffin wax)	9.00	8.93	7.27	6.47
T_7 (Cling film)	9.00	9.00	7.33	6.60
T_8 (No coating)	9.00	8.80	5.80	2.33

Note: Hedonic Scale 1-9 points; 1: Extremely undesirable, 2: Very much undesirable, 3: Moderately undesirable, 4: Slightly undesirable, 5: Neither desirable nor undesirable, 6: Slightly desirable, 7: Moderately desirable, 8: very much desirable, 9: Extremely desirable.

Table 4 : Effect of coating treatments on fruit colour (peel) of local mango during different days of storage.

Treatment	Fruit colour (Peel)			
	Storage period (days)			
	0 Day	5 Days	10 Days	15 Days
T_1 (Castor oil)	1.00	1.20	3.40	4.60
T_2 (Palm oil)	1.00	1.30	3.00	3.80
T_3 (Coconut oil)	1.00	1.50	3.30	3.80
T_4 (Mustard oil)	1.00	1.30	3.40	4.00
T_5 (Aloe vera gel)	1.00	1.30	3.70	3.50
T_6 (Paraffin wax)	1.00	1.20	2.80	3.50
T_7 (Cling film)	1.00	1.10	2.50	3.10
T_8 (No coating)	1.00	1.40	3.60	4.70

Rating for fruit colour peel hedonic scale (1-5); 1: Dark green, 2: Light green, 3: Slightly yellowish, 4: 50 to 70% yellow, 5: Totally yellow.

Effect on Marketability (%)

Marketability was 100% for all treatments up to the 5th day. By the 10th day, cling film (T_7) and paraffin wax (T_6) had the highest marketability (10.02%). On the 15th day, cling film (T_7) maintained the highest marketability (7.02%), while uncoated fruits (T_8) had the lowest (2.63%). Marketability was influenced by fruit appearance, color, firmness and lack of surface injury. Aloe vera gel helped retain moisture and firmness, aligning with findings by Ahmed *et al.* (2009). Wax emulsion also preserved fruit quality, as reported by Tripathi and Dubey

Table 5 : Effect of coating treatments on fruit colour (flesh) of local mango during different days of storage.

Treatment	Fruit colour (Flesh)			
	Storage period (days)			
	0 Day	5 Days	10 Days	15 Days
T_1 (Castor oil)	1.00	1.80	2.80	4.60
T_2 (Palm oil)	1.00	1.60	2.60	3.53
T_3 (Coconut oil)	1.00	1.60	2.66	3.66
T_4 (Mustard oil)	1.00	1.60	2.60	3.60
T_5 (Aloe vera gel)	1.00	1.73	2.80	3.73
T_6 (Paraffin wax)	1.00	1.40	2.46	3.26
T_7 (Cling film)	1.00	1.26	2.33	3.06
T_8 (No coating)	1.00	1.86	3.13	4.80

Rating for fruit colour flesh hedonic scale (1-5); 1: Totally white, 2: Slightly yellowish, 3: 50 % yellow, 4: 70 % yellow, 5: Totally yellow.

Table 6 : Effect of coating treatments on spoilage of local mango during different days of storage.

Treatment	Spoilage (%)			
	Storage period (days)			
	0 Day	5 Days	10 Days	15 Days
T_1 (Castor oil)	0.00	0.00	8.33(2.63)	33.33
T_2 (Palm oil)	0.00	0.00	12.50(3.60)	45.83
T_3 (Coconut oil)	0.00	0.00	8.33(2.63)	37.50
T_4 (Mustard oil)	0.00	0.00	8.33(2.63)	41.66
T_5 (Aloe vera gel)	0.00	0.00	8.33(2.63)	41.66
T_6 (Paraffin wax)	0.00	0.00	0.00(0.70)	29.16
T_7 (Cling film)	0.00	0.00	0.00(0.70)	20.83
T_8 (No coating)	0.00	0.00	25.00(5.04)	49.33

Note: Value that is presented in bracket is the square root transformed value.

(2004), while cling film extended shelf life by 10 days (Rana *et al*., 2015).

Effect on TSS (°Brix)

Total soluble solids (TSS) increased during storage due to starch hydrolysis and sugar formation. At 0 days, TSS was 6.00 °Brix. By the 5th day, cling film (T_7) and paraffin wax (T_6) recorded the lowest TSS (6.06 and 6.16 °Brix), while uncoated fruits (T_8) had the highest (7.40 °Brix). At the 15th day, castor oil (T_1), paraffin wax (T_6) and cling film (T_7) maintained the lowest TSS (7.70 °Brix), while uncoated fruits reached 9.00 °Brix. Lower TSS in coated fruits was due to reduced respiration and delayed ripening. Similar trends were reported in mango (Baldwin *et al*., 1999), guava (Bashir and Abu-Goukh, 2003) and apples (Sabir *et al*., 2004).

Table 7 : Effect of coating treatments on marketability (%) of local mango during different days of storage.

Treatment	Marketable fruit (%)			
	Storage period (days)			
	0 Day	5 Days	10 Days	15 Days
T_1 (Castor oil)	100.00	100.00	70.83 (7.88)	41.66 (6.47)
T_2 (Palm oil)	100.00	100.00	29.16 (5.42)	16.66 (4.08)
T_3 (Coconut oil)	100.00	100.00	41.66 (6.47)	25.00 (5.04)
T_4 (Mustard oil)	100.00	100.00	37.50 (6.10)	16.66 (4.08)
T_5 (Aloe vera gel)	100.00	100.00	33.33 (5.79)	16.66 (4.08)
T_6 (Paraffin wax)	100.00	100.00	100.00 (10.02)	45.83 (6.79)
T_7 (Cling film)	100.00	100.00	100.00 (10.02)	49.33 (7.02)
T_8 (No coating)	100.00	100.00	20.83 (4.56)	12.50 (2.63)

Note: Value that is presented in bracket is the square root transformed value.

Effect of coating treatments on total soluble solids of local mango

The highest total soluble solids (14.67%) were noticed in fruits coated with 2% chitosan and the lowest (12.67%) was in olive oil coating and mustard oil coating at the 8th day of storage Zafrul *et al.* (2020). The increase in TSS in wax coated fruits till 12th day and then gradual decrease might be due to the fact that wax has the capacity to delay the metabolic activities during ripening and storage of fruits (Fan *et al*., 1999).

Effect on acidity (%)

Acidity decreased during storage due to sugar accumulation and organic acid utilization. Initially, acidity was 2.88%. By the 5th, 10th and 15th days, paraffin wax (T_6) and cling film (T_7) retained the highest acidity (2.40%, 2.01% and 1.48%), while uncoated fruits (T_8) had the lowest (1.98%, 1.48% and 1.21%). Coatings slowed respiration, preserving acidity (Yaman and Bayoindirli, 2002). Similar trends were observed in Satsuma mandarin (Bayindirli *et al.*, 1995), mango (Waskar *et al.*, 1999), and papaya (Valverde *et al.*, 2005). Coconut and castor oil coatings-maintained acidity up to 18 days (Bisen *et al*., 2012).

Effect on TSS: Acidity ratio

The TSS: acidity ratio increased during storage due

Table 8 : Effect of coating treatments on TSS: acidity ratio of local mango during different days of storage.

Treatment	TSS: Acidity ratio			
	Storage period (days)			
	0 Day	5 Days	10 Days	15 Days
T_1 (Castor oil)	2.08	2.96	4.24	6.30
T_2 (Palm oil)	2.08	3.61	5.13	6.95
T_3 (Coconut oil)	2.09	3.09	4.26	6.33
T_4 (Mustard oil)	2.08	3.17	4.48	6.52
T_5 (Aloe vera gel)	2.08	3.22	4.73	6.67
T_6 (Paraffin wax)	2.08	2.64	3.51	5.22
T_7 (Cling film)	2.08	2.52	3.30	4.86
T_8 (No coating)	2.08	3.62	5.55	7.01

Table 9 : Effect of coating treatments on reducing sugar of local mango during different days of storage.

Treatment	Reducing Sugar (%)			
	Storage period (days)			
	0 Day	5 Days	10 Days	15 Days
T_1 (Castor oil)	2.29	5.56	6.01	2.48
T_2 (Palm oil)	2.31	6.61	6.82	3.44
T_3 (Coconut oil)	2.32	5.62	6.03	2.54
T_4 (Mustard oil)	2.28	5.64	6.11	3.24
T_5 (Aloe vera gel)	2.27	5.93	6.29	3.42
T_6 (Paraffin wax)	2.32	4.46	5.99	2.31
T_7 (Cling film)	2.33	4.17	5.80	2.18
T_8 (No coating)	2.33	6.70	6.78	3.52

to rising TSS and declining acidity. Initially, it was 2.08. By the 5th, 10th and 15th days, cling film (T_7) showed a gradual increase (2.52, 3.30 and 4.86), while uncoated fruits (T_8) had the highest ratio (3.62, 5.55 and 7.01). Faster respiration in uncoated fruits led to early ripening, increasing TSS and reducing acidity. Similar trends were observed in mango (Mandal *et al*., 2018), where control fruits had a higher TSS: acidity ratio (29.33) than wax-coated fruits (9.60).

Effect on Total sugar (%)

Total sugar content increased during storage due to starch hydrolysis and sucrose biosynthesis. At 0 days, sugar levels ranged from 5.35% to 5.53% across treatments. By the 5th, 10th and 15th days, cling film (T_7) showed the lowest sugar accumulation (7.58%, 8.44%, 9.08%), while uncoated fruits (T_8) had the highest (13.13%, 15.97%, 16.96%). Cling film reduced respiration and delayed sugar formation, whereas uncoated fruits experienced continuous starch breakdown. Similar trends were reported in Blood Red oranges treated with wax coatings (Ahmed *et al*., 1986; Gul *et al*., 1990) and in

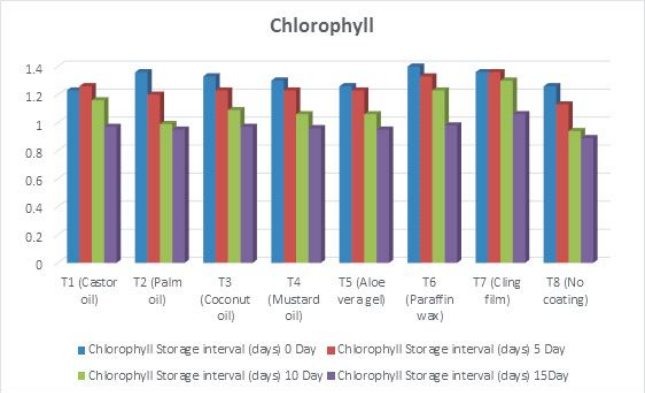

Fig. 5 : Effect of coating treatments on chlorophyll (m_g) of local mango.

studies on sucrose biosynthesis enzymes (Hubbard *et al*., 1991).

Effect on Reducing Sugar (%)

Reducing sugar content increased during storage due to starch breakdown. At 0 days, levels ranged from 2.27% to 2.33% across treatments. By the 5th, 10th, and 15th days, cling film (T_7) had the lowest reducing sugar accumulation (4.17%, 5.80%, 2.18%), while uncoated fruits (T_8) had the highest (6.70%, 6.78%, 3.52%). The slow sugar increase in coated fruits may be due to inhibited mitochondrial activity and enzyme function (Wills and Rigney, 1979). Similar trends were observed in wax-coated Blood Red oranges (Gul *et al*., 1990) and mandarin oranges (Yadav *et al*., 2010).

Effect on Chlorophyll (mg)

Chlorophyll degradation in mango was significantly affected by coatings. Cling film (T_7) retained the most chlorophyll, with minimal degradation from 1.36 mg (0 days) to 1.06 mg (15 days). Uncoated fruits (T_8) showed the highest loss, decreasing from 1.26 mg to 0.89 mg over the same period. Coated fruits exhibited slower chlorophyll breakdown, delaying ripening. Similar trends were observed in mango (Mann *et al*., 1974) and guava (Jain *et al*., 2003), with edible coatings reducing chlorophyll loss (Chitravathi *et al*., 2014).

Conclusion

Cling film and paraffin wax coatings were most effective in minimizing PLW, spoilage, and maintaining fruit quality, including color, peel, flesh and stone weight. These coatings extended the shelf life of mangoes to 12–15 days while preserving good sensory attributes and marketability. They also maintained optimal TSS, acidity, TSS: acidity ratio, reducing sugar and total sugar, ensuring better fruit quality throughout storage.

References

Ahmed, M.J., Singh Z. and Khan A.S. (2009). Postharvest Aloe vera gel-coating modulates fruit ripening and quality of "Arctic Snow nectarine" kept in ambient and cold storage. *Int. J. Food Sci. Techno.*, **44 (5)**, 1024-1033.

Alam, M.K., Rana Z.H. and Islam S.N. (2016). Comparison of the proximate composition, total carotenoids and total polyphenol content of nine orange-fleshed sweet potato varieties grown in Bangladesh. *Rev. Food Sci. Technol.*, **5**, 364-66.

Amerine, M.A., Pangborn R.M. and Roessler E.B. (1965). *Principles of Sensory Evaluation of Foods*. Academic Press, New York, 602 pp.

Anonymous (2013). *Post-Harvest Profile of Mango*. Directorate of Marketing & Inspection Branch, Ministry of Agriculture, Government of India, Nagpur.

Attia, M.N. (1995). Effect of post- harvest treatments on fruit losses and keeping quality of Balady oranges through cold storage. *Alexandria J. Agric. Res*., **40(3)**, 349-363.

Baldwin, E.A., Burns J.K., Kazokas W., Brecht J.K., Hagenmaier R.D., Bender R.J. and Pesis E. (1999). Effect of edible coatings with different permeability characteristics on mango (*Mangifera indica* L.) ripening during storage. *Post. Bio. Technol*., **17(3)**, 215-226.

Bashir, H.A. and Abu-Goukh A.(2003). Compositional changes during guava fruit ripening. *Food Chem*., **80(4)**, 557-563.

Bayindirli, L., Sumnu G. and Kamadan K. (1995). Effects of semperfesh and jn fresh fruit coatings on post storage quality of Satsuma mandarins. *J. Food Proc. Preser.*, **19(5)**, 399-407.

Ben, Yehoshua S., Shapiro B., Chen Z.E. and Lurie S. (1983). Mode of action of plastic film in extending life of lemon and bell pepper fruits by alleviation of water stress. *Plant Physiol.*, **73**, 87–93.

Bisen, A., Pandey S.K. and Patel N. (2012). Effect of skin coatings on prolonging shelf life of kagzi lime fruits (*Citrus aurantifolia* Swingle). *J. Food Sci. Tech.*, **49(6)**, 753–759.

Castillo, S., Navarro D., Zapata P.J., Guillen F., Valero D., Serrano M. and Martinez R.D. (2006). Antifungal efficacy of *Aloe vera in vitro* and its use as a preharvest treatment to maintain postharvest table grape quality. *Postharvest Biol. Technol.*, **57**, 183-188.

Chandra, D. and Kumar R. (2012). Qualitative effect of wrapping and cushioning materials on guava fruits during storage. *Hort. Flora. Res. Spectr.*, **1(4)**, 318–322.

Chitravathi, K., Chauhan O.P. and Raju P.S. (2014). Postharvest shelf-life extension of green chillies (*Capsicum annuum* L.) using shellac-based edible surface coatings. *Postharvest Biol. Technol.*, **92**, 146–148.

Dalal, V.B., Eipeson W.E. and Singh N.S. (1987). Effect of skin coating emulsion on shelf life of Baramasi lemon. *Proc. Fla. Sta. Hort. Soc*., **71**, 205.

Dhall, R.K., Sharma S.R. and Mahajan B.V.C. (2012). Effect of shrink wrap packaging for maintaining quality of cucumber during storage. *J. Food Sci. Technol.*, **49**, 495–499.

Fan, X., Blankenship S.M. and Mattheis J.P. (1999). 1-Methylcyclopropene Inhibits Apple Ripening. *J. Amer. Soci. Hort. Sci.*, **10**, 673-690.

Grierson, D. (1987). Senescence in fruits. *Hort. Sci*., **22**, 859-862.

Gul, S., Ishtiaq M. and Shah S.H. (1990). Studies on the effect of storage on the quality of sweet orange. *Sarhad. J. Agri.*, **6**, 433-436.

Hubbard, N.L., Pharr D.M. and Huber S.C. (1991). Sucrose phosphate synthase and other sucrose metabolizing enzymes in fruits of various species. *Plant Physiol.*, **82**, 191-96.

Jain, N., Dhawan K., Malhotra S. and Singh R. (2003). Biochemistry of fruit ripening in guava (*Psidium guajava* L.) compositional and enzymatic changes. *Plant Food Hum. Nutr*., **58**, 309–315.

Jitareerat, P., Paumchai S., Kanlayanarat S. and Sangchote S. (2007). Effect of chitosan on ripening enzymatic activity, and disease development in mango (*Mangifera indica* L.) fruit. *N. Z. J. Crop Hort. Sci*., **35**, 211-18.

Joshi, R., Kundu M. and Singh C.P. (2013). Efficient tool for identification on different mango cultivars. *Environ. Ecol*., **31(1)**, 385-388.

Kundu, S. and Ghosh S.N. (1992). Studies on physio-chemical characteristics of mango cultivars grown in laterite tract of Pest Bengal. *Haryana. J. Hort. Sci.*, **21 (3-4)**, 129-134.

Leopold, A.C. (1964). *Plant growth and development*. McGraw Hill Book Company, NewYork.183-295.

Leoseck, H.. (1950). Bananas. 2nd edition. Inter Science, NewYork

Malundo, T.M.M., Baldwin E.A., Moshonas M.G., Baker R.A. and Shewfelt R.L. (1997). Method for the rapid headspace analysis of mango (*Mangifera indica* L.) homogenate.

Mandal, S., Hazarika and Shukla (2018). Effect of edible coating on shelf life and quality of local mango cv. Rangkuai of Mizoram. *Res. on Crops*, **19 (3)**, 419-424.

Mann, S.S., Singh R.N. and Pandey R.M. (1974). Maturity studies in Dashehari in Langra cultivars of mango. *Haryana J. Hort. Sci*., **3(3&4)**, 97-105.

Martinez, R.D., Alburquerque N., Valverde J.M., Guillen F., Castillo S. and Valero D. (2006). Post-harvest sweet cherry quality and safety maintainance by *Aloe vera* treatment: a new edible coating. *Postharvest Biol. Technol.*, **39**, 93-100.

N.H.B. (2017-2018). Area and production of horticulture crops for 2017-18 (final). National Horticulture Board. Accessed 26 March 2020.

Nanda, S.K.,Vishwakarma R.K., Bathla H.V.L., Rai A. and Chandra P. (2012). Harvestand Post-harvest losses of major crops and livestock produce in India. All India Coordinated Research Project on Post-Harvest

Technology (ICAR), Ludhiana.

Paladines, D., Valero D., Valverde J.M., Diaz-Mula H., Serrano M. and Martinez-Romero D. (2014). The addition of rosehip oil improves the beneficial effect of aloe vera gel on delaying ripening and maintaining postharvest quality of several stone fruits. *Post. Bio. and Technol.*, **92**, 23-28.

Ragaert, P., Verbeke W., Devlieghere F. and Debevere J. (2004). Consumer perception and choice of minimally processed vegetables and packaged fruits. *Food Qual Prefer.*, **15**, 259-70.

Rana, S., Siddiqui S. and Goyal A. (2015). Extension of the shelf life of guava by individual packaging with cling and shrink films. *J. Food Sci. Techno*., **52(12)**, 8148–8155.

Rao, D.V.S. and Shivashankara K.S. (2015). Individual shrink wrapping extends the storage life and maintains the antioxidants of mangoes (cvs Alphonso and Baganapalli) stored at 8°C. *J. Food Sci. Technol*., **52(7)**, 4351-4359.

Ribeiro, R.S.M., Queiroz J.H., Queiroz L.R.M.E., de Campos F.M. and Santana P.H.M. (2007). Antioxidant in mango (*Mangifera indica* L.) pulp. *Plant Foods Hum. Nutr*., **6**, 13- 21.

Sastry, M.V. and Krishnamurthy N. (1975). Studies on Indian pickles Part IV. Physicochemical variations of some important varieties of mangoes. *Ind. Food Packer*, **29(3)**, 55-61.

Serano, M., Castillo S., Valverde J.M., Martinez-Romero D., Guillean F. and Valero D. (2006). Use of *Aloe vera* gel coating preserves the functional properties of tablegrapes. *Agric. Food Chem.*, **54**, 3882-86.

Singh, T.K., Singh J. and Singh B.D. (2013). Performance of mango varieties in Kymore plateau of Madhya Pradesh. *Progre. Horti.*, **45(2)**, 269-272.

Sonkar, R.K. and Ladaniya M.S. (1999). Individual film wrapping of Nagpur mandarin (*Citrus reticulate* Blanco.) with heat-shrinkable and stretch-cling films for refrigerated storage. *J. Food Sci. Technol.*, **36**, 273–276.

Subramanyam, H., Krishnamurthy S. and Parpia H.A.B. (1975). Physiologyand biochemistry of mango fruit. *Adv. Food Res*., **21**, 223-305.

Sudhakar Rao, D.V. and Gopalakrishna Rao K.P. (2009). Effect of controlled atmosphere conditions and pre-treatments on ripening behaviour of mangoes stored at low temperature. *J. Food Sci. Technol*., **46**, 300–306.

Teerachaichayut, S. and Yokswad W. (2015). Application of image analysis for determinationof Mangosteen density. **2(2)**, 92-97.

Thommohaway, C., Kanlayanarat S., Uthairatanakij A. and Jitareerat P. (2007). Quality of fresh cut guava (*Psidium guajava* L.) as affected by chitosan treatment. In: *Int. Confer. Qual. Manag. Fresh Cut Prod*., **746**, 449-454.

Tripathi, P. and Dubey N.K. (2004). Exploitation of natural products as an alternative strategy to control post - harvest fungal rotting of fruit and vegetables. *Postharvest Biol. Technol.*, **32**, 235-45.

Valvede, J.M., Valero D., Martinez-Romero D., Guillen F., Castillo S. and Serrano M. (2005). Novel coating based on *Aloe vera* gel to maintain table grape quality andsafety. *Agric. Food Chem.,* **53**, 780-781.

Vasugi, C., Dinesh M.R., Sekar K., Shivashankara K.S., Padmakar B. and Ravishankar K.V. (2012). Genetic diversity in unique indigenous mango accessions (Apemidi) of the Western Ghats for certain fruit characteristics. *Curr. Sci.*, **103(2)**, 199-207.

Waskar, D.P. and Gaikwad R.S. (2005). Effect of various postharvest treatments on extension of shelf-life of Kesar mango fruits. *Ind. J. Agric. Res.*, **39 (2)**, 95 –102.

Wills, R.B.H. and Rigney C.J. (1979). Effect ofcalcium on activity of mitochondria and pectic enzymes isolated from tomato fruits. *J. Food Biochem.,* **3**, 103.

Yadav, M., Kumar N., Singh D.B. and Singh G. (2010). Effect of postharvest treatments on shelf-life and quality of Kinnow mandarin. *Ind. J. Hort.,* **67**, 243-248.

Yahia, E.M. (1998). *Postharvest handling of mangoes*. Technical Report. Agricultural Technology Utilization and Transfer Project, Giza, Egypt.

Yaman, O. and Bayoindirli L. (2002). Effects of an edible coating and cold storage on shelf-life and quality of cherries. *Lebnsm. - Wiss. Und. Technol.*, 35: 46-150.

Yuen, C.M.C., Tan S.C., Joyce D. and Chettri P. (1993). Effect of postharvest calcium and polymeric films on ripening and peel injury in Kensington Pride mango. *ASEAN Food J*., **8**, 110-813.

Yuniarti, U.A. and Suhardi S. (1992). Ripening retardation of arumanis mango. *J. Asian Food*, **7(4)**, 207-208.

Zafrul, H., Islam Hera, Morshed and Hassan K. (2020). Effects of Different Coating Materialson Shelf Life and Quality of Mango. *Trends Hortic. Res.*, **10 (1)**, 1-10.