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Ram Preet Singh
Department of Horticulture, College of Agriculture, Central Agricultural University Imphal West, Manipur, India

RK Dilip Singh
Department of Horticulture, College of Agriculture, Central Agricultural University Imphal West, Manipur, India

NG Piloo
Department of Horticulture, College of Agriculture, Central Agricultural University Imphal West, Manipur, India

N Surbala Devi
Department of SSAC, College of Agriculture, Central Agricultural University Imphal West, Manipur, India

N Gopimohan Singh
Department of Basic Science, College of Agriculture, Central Agricultural University Imphal West, Manipur, India

Corresponding Author:
Ram Preet Singh
Department of Horticulture, College of Agriculture, Central Agricultural University Imphal West, Manipur, India

Effect of skin coatings for prolonging of shelf life of immature mangoes (*Mangifera indica* L.) cv. Konsam heinous of Manipur

Ram Preet Singh, RK Dilip Singh, NG Piloo, N Surbala Devi and N Gopimohan Singh

Abstract
The present investigation on "Effect of skin coatings for prolonging shelf life of immature mangoes (*Mangifera indica* L.) cv. Konsam heinous of Manipur" was carried out during month of May-June of the year 2021 at Post Graduate Laboratory, Department of Horticulture, College of Agriculture, Central Agricultural University, Manipur. Freshly harvested uniform sized mango fruits were selected, washed, cleaned and treated with different coatings viz. castor oil(T1), palm oil(T2), coconut oil(T3), mustard oil(T4), aloe vera gel(T5), paraffin wax(T6), cling film(T7) and no- coated(T8) in laboratory. The experiment was framed in CRD (Completely Randomized Design) and repeated 3 times with 7 treatments and an uncoated treatment. The results obtained from the current investigation indicated that fruits treated with cling film (T7) recorded significantly lowest sphysiological loss in weight, specific gravity and marketability with a highest sensory quality during 12-15 days of storage, whereas the fruits coated with paraffin wax (T6) also recorded maximum retention of marketability with minimum spoilage and maximum shelf-life up to 15th days of stored under ambient condition.

Keywords: CRD, immature, marketability, coating, storage, experiment etc.

1. Introduction
Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae and originated in the Indo-Burma region (Subramanyam *et al*. 1975) [6]. It is one of the choicest fruits in the world (Joshi *et al*. 2013) [3] 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) [7]. 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) [5].

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) [1].

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 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) [8]. Nanda *et al*. (2012) [4] 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.

2. Materials and Methods

2.1 Physiological loss in weight of fruits

The loss in weight of mango fruits was recorded on the basis of their initial weight. After each interval weight of the fruits were recorded and per cent of physiological loss in weight (PLW) was obtained by noting both initial weight and final weight of mango.

2.2 Specific gravity

2.3 Sensory quality

Amerine *et al.* (1965) described the sensory quality evaluation on the basis of different quality attributes of fruits. The mango fruits were evaluated for sensory qualities by the panel of five judges and rated as per '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

2.4 Color (Peel and Flesh)

Fruits from each replication were randomly selected for peel and pulp color. The determination of color of fruits were carried out by noting color from different sides of each sample by using a sensory evaluation and rated as per hedonic scale (1-5); for peal

1. Dark green,
2. Light green,
3. Slightly yellowish,
4. 50% to 70% yellow,
5. Totally yellow; for flesh

1. Totally white
2. Slight yellowish
3. 50% Yellow
4. 75% Yellow
5. Totally yellow.

2.5 Spoilage percentage

The spoilage percentage was obtained based on number of fruits which got spoiled as well as total number of fruits on every storage interval period. The spoilage (%) was calculated.

2.6 Marketable Fruit

The marketable percentage of fruits was recorded during storage period by counting the number of fruits that attained the eating stage by visual observations at room temperature. It was expressed as percentage over the total number of fruits.

3. Tables, Figures and Equations

3.1 Tables and Figures

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

Treatment	Physiological loss in weight (%) Storage interval (days)			
	0 Day	5 Day	10 Day	15Day
T1 (Castor oil)	0.00	3.09	4.34	5.56
T2 (Palm oil)	0.00	3.71	5.15	6.80
T3 (Coconut oil)	0.00	3.22	4.44	5.98
T4 (Mustard oil)	0.00	3.28	4.56	6.56
T5 (Aloe vera gel)	0.00	3.40	4.77	6.82
T6 (Paraffin wax)	0.00	1.48	2.15	3.20
T7 (Cling film)	0.00	1.05	1.80	3.04
T8 (No coating)	0.00	3.93	5.50	7.62
SEM	0	0.09	0.18	0.40
CD 5%	0	0.28	0.55	1.21

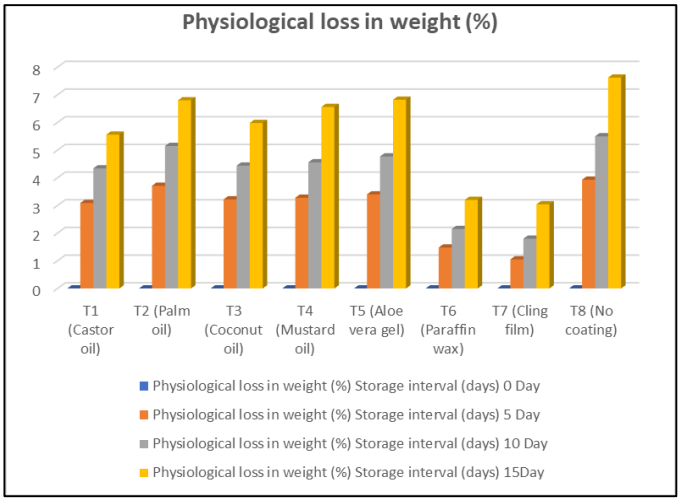

Fig 1: Effect of coating treatments on physiological loss in weight (%) of mango.

Table 2: Effect of coating treatments on specific gravity (g/cm^3) of local mango during different days of storage.

Treatment	Specific Gravity Storage interval (days)			
	0 Day	5 Day	10 Day	15Day
T_1 (Castor oil)	0.94	0.94	0.95	1.01
T_2 (Palm oil)	0.95	0.96	0.99	1.03
T_3 (Coconut oil)	0.95	0.96	0.97	1.02
T_4 (Mustard oil)	0.94	0.95	0.97	1.02
T_5 (Aloe vera gel)	0.95	0.96	0.98	1.03
T_6 (Paraffin wax)	0.94	0.94	0.95	1.00
T_7 (Cling film)	0.93	0.93	0.94	0.98
T_8 (No coating)	0.94	0.97	1.02	1.04
SEM	0.008	0.006	0.008	0.003
CD 5%	NS	0.019	0.024	0.010

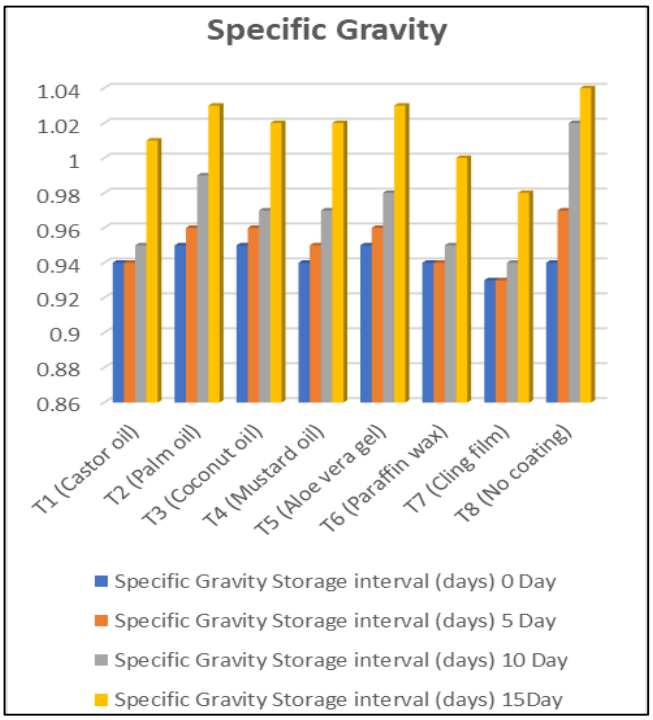

Fig 2: Effect of coating treatments on specific gravity (g/cm^3) of mango.

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

Treatment	Sensory Quality			
	Storage interval (days)			
	0 Day	5 Day	10 Day	15Day
T1(Castor oil)	9.00	8.93	5.93	2.60
T2(Palm oil)	9.00	8.93	7.27	6.33
T3(Coconut oil)	9.00	8.60	6.67	5.87
T4(Mustard oil)	9.00	8.53	6.47	6.27
T5(Aloe vera gel)	9.00	8.67	6.27	6.40
T6(Paraffin wax)	9.00	8.93	7.27	6.47
T7(Cling film)	9.00	9.00	7.33	6.60
T8(No coating)	9.00	8.80	5.80	2.33
SEM	0	0.10	0.09	0.5
CD 5%	0	0.29	0.28	1.51

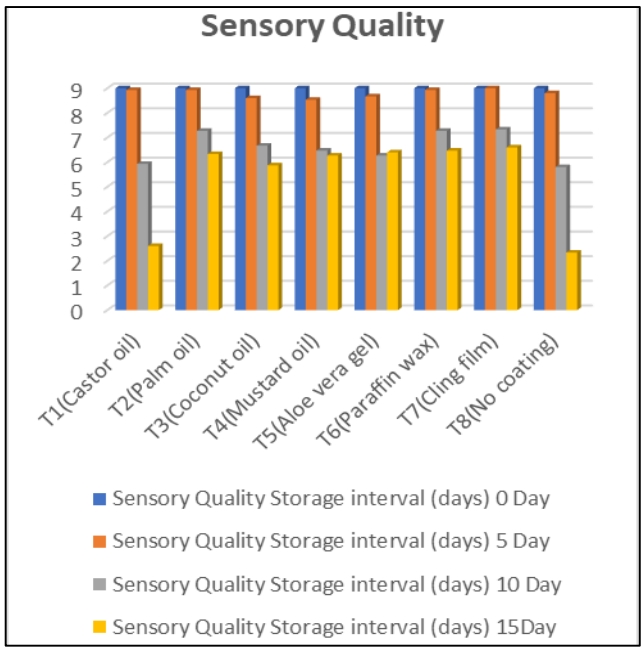

Fig 3: Effect of coating treatments on sensory quality of mango.

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

Treatment	Fruit color (Peel)			
	Storage interval (days)			
	0 Day	5 Day	10 Day	15Day
T1(Castor oil)	1.00	1.20	3.40	4.60
T2(Palm oil)	1.00	1.30	3.00	3.80
T3(Coconut oil)	1.00	1.50	3.30	3.80
T4(Mustard oil)	1.00	1.30	3.40	4.00
T5(Aloe vera gel)	1.00	1.30	3.70	3.50
T6(Paraffin wax)	1.00	1.20	2.80	3.50
T7(Cling film)	1.00	1.10	2.50	3.10
T8(No coating)	1.00	1.40	3.60	4.70
SEM	0	0.07	0.12	0.19
CD 5%	0	0.22	0.36	0.57

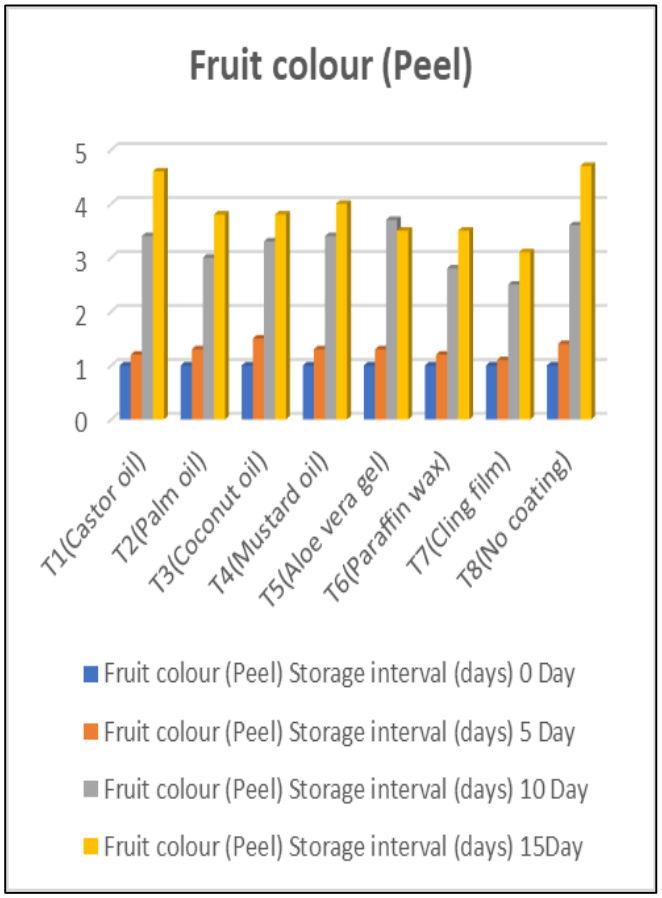

Fig 4(a): Effect of coating treatments on fruit colour (peel) of local mango.

Table 4(b): Effect of coating treatments on fruit color (flesh) of local mango during different days of storage.

Treatment	Fruit color (Flesh)			
	Storage interval (days)			
	0 Day	5 Day	10 Day	15Day
T1(Castor oil)	1.00	1.80	2.80	4.60
T2(Palm oil)	1.00	1.60	2.60	3.53
T3(Coconut oil)	1.00	1.60	2.66	3.66
T4(Mustard oil)	1.00	1.60	2.60	3.60
T5(Aloe vera gel)	1.00	1.73	2.80	3.73
T6(Paraffin wax)	1.00	1.40	2.46	3.26
T7(Cling film)	1.00	1.26	2.33	3.06
T8(No coating)	1.00	1.86	3.13	4.80
SEM	0	0.14	0.09	0.08
CD 5%	0	NS	0.28	0.26

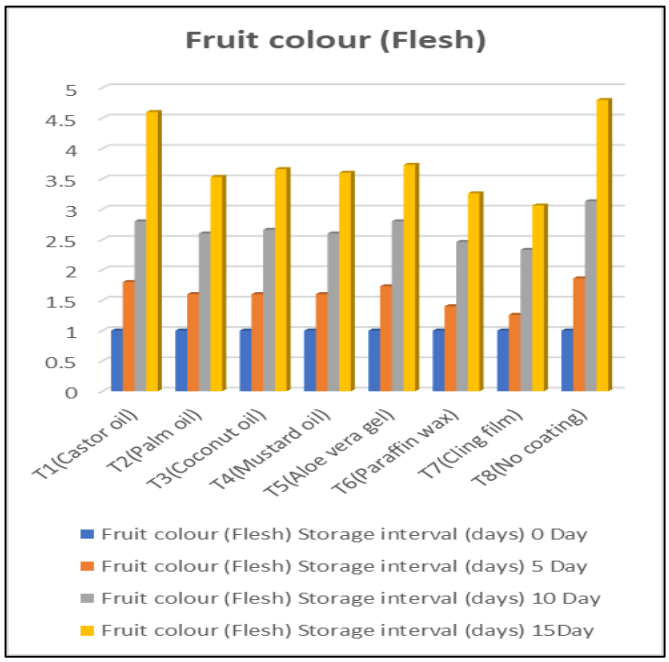

Fig 4.1.5(b): Effect of coating treatments on fruit color (flesh) of mango.

Table 5: Effect of coating treatments on spoilage of local mango during different days of storage.

Treatment	Spoilage (%) Storage interval (days)			
	0 Day	5 Day	10 Day	15Day
T1 (Castor oil)	0.00	0.00	2.63	33.33
T2 (Palm oil)	0.00	0.00	3.60	45.83
T3 (Coconut oil)	0.00	0.00	2.63	37.50
T4 (Mustard oil)	0.00	0.00	2.63	41.66
T5 (Aloe vera gel)	0.00	0.00	2.63	41.66
T6 (Paraffin wax)	0.00	0.00	0.70	29.16
T7 (Cling film)	0.00	0.00	0.70	20.83
T8 (No coating)	0.00	0.00	5.04	49.33
SEM	0	0	0.68	5.005
CD 5%	0	0	2.04	15.006

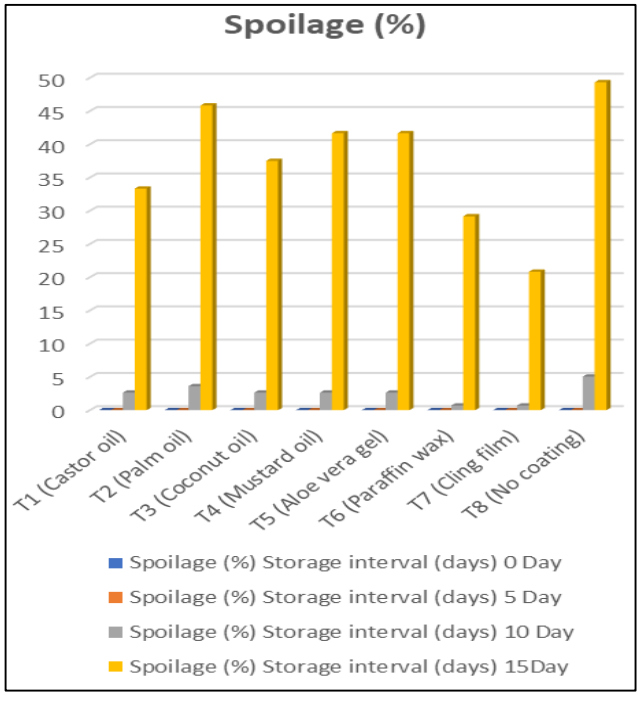

Fig 5: Effect of coating treatments on spoilage of local mango.

Table 6: Effect of coating treatments on marketability (%) of mango during different days of storage.

Treatment	Marketable Fruit (%) Storage interval (days)			
	0 Day	5 Day	10 Day	15Day
T1(Castor oil)	100.00	100.00	7.88	6.47
T2(Palm oil)	100.00	100.00	5.42	4.08
T3(Coconut oil)	100.00	100.00	6.47	5.04
T4(Mustard oil)	100.00	100.00	6.10	4.08
T5(Aloe vera gel)	100.00	100.00	5.79	4.08
T6(Paraffin wax)	100.00	100.00	10.02	6.79
T7(Cling film)	100.00	100.00	10.02	7.02
T8(No coating)	100.00	100.00	4.56	2.63
SEM	0	0	0.83	0.50
CD 5%	0	0	2.49	1.51

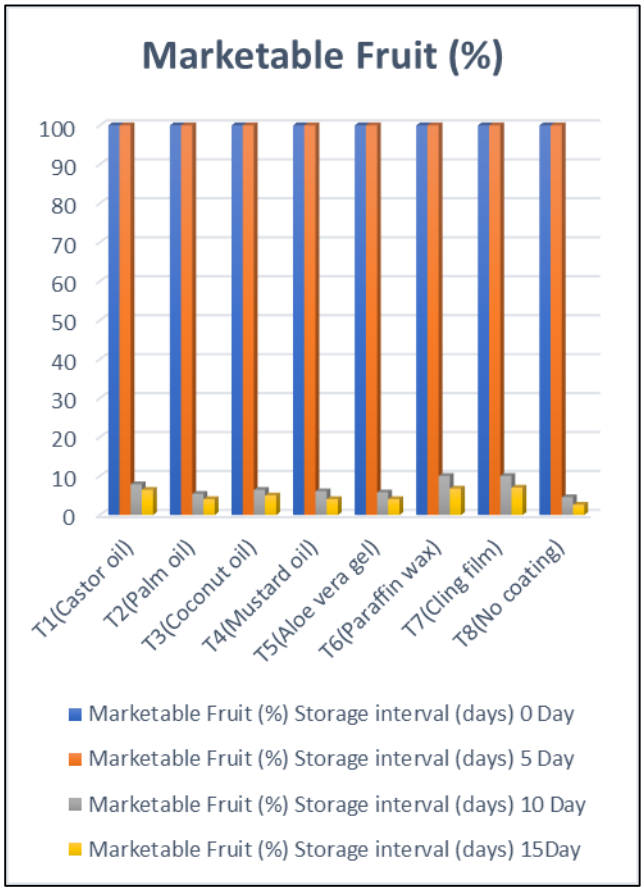

Fig 6: Effect of coating treatments on marketability (%) of mango.

3.2 Equations

3.2.1 Physiological loss in weight of fruits

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

3.2.2 Specific gravity

It will be calculated as below

$$\text{Specific gravity } (g/cm^3) = \frac{\text{Weight of fruit (g)}}{\text{Volume of water displaced } (cm^3)}$$

3.2.3 Sensory quality

Hedonic Scale (1-9 points;

1. 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.

3.2.4 Colour (Peel and Flesh)

Hedonic scale (1-5); for peal

1. Dark green,
2. Light green,
3. Slightly yellowish,
4. 50% to 70% yellow,
5. Totally yellow; for flesh

1. Totally white,
2. Slight yellowish,
3. 50% Yellow,
4. 75% Yellow,
5. Totally yellow.

3.2.5 Spoilage percentage

$$\text{Spoilage (\%)} = \frac{\text{Spoiled fruits}}{\text{Total fruits}} \times 100$$

3.2.6 Marketable Fruit

The marketable percentage of fruits was recorded during storage period by counting the number of fruits that attained the eating stage by visual observations at room temperature. It was expressed as percentage over the total number of fruits.

4. Conclusions

The application of cling film & paraffin wax was found to be better in minimising PLW, spoilage, maintenance the fruit colour and also demonstrated a good marketability in the current study. Cling film and paraffin wax coated fruits had an extended shelf life of around 12-15 days with good sensory score and marketability.

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