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Effect of beeswax and hydroxypropyl methylcellulose coatings on physical paramaters of guava cv. Shweta under ambient conditions

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Abstract
The study entitled Effect of beeswax and hydroxypropyl methylcellulose coatings on Physical paramaters of guava cv. Shweta under ambient conditions. The winter fruits of guava cv. Shweta coated with hydroxypropyl methyl cellulose (5%, 10%), beeswax (3%, 6%, 9%) and their combinations, packed in CFB boxes and kept at room temperature in month of December. The uncoated fruits (T_{12}-control) packed in CFB boxes were also included in experiment for comparison. The guava fruits coated with HPMC 10% + beeswax 9% had recorded significantly lower mean physiological loss in weight (3.13%) as compared to control (PLW 6.16%). Likewise, HPMC 10% + beeswax 9% had exhibited highest mean fruit firmness (18.78 Ibf) as compared to others treatments. After 7-days of ambient storage, significantly higher organoleptic rating (8.35) was observed in treatment (T_{11}) in which HPMC 10% + beeswax 9%, coatings were applied as compared to control. The untreated fruits had the highest rate of deterioration (spoilage %), whereas all coatings applied fruits had significantly lower spoilage with minimum mean spoilage (2.28%) under ambient storage conditions. Hence, the study revealed that the fruits of winter guava cv. Shweta applied with HPMC 10% + beeswax 9% coatings can be stored for 7-9 days under ambient conditions.

Keywords: Ambient conditions, edible coating, HPMC, beeswax, guava, shelf life

1. Introduction
Guava (*Psidium guajava)* is a drought-tolerant tropical tree or shrub. It is a popular fruit known for its nutritional value across the world. The guava is a fruit that grows wild in tropical America. In the seventeenth century, it was brought to India. In India, the best quality guavas are produced in Allahabad and its adjoining areas in Uttar Pradesh. The winter crop is of very high quality. Guava is a climacteric fruit, with a fast physiological metabolism, high respiratory rate, and quick maturation, necessitating a quick commercialization time. (Jacomino, Ojeda, Kluge, & Scarpare Filho, 2003) [7]

The abundance of dietary fiber makes it a natural fruit that can satisfy the daily requirement for fiber (Jimenez-Escrig *et al*., 2001) [8] Guava has a high-quality supply of antioxidants like phenols and vitamin C (Ascorbic acid) and the peel has a higher concentration of Vitamin C and phenols than the pulp (Bashir & Abu-Goukh, 2003) [2] Fruit's respiration and ethylene production are at their peaks during ripening. Hence, it is a very transient fruit, undergoes quick ripening after harvest under room conditions, and degrades in a few days. Thus, despite its good nutritional composition, the commerce of guava fruit at the world level is limited due to its subtle nature, short life after harvest, and sensitivity to chilling injury and pathogens (Brown & Wills, 1983) [3] The edible coatings are applied directly to the surface of the fruit, consisting of thin membranes that are invisible to the naked eye. They can carry natural additives and are important in extending the shelf life of foods as they enhance the protective action of the fruit epidermis in preventing water loss, color changes, mechanical lesions, and even microbial deterioration, and generally give the surface a glossy appearance (Assis & Britto, 2014; Santos *et al*., 2018) [1] Coatings based on cellulose derivatives (hydroxypropyl methylcellulose) are specially formulated to reduce the exchanges of O_2 and CO_2, delaying fruit ripening. These types of coatings fit appropriately with guava characteristics, controlling the respiratory rate and delaying fruit maturation. Lipid-based coatings are generally used to produce good barriers to moisture. Among lipid materials, beeswax is often used to improve the characteristics of other coatings that lack the function of a moisture barrier (Fagundes,

Pérez-Gago, Monteiro & Palou, 2013) [6] In this aspect, this study aimed to evaluate the effect of edible coatings based on HPMC and beeswax to enhance the shelf life of guava cv Shweta under ambient conditions.

2. Materials and Methods

2.1 Edible coatings

Coatings were prepared according to Navarro-Tarazaga, Massa, & Pérez-Gago (2011), with modifications. The HPMC Coating of 5(%) and 10 (%) concentration was made by dissolving 5 gram and 10 gram of HPMC in 100 milliliter of water similarly beeswax coatings of 3%, 6% and 9% were made and mixtures from it prepared by dissolving them. Stearic acid (SA) (Synth, Brazil) was added as an emulsifier in the ratio of 5:1 (BW:SA) (db) and glycerol (Synth, Brazil) as the plasticizer in a ratio of 2:1 (HPMC: glycerol) (db). The mixture was heated in a microwave oven at 90 ± 2 °C and homogenized for 1 min at 968 g and 3 min at 3871 g in a bench homogenizer (Marconi, model MA 102). The solution was cooled in an ice bath at 20 °C, allowed to stand for 45 min, and stored under refrigeration.

2.2 Fruits

Appropriate plants were selected and fruits from it are harvested in the month of December. Mature fruits of uniform size and free from scares and spots were harvested and collected in cushioned plastic crates and sent to P.G. Laboratory situated at the department of Fruit Science, Punjab Agricultural University, Ludhiana. Fruits were sorted, graded and then washed with running water. Afterward fruits were subjected to chlorine (100 ppm) treatment as dipping for 5 minutes in solution.

2.3 Treatments

Table below shows treatments of HPMC and Beeswax and their different mixtures. After coating fruits were stored in CFB boxes having proper aeration in room conditions at temperature of 25 °C and 75% RH.

Treatments

S. No.	Treatment	Concentration
T_1	HPMC	5%
T_2	HPMC	10%
T_3	BEESWAX	3%
T_4	BEESWAX	6.%
T_5	BEESWAX	9.%
T_6	HPMC + BEES WAX	5% + 3%
T_7	HPMC + BEESWAX	5% + 6%
T_8	HPMC + BEESWAX	5%+ 9%
T_9	HPMC + BEESWAX	10% + 3%
T_{10}	HPMC + BEESWAX	10% + 6%
T_{11}	HPMC + BEESWAX	10% + 9%
T_{12}	CONTROL (Untreated fruits)	_____

2.4 Experimental design

The RBD (randomized block design) with factorial arrangement was used to conduct research work. Data obtained from research was used to work out treatment mean values, two way ANOVA (Analysis of variance) and LSD (Least significant difference) between mean values at a significance level of $p \leq 0.05$ by using the Statistical Analysis System 9.3 (S.A.S. Institute Inc., Cary, NC, USA).

3. Physical Parameters

3.1 Physiological loss in weight

Reading of initial weight and final weight of fruits were taken and PLW was calculated by the formula

$$\text{PLW} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} X\ 100$$

3.2 Firmness

Fruit firmness was recorded by using "Penetrometer" (Model FT-327, QA Supplies, Norfolk, VA, USA). The device has probe (8mm diameter) made of stainless steel which was used to penetrate into a peeled guava flesh and force used was recorded as pound-force (lbf).

3.3 Spoilage

The total number of guava fruits each replication was counted, and the spoilage (stated as a percentage) was computed using the formula

$$\text{Spoilage} = \frac{\text{No of spoiled fruits}}{\text{Total number of fruits}} \text{ X } 100$$

3.4 Colour

Two fruit colour reading was taken per fruit from opposite sides. From each replication 3 fruits are picked for analysation without any bias and then average was noted as final reading. The color Difference Meter (Model: Mini Scan XE Plus, Made: Hunter Lab, USA) was used for taking readings and expressed in terms L, a, b Hunter colour values (Hunter, 1975).

3.5 Organoleptic rating

A team of 6 members was requested to measure palatability rating of fruits on hedonic scale on basis of sensory parameters like aroma, flavor, texture and external look Amerine *et al*., (1965).

5. Results

5.1 Physiological loss in weight

The rate of loss in weight is slow in the fruits treated with edible coatings than the untreated fruits. Not more than 5 percent weight loss was seen in treated fruits up to five days of storage whereas in control (7.29%) loss in weight was recorded. The treatment HPMC 10% + Beeswax 9% registered the least amount of weight loss after five days under ambient storage conditions (3.27%). At the end of the experiment, fruits coated with HPMC 10% + Beeswax 9%

exhibited minimum mean loss in weight (3.13%) which was significant better than weight loss observed in HPMC 10% + Beeswax 6% (4.17%) treatment. The maximum mean PLW (6.16%) was registered in the control fruits under ambient storage conditions respectively.

5.2 Spoilage

There was no occurrence of spoilage in fruits under any treatment up to five days under room conditions. At the end of experiment Beeswax 9% + HPMC 10% treated fruits had lowest average spoilage (2.28%) under ambient conditions which was significantly better than all other treatments. The HPMC 10% + beeswax 6% (2.92%) is emerged as second best treatment w.r.t. lowering spoilage percentage Average spoilage was highest in control fruits (10.45%) followed by HPMC 5% (5.74%).

5.3 Firmness

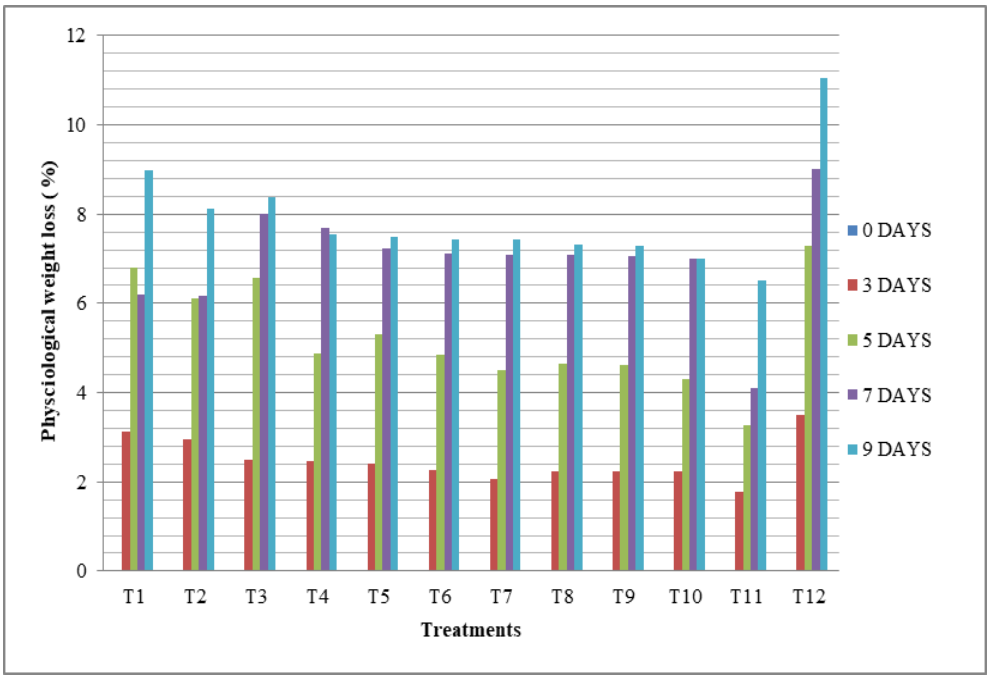
The value of firmness obtained on the day of harvest is (23 Ibf). After five days of storage the highest decrease in firmness (41.31 lbf) was observed in control fruits and lowest fruit firmness (20.87 lbf) was observed in HPMC 10% + Beeswax 9%. Highest mean value of fruit firmness was recorded in fruits treated with HPMC 10% + beeswax 9% (18.78 lbf) followed by HPMC 10% + beeswax 6% (17.97 lbf) which was statistically at par with HPMC 10% + beeswax 3% under ambient conditions. Fruits without any treatment have lowest mean value of firmness (15.82 Ibf) which is significantly lower than all other treatments.

5.4 Fruit color

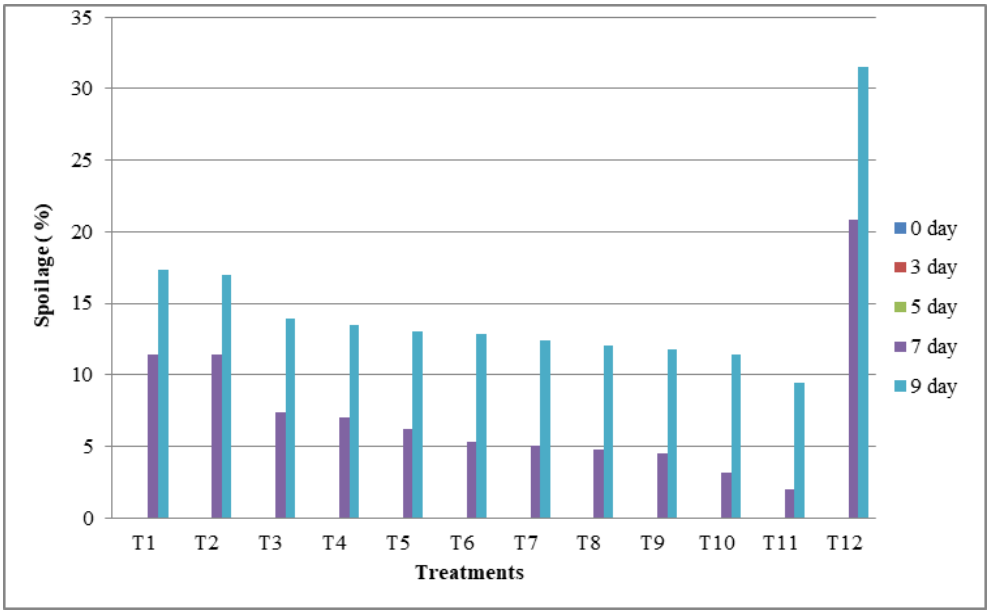
Control fruits have the highest mean value of lightness (L value) under ambient conditions (68.36), followed by Beeswax 3 percent (68.04), Beeswax 6 percent, and Beeswax 9 percent, which are all statistically at par, and HPMC 5 percent + beeswax 6 percent has the lowest value (64.84). For "A" value the average maximum value for untreated fruit (3.286) is significantly higher than mean values for treated fruits, and the maximum value for greenness is attained in HPMC 10% + beeswax 3% and HPMC 10% + beeswax 3% treated fruits. Control fruits retained green color for 3 days only whereas HPMC 10% + Beeswax 6% treated fruits became yellowish on 5^{h} day of storage. Under ambient storage a steady increase in the 'b' value is found in control fruits samples and various treatments. The increase in 'b' value is due to degradation of chlorophyll pigment and production of carotenoids. Highest 'b' value has observed in control fruits (47.978) and minimum value of 'b' was observed in HPMC 10% + beeswax 6% followed by HPMC 10% and Beeswax 9% (33.84 and 34.09) under ambient storage conditions.

5.5 Organoleptic Rating

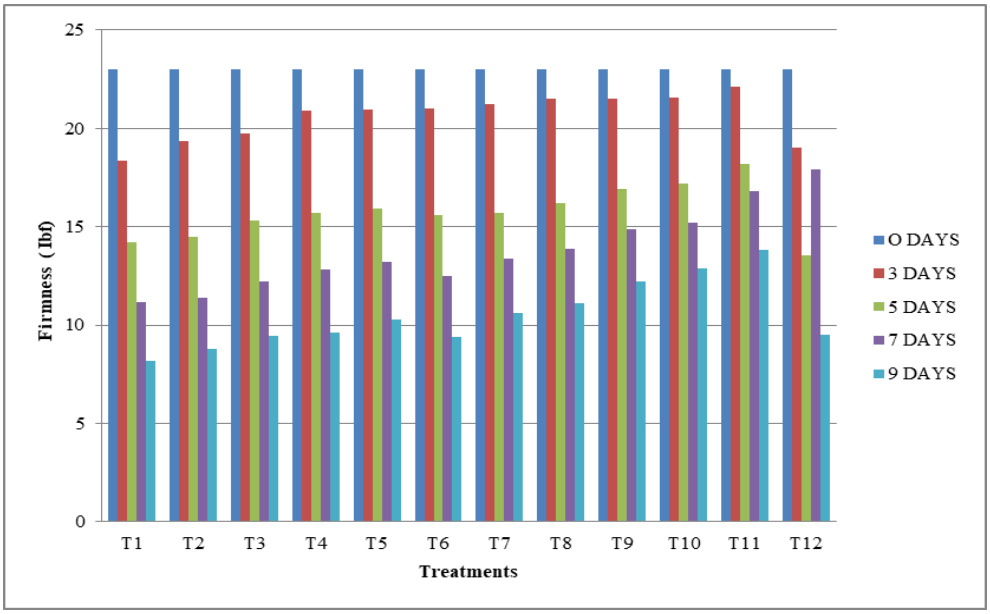
After five days maximum value of organoleptic rating obtained in treatment HPMC 10% + beeswax 9% (8.34). The fruit remained palatable under ambient conditions until the fifth day of storage, after which it dropped in all treatments, but more noticeably in control fruits. From the 5th (8.1) to the 9th (5.3) day of storage, the palatability of control fruits decreased dramatically.



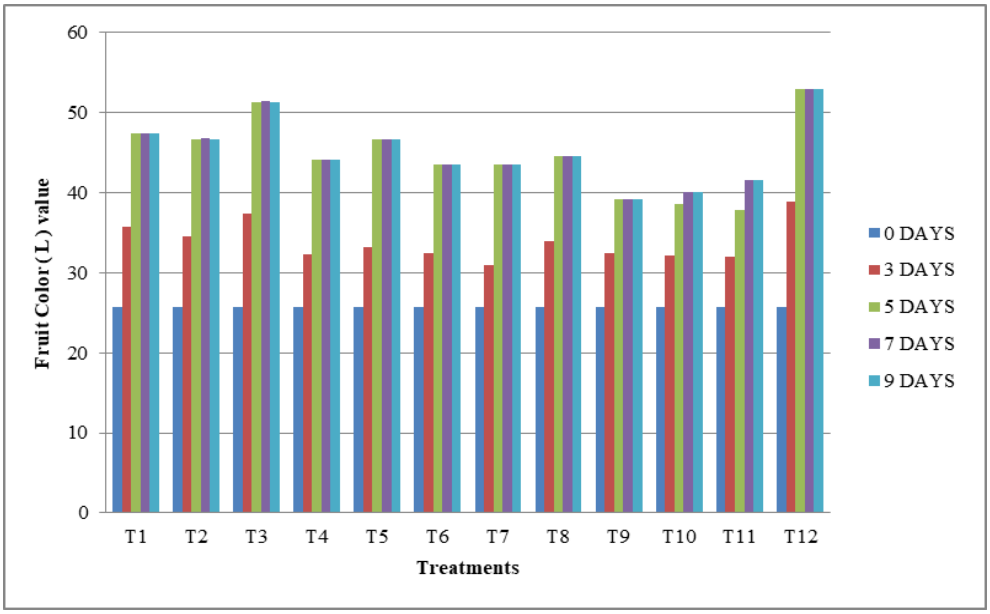
(A)


35
30
25
20
15
10
5
0
Spoilage (%)
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
Treatments
0 day
3 day
5 day
7 day
9 day

(B)

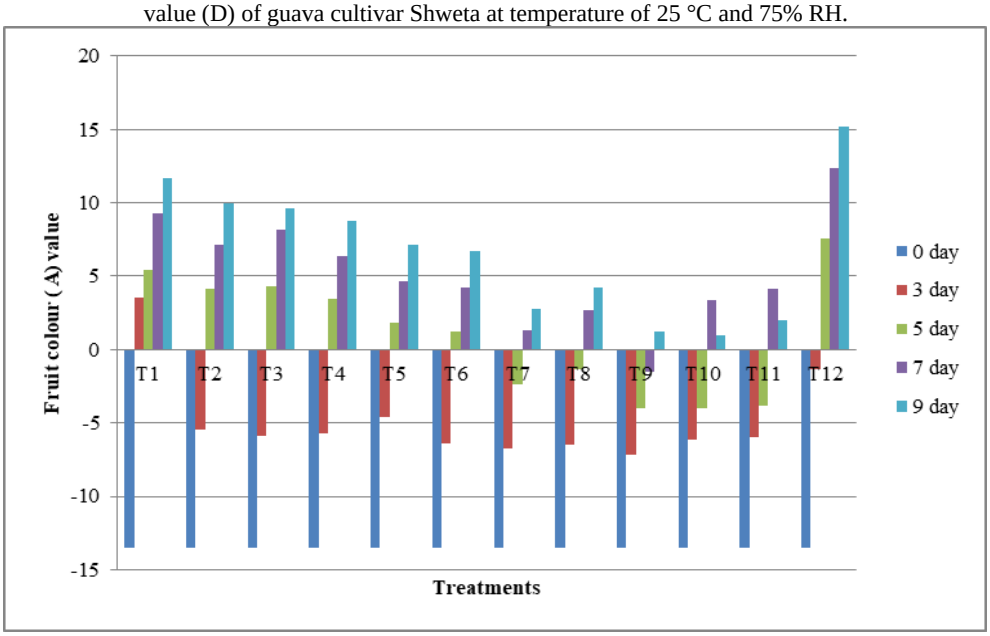

25
20
15
10
5
0
Firmness (lbf)
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
Treatments
O DAYS
3 DAYS
5 DAYS
7 DAYS
9 DAYS

(C)

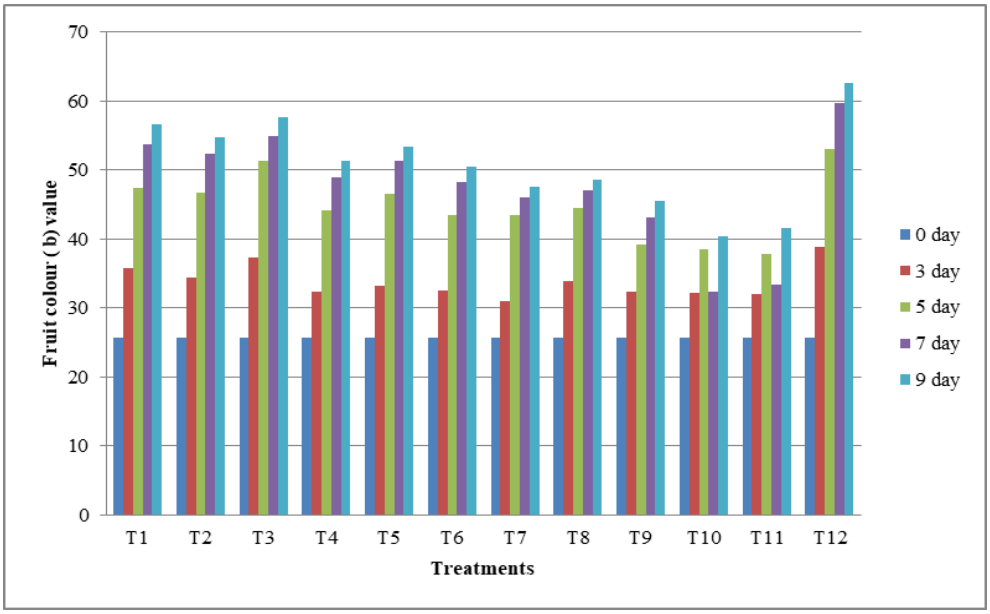


(D)

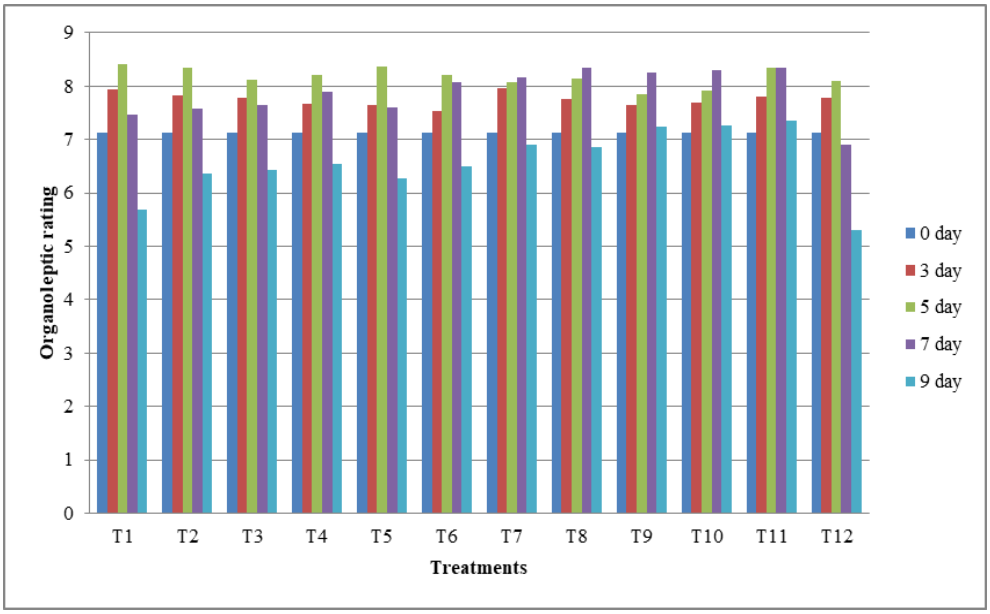
Fig 1: Effect of HPMC and beeswax based edible coatings on Physiological loss in weight (A), Spoilage (B) , firmness (C), fruit color ' L ' value (D) of guava cultivar Shweta at temperature of 25 °C and 75% RH.



(E)



(F)



(G)

Fig 2: Effect of HPMC and beeswax based edible coatings on Fruit color ('A') value (E), (B) VALUE (F) and organoleptic rating (G), of guava cultivar Shweta at temperature of 25 °C and 75% RH.

6. Discussion

The physiological loss in weight is mainly due to evaporation of water from the fruits. Control fruits have the highest rate of PLW as compared to coated fruits, which could be due to higher moisture loss and enhanced respiration due to an uninterrupted air column and lower relative humidity (Pongener *et al.* 2011) [11] Paliyath and Subramanian (2008) [10] reported that the lipid disintegration or degradation is the region behind loss of firmness in uncontrolled and fast manner which leads to quick deterioration of fruit and low shelf-life. The development of better appearance in the wax coated fruits could be possibly due to creation of favorable gaseous atmosphere under congenial temperature. Present study is in close conformity with the findings of Ladaniya (1997) [9] in Mosambi sweet orange where the wax coated fruits had better appearance as compared to other fruits, study is also in close conformity with the findings of Predieri *et al.* (2006) [12] in peach. After the fruit is harvested, it continues to respire and undergoes biochemical changes, resulting in fruit softening and deterioration, which eventually leads to spoiling. Presence of microbes and injury over fruit skin leads to increase in incidence of spoilage so external application of waxes replenish the natural wax cover of fruit, heal wounds, limit growth of microbes thus ultimately reducing spoilage. The results are in line with study of Eshetu *et al* (2019) [5] that reported 2.0% beeswax coated fruits of mango shown reduced incidence of spoilage.

7. Conclusion

Coatings of Hydroxypropyl methylcellulose (HPMC) and Beeswax has positive impact to increase the shelf life of Guava cv. Shweta. Coated fruits remain greener, firmer and turgid after nine days of storage at room temperature. HPMC 10% + Beeswax 9% give the best result in enhancing shelf life and maintain fruit quality.

8. Acknowledgment
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