International Journal of Plant & Soil Science

Volume 35, Issue 14, Page 1-12, 2023; Article no.IJPSS.100160
ISSN: 2320-7035

Effect of Chitosan on Storage Behaviour of Sapota *Manilkara achras* (Mill) fosberg cv. 'Kalipatti'

M. M. Saste [a++*], J. H. Kadam [b#] and P. P. Relekar [a†]

[a] Post Harvest Management in Fruits, Vegetable and Flower Crops, Post Graduate Institute of Post Harvest Technology and Management, Killa-Roha, India.
[b] Post Harvest Management of Medicinal, Aromatic, Plantation, Spices and Forest Crops, Post Graduate Institute of Post Harvest Technology and Management, Killa-Roha, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i143012

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/100160

Original Research Article

Received: 12/03/2023
Accepted: 16/05/2023
Published: 26/05/2023

ABSTRACT

The present study was undertaken to study the effect of chitosan treatments on the storage behaviour of sapota *Manilkara achras* (Mill) fosberg cv. Kalipatti is stored at ambient temperature. The climacteric rise in sapota fruits shortens the postharvest life and degrades the quality of the fruits. A polysaccharide like a chitosan has been used as an edible coating to extend the storage life of sapota fruits, which is an innovative approach for fruit preservation and sustainable development. Chitosan-based coatings have tremendous potential in several fruits to extend the shelf-life. An investigation was carried out to know the effectiveness of post-harvest treatments with edible coatings (0.5%, 1%, 1.5%, and 2% chitosan) compared with the control. 1% chitosan coating resulted in maximum fruits (more than 75%) having a shelf life of 7 days under ambient condition

[++] M.Sc PHM;
[#] Associate Professor;
[†] Head of Department;
**Corresponding author: E-mail: meghanasaste1682@gmail.com;*

which was at par with 1.5% chitosan coating. Chitosan coating reduced the physiological losses in weight as compared to the uncoated fruits. The maximum retention of physical parameters such as fruit firmness, specific gravity, colour L*, a* and b* values as well as slow ripening and less spoilage behaviour was observed in chitosan-coated sapota fruits.

Keywords: Sapota; chitosan; physical parameters; shelf life.

1. INTRODUCTION

Sapota (*Manilkara achras)* is a tropical fruit native to Mexico and Central America and belongs to the family Sapotaceae. It is a climacteric fruit which requires ethylene to ripen due to which it gets ripens within 3-5 days after harvest [1]. Sapota is referred to by many names, including chico, sapodilla, lamut, and chicle, among others. Fruits from it are almost available around the year. It is robust, extremely productive, and typically free of harmful pests, illnesses, and physiological issues. As a result, it has become a significant fruit crop that is widely grown in India.

In India, sapota ranks fifth both in production and consumption next tomango, banana, citrus and grapes [2]. Sapota is grown mainly in coastal areas such as Maharashtra, Gujarat, Karnataka and Tamil Nadu. It is consumed mostly indigenously. Sapota contains various important nutrients which have certain health benefits [3]. The fruits have an appreciable amount of protein, fat, fibre, calcium, phosphorus, iron, carotene and vitamin C. It is also rich in bio-iron required for the formation of haemoglobin [4].

Fruits like sapota have a very short shelf life when stored in ambient conditions because they are highly perishable. Furthermore, it is delicate to cold storage [5]. Fruit post-harvest losses are high in tropical countries like India, ranging between 25 and 30%. The respiration rate and ethylene production significantly increase during ripening, which happens quickly. All of these which classify it as a fruit with a very short shelf life and high perishability, making its commercialization more challenging [6].

With their strong climacteric ripening behaviour and high perishability, sapota fruit must be handled carefully after harvest to transport to distant markets in the best possible condition. The postharvest quality and shelf life of sapota fruits are affected by pre-harvest factors like plant nutrition and post-harvest factors like storage conditions, and packaging [7].

Chitosan plays a vital role in the post-harvest management of horticultural crops by minimizing post-harvest losses and enhancing the quality of produce. Chitosan is currently employed in post-harvest fruit preservation. The main advantages of edible active coatings are to preserve the quality, increase the shelf life, and guard against the microbiological decomposition of fresh fruits. The chemical compound chitosan has a wide range of possible uses in the chemical, biological, food, pharmaceutical, and medical industries. Because of its film-forming abilities, antibacterial effects, lack of toxicity, biodegradability, and biochemical features, chitosan one of the finest nutritionally and physiologically safe preservative coatings for various sorts of foods. Permeable films on fruit surface, modify the fruits internal atmosphere, regulate gas exchange, reduce transpiration losses, delay the ripening, and maintain the quality of harvested fruit [8]

The chitosan-based edible coating with a known allergen on the food products should be clearly understood and labelled. This is because of chitosan coating with many kinds of antimicrobial agents is made from ingredients that might cause the allergic reaction on the surface of fruits and vegetables [9].

2. MATERIALS AND METHODS

The present investigation entitled Study on the effect of chitosan on storage behaviour of sapota [*Manilkaraachras* (Mill) Forsberg] cv. ‘Kalipatti’ was undertaken at the Laboratory of the Department of Post Harvest Management of Fruit, Vegetable and Flower Crops, Post Graduate Institute of Post Harvest Technology and Management (PGI-PHTM), Killa-Roha, Dist-Raigad (Maharashtra State) during the year 2021-22. The experiment was laid out in a Completely Randomized Design (CRD) with four replications (25 fruits / replication). There were five treatments viz., T_1: Control, T_2: 0.5% Chitosan, T_3: 1% Chitosan, T_4: 1.5% Chitosan and T_5: 2% Chitosan under ambient conditions.

2.1 Edible Coating Preparation and Fruit Treatment

The chitosan solution having a concentration of 7% was purchased from the market. Chitosan solution of different concentrations i.e., 0.5, 1.0, 1.5, and 2.0 per cent w/v was made. Solutions were homogenously mixed with the use of a hot magnetic stirrer 1200rpm for 5 minutes each. The freshly harvested fruits were washed in water, dried, and dipped in a coating solution for five min followed by air drying. After surface drying, the fruits of each treatment were kept in cardboard boxes of previously placed in the laboratory of PGI-PHTM of the FVF Department at ambient storage conditions. During storage, the fruits were observed daily (after 24 hrs) for changes in physical and chemical parameters.

2.2 Physical Parameters

Colour

The colour reader (make Konica Minolta, Japan CR-10) was used to determine the skin colour of sapota fruits and expressed as L*, a* and b* values.

2.3 Physiological Weight in Loss (%)

The sapota fruits were weighed initially as well as at each storage interval. The difference between the initial and final weights of fruit was recorded as a complete loss of weight. Results were presented using the standard method of and expressed as a percentage loss of the starting weight [10].

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

2.4 The Specific Gravity of Fruits

Individual fruit was weighed on monoplane sensitive electronic balance. The volume of fruit was determined by the water displacement method using a measuring cylinder and the average volume of 10 fruits was recorded in millilitres (ml). The specific gravity of the fruit was computed by dividing the values of fresh weight of the fruit by that of volume and the average of 10 fruits was calculated by formula.

The specific gravity of fruit = Weight of fruit (g)/ Volume of fruit (ml)

2.5 Fruit Firmness (kg/cm^2)

A total of ten fruits per treatment were observed for fruit firmness and determined by using a fruit pressure tester and recorded at kg/cm^2

2.6 Ripening and Spoilage Pattern

For studying the ripening and spoilage pattern fifty fruits per treatments were observed for stages like unripe, half-ripe, ripe, shrivelled and diseased every alternate day.

2.7 Sensory Evaluation

The fruits treated with various concentrations of chitosan were evaluated for their organoleptic qualities like colour, flavour, texture and overall acceptability on a hedonic scale [11] as given below.

A panel of six judges was selected based on their consistency and reliability of judgment. The panellists were asked to score the differences between the samples by allotting the numbers from 1 to 9, where 1 represented Dislike extremely, 2, Dislike very much, 3, Dislike moderately, 4, Dislike slightly, 5,Neither like nor dislike, 6, Like slightly, 7, Like moderately, 8, Like very much and 9, Like extremely.

3. RESULTS AND DISCUSSION

3.1 Colour

L* value for the colour

The L* in-control decreased from 62.03 to 25.37 while it was better maintained in chitosan-coated fruits with less amount of decrease. The mean of the treatments shows that the L* value for colour was maintained better inT_3 and T_4 treatments.

The maximum L* value for colour was found in T_3 (35.58) which was at par with T_4 (34.33) followed by T_2 (33.43) and T_5 (31.55) while the minimum colour L* value was found in T_1 (25.37) on 7th day of storage.

Colour is one of the major visual attributes of fruits. The change in colour of sapota fruits from light brown to dark brown continued over the storage period due to which there is a decrease in colour values. Control fruits showed faster colour change than coated ones. A lower rate of decrease in colour values found in coated fruits indicated that edible coating has relatively delayed the browning and colour development of the peel which leads to slower changes in colour development. The slow colour development can be attributed to the modified internal atmosphere created within the fruit [12].

a* value for the colour

During the initial days of storage i.e., 0 to 2nd day, the a* value for colour was found to be non-significant, while the-a* value for colour was increased from 3rd day to 7th day of storage the minimum a* value for colour was observed in T_3 (11.32) which was at par with T_4 (11.40) while, maximum a* values for colour was recorded in T_1 (11.58).

The result of similar findings was observed in an experiment on Study of physico-chemical properties of sapota (*Achras sapota* L.) Sapota a* values of sapota fruits was found between was 7.10 to 10.42 and average a* value of sapota were 7.14±0.02 (Jadhav et al. 2018). The colour of the outer peel of sapota was turning reddish brown. However, this colour change towards red was more in control than that of treated ones and this edible coating could delay the ripening process of Sapota fruit there-by becoming more reddish brown [13].

b* value for the colour

The b* values for colour showed a decreasing trend of values for both the control and treated sapota. The b* value for colour was found to be non-significant at the initial days of storage. On the 7th day of storage, significant maximum b* values for colour were found in T_3 (17.35), while the minimum b* value for colour were found in T_1 (14.39). The result of similar findings was observed that the b* value of colour in sapota fruits ranges between 37.26 to 41.91 and the average value of b* is 40.50±0.03 (Jadhav *et al.*, 2018). b* value shows a decreasing trend of values for both control and treated sapota. The degree of decrease was more in control fruits [12].

3.2 Specific Gravity

The specific gravity was found to be non-significant during the initial days of storage. Maximum specific gravity was found in T_3 (1.09), (1.110), (1.088) and T_4 (1.100), (1.090) respectively, while minimum specific gravity was observed in T_1 (1.066) and T_5 (1.061).

The findings of Khanvilkar et al. [13] in sapota cv. 'Kalipatti' support the current studies. Jain et al. [14] and Baidya et al. [15] observed significant variation in fruit weight and volume, which resulted in variation in the specific gravity of sapota fruits (2020).The specific gravity of mature sapota fruit has been indicated between 1.025 and 1.10 depending on the cultivar, for 'Kalipatti' it has been reported as being 1.10 Awasarmal et al. [16].

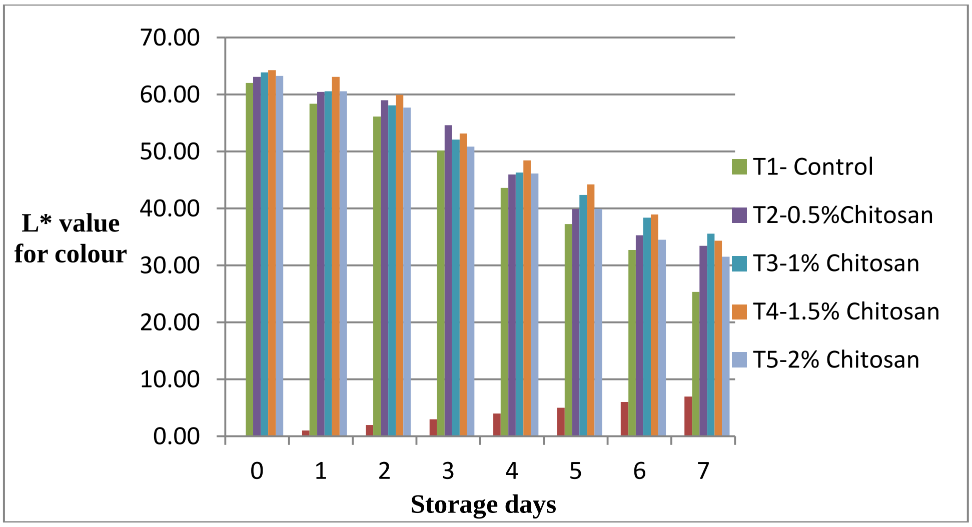

Fig. 1. Effect of chitosan-based edible coating on L* value forthe colourof sapota fruits cv. Kallipatti during storage

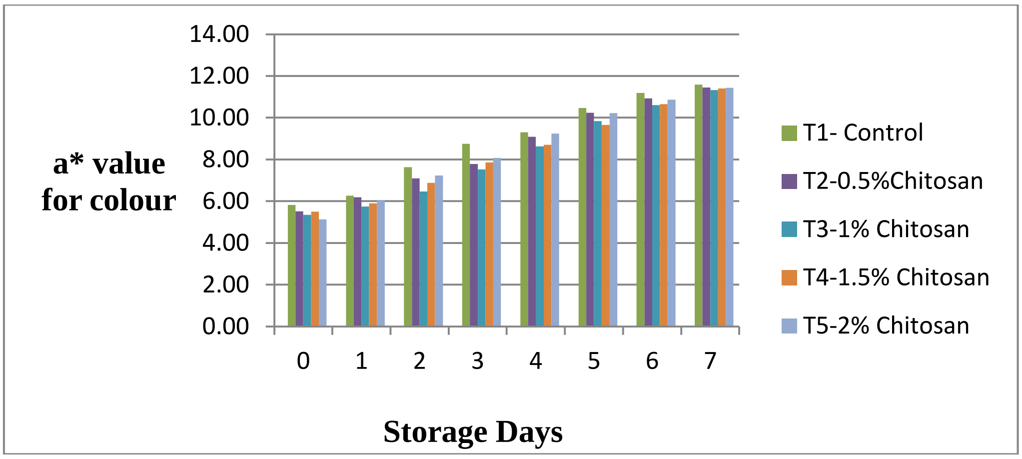

Fig. 2. Effect of chitosan-based edible coating on a* values for the colourof sapota fruits cv. Kalipatti during storage

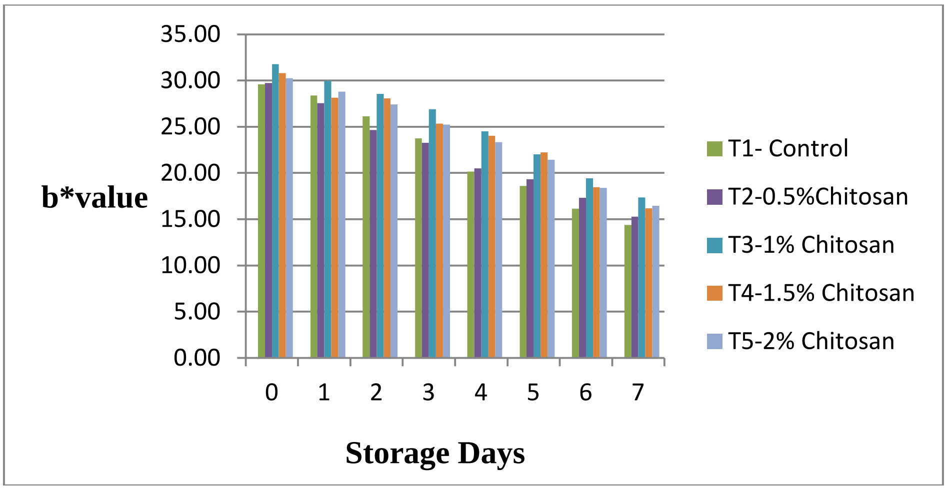

Fig. 3. Effect of chitosan-based edible coating on b* values for the colourof sapota fruits cv. Kalipatti during storage

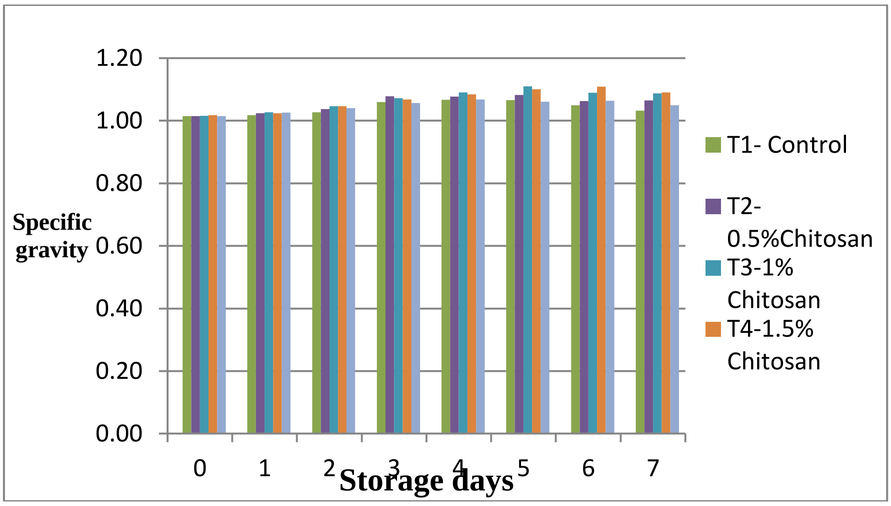

Fig. 4. Effect of chitosan-based edible coating on specific gravity (kg m^{-3}) of sapota fruits cv. Kalipatti during storage

Table 1. Effect of chitosan-based edible coating on L* value and a* value for the colour of sapota fruits cv. Kalipatti during storage

L* value for the colour									**a* value for the colour**							
Treatments	**Days of Storage**								**Days of Storage**							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
T_1	62	58.4	56.2	50.2	43.6	37.3	32.7	25.4	5.82	6.27	7.63	8.74	9.31	10.5	11.2	11.6
T_2	63.1	60.5	59	54.7	46	39.9	35.3	33.4	5.51	6.18	7.1	7.79	9.08	10.4	10.9	11.5
T_3	63.9	60.6	58.1	52.1	46.3	42.4	38.4	35.6	5.34	5.75	6.46	7.52	8.63	9.85	10.6	11.3
T_4	64.3	63.1	59.9	53.1	48.5	44.2	38.9	34.3	5.50	5.9	6.88	7.86	8.71	9.65	10.7	11.4
T_5	63.3	60.6	57.7	50.9	46.1	39.9	34.5	31.6	5.13	6.04	7.23	8.08	9.23	10.2	10.9	11.4
Mean	**63.3**	**60.6**	**58.2**	**52.2**	**40.7**	**36**	**36**	**32.1**	**5.46**	**6.03**	**7.06**	**8**	**10.1**	**10.9**	**10.9**	**11.4**
S.E ±	2.41	3.02	2.39	2.94	2.91	1.12	0.91	0.43	0.25	0.3	0.26	0.14	0.13	0.09	0.07	0.03
CD @ 5%	NS	NS	NS	NS	NS	3.66	2.96	1.41	NS	NS	NS	0.47	0.41	0.3	0.24	0.1

Table 2. Effect of chitosan-based edible coating on b* values and Specific gravity for the colourof sapota fruits cv. Kalipatti during storage

b* value for the colour									**Specific gravity**							
Treatments	**Days of storage**								**Days of storage**							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
T_1	29.6	28.4	26.1	23.8	20.2	18.6	16.1	14.4	1.02	1.02	1.03	1.06	1.07	1.07	1.05	1.03
T_2	29.7	27.6	24.7	23.3	20.5	19.3	17.3	15.3	1.02	1.02	1.04	1.08	1.08	1.08	1.06	1.07
T_3	31.8	30	28.6	26.9	24.5	22	19.4	17.4	1.02	1.03	1.05	1.07	1.09	1.11	1.09	1.09
T_4	30.8	28.2	28.1	25.3	24	22.2	18.5	16.2	1.02	1.02	1.05	1.07	1.08	1.1	1.11	1.09
T_5	30.3	28.8	27.4	25.2	23.4	21.4	18.4	16.4	1.02	1.03	1.04	1.06	1.07	1.06	1.06	1.05
Mean	**30.43**	**28.57**	**26.97**	**24.9**	**20.72**	**17.94**	**17.94**	**15.92**	**1.016**	**1.024**	**1.039**	**1.067**	**1.077**	**1.084**	**1.075**	**1.065**
S.E ±	0.55	0.5	0.97	0.81	0.46	0.38	0.25	0.24	0	0	0	0.01	0.01	0.01	0.01	0
CD @ 5%	NS	NS	NS	NS	1.49	1.23	0.82	0.78	NS	NS	NS	NS	0.01	0.02	0.03	0.01

3.3 Physiological Loss in Weight (%)

The data revealed that the different concentrations of chitosan treatments exerted significant effects on PLW from 4th day of storage. Fruits under control not survived on day 5, whereas fruits in T_3 and T_4 treatments not survived on day 7. On 5th day maximum PLW was recorded in T_1 (18.28%) while the minimum was recorded in T_3 and T_4 treatments (10.33%) and (11.77%) respectively, while on the 7th day maximum PLW was recorded in T_1 (28.64%) while the minimum was recorded in T_3 (15.67).

Chitosan coating forms a thin and transparent layer on the sapota skin surface that contributes to slowing down the dehydration process, responsible for fruit weight loss. Our results are in agreement with previous studies that demonstrated that chitosan coating retarded fruit weight loss in different fruit crops, such as strawberry, sweet cherry, loquat, and plum [17].

3.4 Fruit Firmness (kg/cm^2)

Chitosan exerted an effect on fruit firmness during the initial storage period and was found to be non-significant. The fruit firmness was found to be non-significant during the initial days of storage to 2nd day, while the fruit firmness was continuously decreased from 3rd day to 7th day of storage.

The firmness increased irrespective of treatments in the storage duration. Fruits under control were not survived on day 5 whereas fruits in T2 and T3 treatment survived on day 7. On the 5th day of storage minimum firmness was recorded in T_3 (10.33 kg/cm^2), whereas the maximum fruit firmness was recorded in T_1 (18.28 kg/cm^2). At the end of storage lowest firmness (15.67 kg/cm^2) observed in T_3 treatment. 1% chitosan coating showed a highest firmness at 7th day of storage.

The retention of firmness with chitosan coating is in agreement with the results of Ali et al. (2011) that the higher firmness of the coated fruits may be because as the respiration rate is reduced also reduced the degradation of water-insoluble calcium pectate (Ca-pectate) or calcium bridge that renders strength to the fruit skin according to the [18].

3.5 Ripening and Spoilage Pattern

Maximum unripe fruits were observed in T_3 (15.38%) and T_4 (12.31%) on the 5th day, while maximum half-ripe fruits were observed in T_4 (33.85%), whereas minimum half-ripe fruits were noted in T_2 (12.15%) and half ripe fruits were not observed in T_1 at the same day.

On 7th day of storage, maximum ripe fruits were noted in T_3 (76.92%) and T_4 (73.85%), while the minimum was noted in T_1 (44.15%). Maximum shrivelling and spoilage were observed in T_1 (28.8%), followed by T_5 (23.08%). Maximum diseased fruits are observed in T_2 (30.77%) and T_1 (27.05%), respectively, while minimum noted in T_3 (12.31%) and T_4 (15.38%), respectively.

Shriveling of sapota decreased with increase in the level of chitosan concentration for post-harvest coating of sapota. As the chitosan coating acts as a gas barrier, it slows down the loss of the respiration processes and moisture loss and allows retention of the firmness of fruits during storage. The results are confirmed as also reported [19] in grape. It might be due to the loss of moisture affecting the firmness of the berries during storage demonstrated by [20].

3.6 Sensory Evaluation

There were significant differences in all parameters of colour, flavour, texture, and overall acceptability. The flavour of the fruits with 1% and 1.5% coating was rated excellent (7.7 and 7.4), while minimum scoring was rated in control fruits (6.6).

The texture of the fruits with 1% and 1.5% coating was rated excellent (8.1 and 8) respectively, while minimum scoring was rated in control fruits (6.8).

Overall acceptability of the fruits with 1% and 1.5% coating was rated excellent (8.4 and 8.1) respectively, while minimum scoring was rated in control fruits (7.4).

Sensory attributes of the papaya fruits treated with 1.5% chitosan concentration demonstrated the overall superiority, after 5 weeks of cold storage [21]. [22] noticed that 1.0% chitosan coated mangoes had better sensory traits than the control and the waxol-treated mangoes, after 21 days of storage.

Table 3. Effect of chitosan based edible coating on physiological loss in weight (%) and Fruit firmness (kg/cm^2) of sapota fruits cv. Kalipatti during storage

Treatments	Physiological loss in weight (%)									Fruit firmness (kg/cm^2)							
	Days of storage									Days of storage							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
T_1	0	2.78	4.89	7.96	12.8	18.3	22.9	24.4	28.6	65.9	57	48.9	39.8	31.9	19.9	17.9	11
T_2	0	2.61	4.86	6.98	11.9	13.3	17.5	21	22.9	68.4	56.4	48.2	39.8	33.6	24.5	19.5	12.6
T_3	0	3.13	4.7	6.31	8.69	10.3	11.4	14.1	15.7	67.3	61.5	53.1	45.8	38.4	30.2	23.7	15.2
T_4	0	2.75	4.73	6.91	9.45	11.8	12	16.1	19.1	66	59.4	50.8	44.9	39.3	30.9	24	15.1
T_5	0	3.01	4.99	7.34	10	12	15.6	17.7	18.6	69.7	57.2	49.2	40.3	34.3	24.3	20.8	12.9
Mean	**0**	**2.86**	**4.83**	**7.1**	**10.56**	**13.12**	**15.88**	**18.64**	**20.98**	**67.45**	**58.29**	**50.04**	**42.12**	**35.48**	**25.93**	**21.19**	**13.34**
S.E ±	0	0.29	0.31	0.39	0.36	0.25	0.25	0.22	0.21	1.8	1.38	1.24	0.69	0.61	0.52	0.5	0.33
CD @ 5%	0	NS	NS	NS	1.17	0.81	0.8	0.71	0.67	NS	NS	NS	2.25	1.98	1.68	1.64	1.06

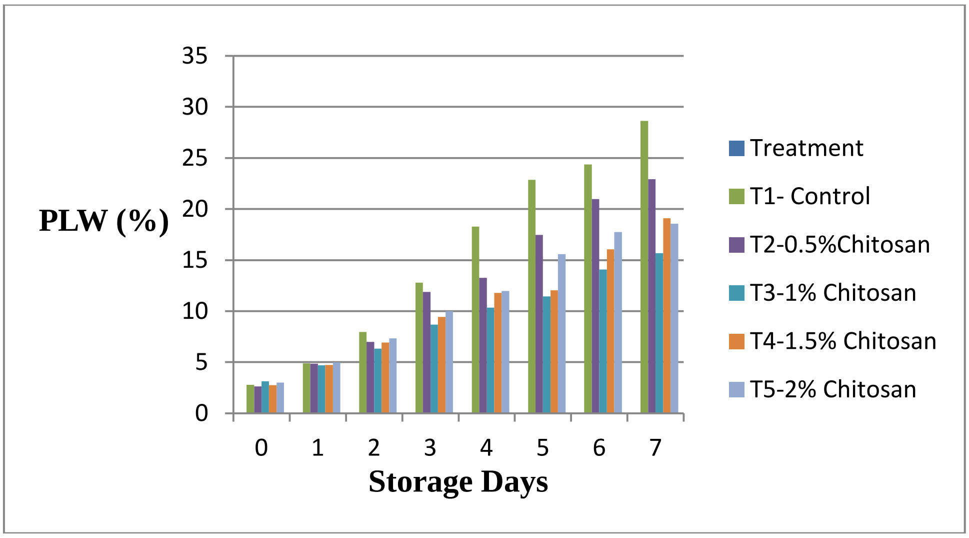

Fig. 5. Effect of chitosan-based edible coating on Physiological loss in weight (%) of sapota fruits cv. Kalipatti during storage

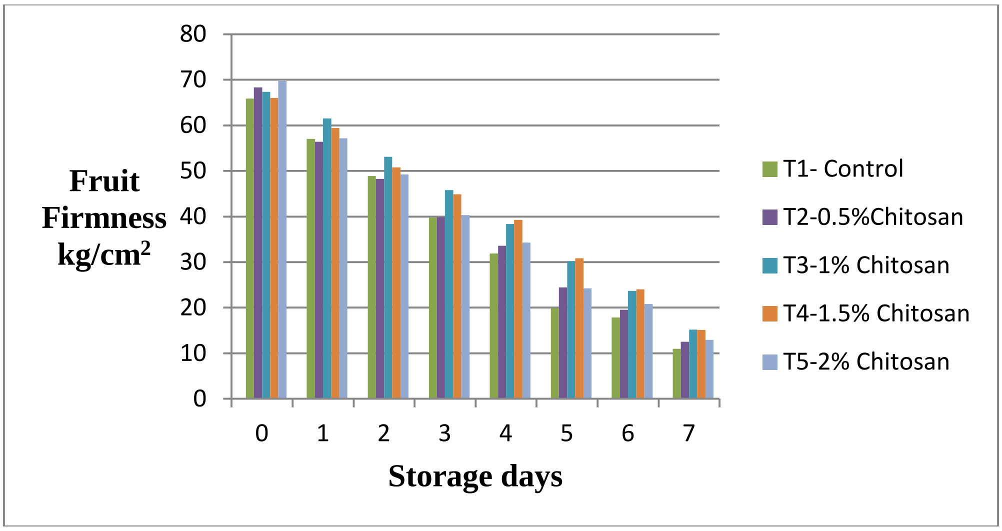

Fig. 6. Effect of chitosan-based edible coating on Fruit firmness(kg/cm^2) of sapota fruits cv. Kalipatti during storage

Table 4. Effect of chitosan-based edible coating on ripening and spoilage pattern (%) of sapota fruits cv. Kallipatti during storage

Treatments		Days of Storages							
T_1	Stages	0	1	2	3	4	5	6	7
	UR	100	93.85	60.15	41.25	10.86			
	HR		6.15	30.14	42.5	22.56			
	R			9.71	16.25	46.36	70.55	46.15	44.15
	S					10.52	15.34	27.7	28.8
	D					9.7	14.11	26.15	27.05
T_2	UR	100	92.31	85.31	56.55	31			
	HR		7.69	14.69	33.33	35.31	12.15		
	R				10.12	30.61	65.41	61.54	49.23
	S					3.08	15.14	15.38	20
	D						7.3	23.08	30.77

Treatments		Days of Storages							
T_3	UR	100	100	80	68.46	38.46	15.38		
	HR			20	31.54	33.85	30.77	18.46	
	R					27.69	53.85	63.08	76.92
	S							9.23	10.77
	D							9.23	12.31
T_4	UR	100	95.38	73.85	52.31	27.69	12.31		
	HR		4.62	26.15	43.08	53.85	33.85	7.69	
	R				4.61	18.46	49.23	69.23	73.85
	S						4.61	10.77	10.77
	D							12.31	15.38
T_5	UR	100	92.31	86.15	66.1	18.46			
	HR		7.69	13.85	33.9	46.15	30.77	6.15	
	R					35.39	46.15	61.54	53.85
	S						9.23	15.38	23.08
	D						13.85	16.93	23.07
	Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 5. Effect of chitosan-based edible coating on sensory quality parameters of sapota fruits cv. Kalipatti during storage

	Sensory quality parameters			
Treatment	**Colour**	**Flavor**	**Texture**	**Overall acceptability**
T_1- Control	7.25	6.68	6.85	7.40
T_2-0.5%Chitosan	7.75	7.30	7.53	8.03
T_3-1% Chitosan	8.50	7.78	8.15	8.43
T_4-1.5% Chitosan	8.00	7.40	8.00	8.15
T_5-2% Chitosan	7.25	7.00	7.25	7.95
Mean	**7.75**	**7.23**	**7.56**	**7.99**
S.E ±	0.08	0.07	0.06	0.04
CD @ 5%	0.26	0.24	0.20	0.67

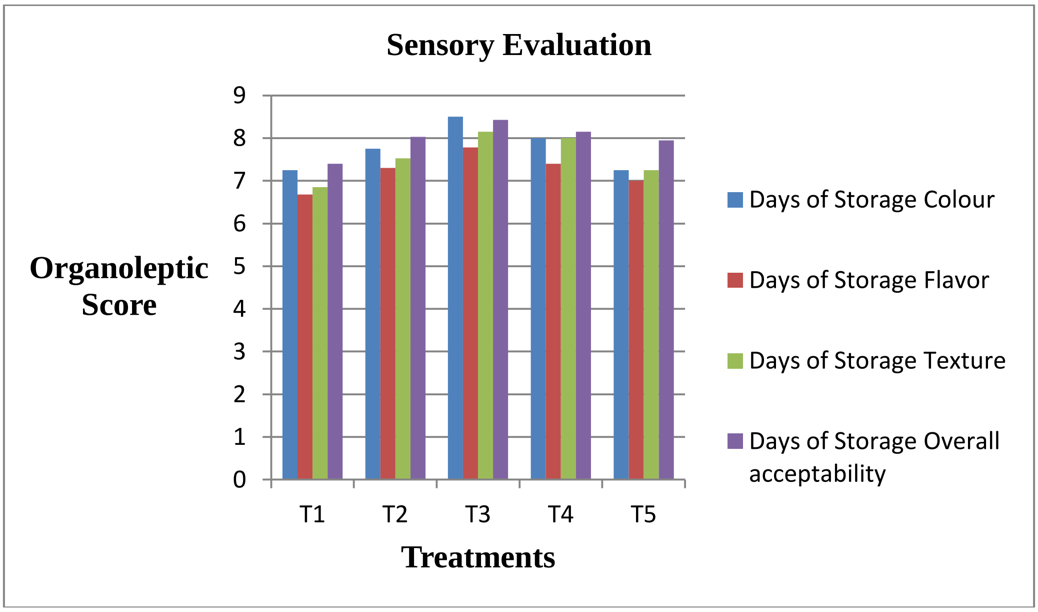

Fig. 7. Effect of chitosan-based edible coating on sensory evaluation of sapota fruits cv. Kalipatti during storage

4. CONCLUSION

It was determined that chitosan has the potential to be used as a coating technique for better sapota fruit storage.It can be concluded from the present investigation that the fruits treated with chitosan coating @ 1% followed by 1.5% helps in maintaining the quality and shelf life of sapota fruits up to the 7th day of storage. The fruits retained desirable colour, texture and postharvest quality till the end of their storage life.

ACKNOWLEDGEMENT

We appreciate the Post Graduate Institute of Post Harvest Technology and Management Killa-Roha for providing the necessary facility.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Lakshminarayana S, Subramanyam H. Physical, chemical and physiological changes in sapota fruit [*Achras sapota* Linn. (Sapotaceae)] during development and ripening". J Food Sci Technol. 1966;3:151-4.
2. Srivastava AK, Kashyap P, Meena VS, Verma N, Singh SP. Sapota [(*Manilkara achras* (mill.) Fosberg (Syn: *Achras zapota* L.)]. Underutilized Fruit Crops Importance Cultivation. 2017;1159:1194.
3. Kulkarni AP, Policegoudra RS, Aradhya SM. Chemical composition and antioxidant activity of sapota (*Achras sapota* Linn.) fruit. J Food Biochemistry. 2007;31(3):399-414.
DOI: 10.1111/j.1745-4514.2007.00122.x
4. Jaishankar h. P. and laxmankukanoor, Effect of post harvest treatments on physiological changes of Sapota cv. Kalipatti at ambient storage. Adv Life Sci. 2016;5(7), Print : ISSN 2278-3849:2942-9.
5. Sudha R, Amutha R, Muthulaksmi S, Baby RW, Indira K, Mareeswari P. Influence of pre and post-harvest chemical treatments on physical characteristics of Sapota (*Achras sapota* L.) var. PKM 1. Res J Agric Biol Sci. 2007;3(5):450-2.
6. Madani B, Mirshekari A, Yahia E, Golding JB. Sapota (*Manilkara achras* forb.) factors influencing fresh and processed fruit quality. Hortic Rev. 2018;45:105-42.
7. Kaya M, Česonienė L, Daubaras R, Leskauskaitė D, Zabulionė D. Chitosan coating of red kiwifruit (*Actinidia melanandra*) for extending of the shelf life. Int J Biol Macromol. 2016; 85:355-60.
DOI: 10.1016/j.ijbiomac.2016.01.012, PMID 26772912.
8. Xing Y, Xu Q, Li X, Chen C, Ma L, Li S et al. Chitosan-based coating with antimicrobial agents: Preparation, property, mechanism, and application effectiveness on fruits and vegetables. Int J Polym Sci. 2016;2016:1-24.
DOI: 10.1155/2016/4851730
9. AOAC (Association of Official Analytical Chemists). Official methods of analysis. 16th ed. Virginia; 1994.
10. Amerine MA, Pangborn RM, Rocssler EB. Principles of sensory evaluation of food. London: Academic Press; 1965.
11. Saha A, Gupta RK, Tyagi Y. Effects of edible coatings on the shelf life and quality of potato (*Solanum tuberosum* L.) tubers during storage. J Chem Pharm Res. 2014;6:802-9.
12. Padmaja N, Don Bosco SJD, Rao JS. Physicochemical analysis of sapota (*Manilkara zapota*) coated by edible aloe vera gel. Int J Appl Sci Biotechnol. 2015;3(1):20-5.
DOI: 10.3126/ijasbt.v3i1.11703
13. Khanvilkar MH, Kaushik RA, Pawar CD, Pethe UB, Talha PM, Sarolia DK, et al. Response of post harvest treatments of various chemical and plant growth regulators on physical parameters of sapota fruits cv. Kalipatti. Int J Chem Stud. 2018;6(2):3429-31.
14. Jain SK, Malshe KV, Pawar CD. Effect of GA3 and NAA on fruit quality and storage characteristics of fruit in Sapota cv. Kalipatti. Int J Chem Stud. 2019;8(1):1667-71.
15. Baidya BK, Mahato A, Pattnaik RK, Sethy P. A Review of physiological and biochemical changes related to ripening along with postharvest handling and treatments of Sapota. J Pharmacogn Phytochem. 2020;9(4):2030-5.
16. Awasarmal AB, Soni SB, Divekar SP. Effect of different packaging materials on

shelf life of sapota fruit. Int J Process Post Harvest Technol. 2011;2(2):125-8.

17. Adiletta G, Zampella L, Coletta C, Petriccione M. Chitosan coating to preserve the qualitative traits and improve antioxidant system in fresh figs (*Ficus carica* L.). Agriculture. 2019;9(4):84. DOI: 10.3390/agriculture9040084
18. Claybon KT, Barringer SA. Consumer acceptability of color in processed tomato products by African, American, Latino and prototypical consumers. J Food Quality. 2002;25(6):487-98. DOI: 10.1111/j.1745-4557.2002.tb01042.x
19. Yaman Ö, Bayoındırlı L. Effects of an edible coating and cold storage on shelf-life and quality of cherries. LWT Food Sci Technol. 2002;35(2):146-50. DOI: 10.1006/fstl.2001.0827
20. Yadav VB, Sargar KHPYA. Effect of pre and post-harvest application of chitosan on chemical parameters quality of grape Cv. ManikChaman During Storage. 2022:0 C temperature.
21. Ali A, Muhammad MTM, Sijam K, Siddiqui Y. Effect of chitosan coatings on the physicochemical characteristics of Eksotika II papaya (*Carica papaya* L.) fruit during cold storage. Food Chem. 2011;124(2):620-6. DOI: 10.1016/j.foodchem.2010.06.085
22. Kittur FS, Saroja N, Habibunnisa R, Tharanathan R. Polysaccharide-based composite coating formulations for shelf-life extension of fresh banana and mango. Eur Food Res Technol. 2001;213(4-5):306-11. DOI: 10.1007/s002170100363

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/100160