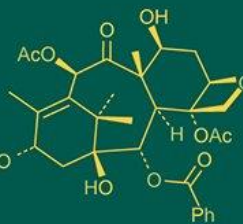
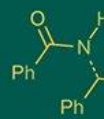
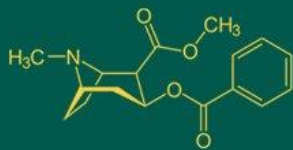


## International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693  
ISSN Online: 2617-4707  
NAAS Rating (2025): 5.29  
IJABR 2025; SP-9(9): 1600-1603  
[www.biochemjournal.com](http://www.biochemjournal.com)  
Received: 10-07-2025  
Accepted: 14-08-2025

**Ankita Pradhan**  
M.Sc. Scholar, Department of  
Fruit Science, College of  
Horticulture and  
Research Station, MGUVV,  
Durg, Chhattisgarh, India

**Dr. Sevan Das Khunte**  
Assistant Professor,  
Department of Fruit Science,  
College of Horticulture and  
Research Station, MGUVV,  
Durg, Chhattisgarh, India

**Dr. Amit Dixt**  
Professor, Department of  
Vegetable Science, College of  
Horticulture and  
Research Station, MGUVV,  
Durg, Chhattisgarh, India

**Dr. Purnendra Kumar Sahu**  
Assistant Professor,  
Department of Fruit Science,  
College of Horticulture and  
Research Station, Saja  
MGUVV, Durg, Chhattisgarh,  
India

**Dr. Eshu Sahu**  
Assistant Professor,  
Department of Vegetable  
Science, Krantikari Debridhur  
College of Horticulture and  
Research Station MGUVV,  
Durg, Chhattisgarh, India

**Hemant Toppo**  
Assistant Professor,  
Department of Genetics and  
Plant Breeding, College of  
Horticulture and Research  
Station, MGUVV, Durg,  
Chhattisgarh, India

**Corresponding Author:**  
**Ankita Pradhan**  
M.Sc. Scholar, Department of  
Fruit Science, College of  
Horticulture and  
Research Station, MGUVV,  
Durg, Chhattisgarh, India

## Effect of coatings materials on shelf life and organoleptic parameters of sweet orange (*Citrus sinensis* Osbeck)

**Ankita Pradhan, Sevan Das Khunte, Amit Dixt, Purnendra Kumar Sahu, Eshu Sahu and Hemant Toppo**

DOI: <https://www.doi.org/10.33545/26174693.2025.v9.i9St.5730>

### Abstract

The present investigation “Effect of coatings materials on shelf life and organoleptic parameters of sweet orange (*Citrus sinensis* Osbeck)” was conducted at department of Fruit Science in College of Horticulture and Research Station Sankara, Patan, Durg 2024-2025. Under this experiment 10 treatment laid out on Completely Randomized Design with three replication. Experiment treatment were T<sub>0</sub> Control, T<sub>1</sub> CaCl<sub>2</sub> 1%, T<sub>2</sub> CaCl<sub>2</sub> 3%, T<sub>3</sub> GA<sub>3</sub> 0.05%, GA<sub>3</sub> 0.1%, T<sub>5</sub> KMnO<sub>4</sub> 1%, T<sub>6</sub> KMnO<sub>4</sub> 2%, T<sub>7</sub> Marigold Extract 4%, T<sub>8</sub> Turmeric mixture 4%, T<sub>9</sub> *Aloe vera* 75%. Uniform size eight fruits are selected in each treatment. each replication. Air dried fruit were dipped separately in each solution for five minutes as per the treatments. The observations on physio-chemical changes in fruits were recorded at 7 days interval up to 21 days at room temperature. Initial observation was recorded before keeping the fruits in boxes. Results revealed Shelf life of sweet orange fruit maximum (21.26) days at CaCl<sub>2</sub> 3%. Organoleptic parameters maximum Colour and appearance score (7.64), flavour (7.65), texture (6.88), taste (6.75), overall acceptability (6.78) at room temperature for 21 days.

**Keywords:** *Aloe vera*, calcium chloride, potassium permanganate, sweet orange shelf life

### Introduction

Sweet orange (*Citrus sinensis* Osbeck) is one of the most important fruit crops among the citrus group in India, belonging to the family of Rutaceae with chromosome number 2n = 18. It's originated in South East Asia (Chadha 2009) <sup>[11]</sup>. Sweet orange fruits are considered refreshing, delicious and health promoting. Hence, they deserve a prominent place in daily diet. Sweet orange is also referred to as tight skinned oranges and constitutes a major share of citrus production in India. Sweet orange is considered as second important citrus species after mandarin orange in India and it shares 25% of production among all the citrus cultivars. (Hiwarale *et al.*, 2023) <sup>[13]</sup>.

The citrus fruits are produced in all tropical and subtropical areas of the world. Brazil is the largest producer of oranges followed by USA. Sweet orange contributes 71 percent of the total citrus fruit production in the word (Kakade *et al.*, 2021) <sup>[14]</sup>. In India, approximately 234.00 Thousand haters of land area were under sweet orange cultivation with the production of 4381.00 thousand MT of fruit with average productivity of 17.4 MT/ha. India is 6<sup>th</sup> largest producer of sweet orange in the world and maximum area under sweet orange is in Andhra Pradesh followed by Maharashtra, Karnataka and Maharashtra contributes to approximately 49% of the total production of sweet orange in the country. The major growing states in India are Maharashtra, Andhra Pradesh, Karnataka, Punjab, Rajasthan and Haryana. In Maharashtra, area under sweet orange cultivation was 78.2 thousand hectares with the production of 856.00 thousand MT of fruits and productivity is 9.1 MT per ha during 2021-22 (Anon., 2022) <sup>[4]</sup>.

The sweet orange fruit is commercially processed in various form mainly juice, frozen concentrates, squash, RTS drinks, nectar, dry mixes, canned segments, juice blends, marmalades and other value-added product like pectin and essential oil from peel, natural colours candied peel, feed and yeast. Fresh juice of sweet orange is an important nutritious product providing 45 Kcal, moderate quantity of vitamin C. potassium, bioflavonoid folic and other essential nutrients.

It is refreshing, thirst quenching and energizing carbonated drink that improves health and nutritional requirements. Coatings have been long used to maintain the quality and extend the shelf-life of many fresh fruits viz. apple and citrus. They have been used directly on fruit surfaces as a thin coating. There are several modes of application for applying edible coatings viz. dipping, spraying, or brushing which create a modified atmosphere Basically, the use of food-grade wax coatings on fresh fruits has been allowed by the Indian govt. and with the adoption of this technique, many wax formulations are now available by suppliers markets. In India, citrus fruits experience approximately 30-40% post-harvest losses due to multiple factors. These include improper harvesting practices, limited awareness of appropriate maturity standards, inadequate storage infrastructure, shortage of skilled labour, and poor handling during storage and transportation. Additionally, pest and disease infestations significantly contribute to the decline in fruit quality after harvest (Bangarusamy, 2001) [17].

Potassium permanganate (KMnO<sub>4</sub>) is quite effective in reducing ethylene levels by oxidizing it to carbon dioxide and water. It is a chemical which has long been used to remove ethylene from the storage atmosphere. It was demonstrated that KMnO<sub>4</sub> retarded the ripening of many fruits. CaCl<sub>2</sub> with based coating are supportive to coating are supporting to maintain firmness and reduce physiology weight loss. GA<sub>3</sub> application delayed senescence in sweet orange by maintaining green colour of the rind and reducing weight loss during storage, thereby improving postharvest life (Lakshmi and Reddy, (2008) [15].

## Materials and Methods

The present investigation entitled “Effect of coatings materials on shelf life and organoleptic parameters of sweet orange (*Citrus sinensis* Osbeck)” was conducted in College of Horticulture and Research Station Sankara, Patan, Durg during 2024-25. The experiment was laid out completely randomized design with 10 treatment T<sub>0</sub> control T<sub>1</sub> CaCl<sub>2</sub> @ 1%, T<sub>2</sub> CaCl<sub>2</sub> @ 3% T<sub>3</sub> GA<sub>3</sub> @ 0.05%, T<sub>4</sub> GA<sub>3</sub> @ 0.1%, T<sub>5</sub> KMnO<sub>4</sub> @ 1%, T<sub>6</sub> KMnO<sub>4</sub> @ 2% T<sub>7</sub> Marigold Extract @ 4%, T<sub>8</sub> Turmeric mixture @ 4% and T<sub>9</sub> *Aloe vera* @ 75% which replicated 3 times.

Uniform size eight fruits are selected in each treatment and each replication. Air dried fruit were dipped separately in each solution for five minutes as per the treatments. The observations on physio-chemical changes in fruits were recorded at 7 days interval up to 21 days at room temperature. Initial observation was recorded before keeping the fruits in boxes.

The end of experiment shelf life of fruit was appraised by visualising the surface shrivelling, firmness, luster, flavor and rotting of sweet orange fruits. Shelf life was calculated in terms of number of days the fruits were fresh from the date of harvesting. The treated fruits were also evaluated for sensory quality for colour and appearance, flavour, texture, taste and overall acceptability by a semi trained panel of 5 member judges on a 9-point hedonic scale (1-extremely dislike and 9-extremely like) in accordance with method suggested by Amerine *et al.* (1965) [3]. On the basis of overall acceptability score samples further evaluated for sensory quality by using the score card.

## Results and Discussion

### 1. Shelf life

The data on the shelf life of sweet orange fruit as influenced by different post-harvest treatments were recorded and

presented as number of days in Table 1

The Treatment T<sub>2</sub> (CaCl<sub>2</sub> 3%) was observed maximum shelf life (21.26) followed by Treatment T<sub>1</sub> (CaCl<sub>2</sub> 1%) (20.40) at 21 days storage period. The treatment T<sub>0</sub> control minimum shelf life (10.35) the fruit with control. Bisen *et al.* (2012) [10] who recorded the organoleptic value of taste decreases with the advancement of storage period in all treatments. Also in Bapirao (2015) [8]

**Table 1:** Effect of postharvest treatment on shelf life of sweet orange

Notations	Treatment	Shelf life (Days)
T <sub>0</sub>	Control	10.35
T <sub>1</sub>	CaCl <sub>2</sub> @ 1%	20.40
T <sub>2</sub>	CaCl <sub>2</sub> @ 3%	21.26
T <sub>3</sub>	GA <sub>3</sub> @ 0.05%	18.49
T <sub>4</sub>	GA <sub>3</sub> @ 0.1%	18.60
T <sub>5</sub>	KMnO <sub>4</sub> @ 1%	19.27
T <sub>6</sub>	KMnO <sub>4</sub> @ 2%	19.50
T <sub>7</sub>	Marigold Extract @ 4%	16.02
T <sub>8</sub>	Turmeric Mixture @ 4%	16.80
T <sub>9</sub>	<i>Aloe vera</i> @ 75%	20.03
	SE (m)±	0.389
	C.D. at 5%	1.157

## 2. Organoleptic parameter

### 2.1 Colour and appearance

The data recorded at 7 days interval in respect sensory evaluation of colour and appearance content of sweet orange fruit as influenced by different postharvest. Table 2

It is evident from data in Table 2 that at initial days, all the treatments showed non-significant effect in colour and appearance. At 7 days of storage, maximum colour and appearance was recorded in T<sub>2</sub> CaCl<sub>2</sub> @ 3% (8.24), followed by in treatments T<sub>1</sub> CaCl<sub>2</sub> @ 1% (7.88). The minimum colour and appearance was recorded in control T<sub>0</sub> control treatment (6.15). After 14 days of storage, maximum colour and appearance was recorded in treatment T<sub>2</sub> CaCl<sub>2</sub> @ 3% (7.71) followed by in treatment T<sub>1</sub> CaCl<sub>2</sub> @ 1% (6.42). After 21 days of storage, maximum colour and appearance was recorded in treatment T<sub>2</sub> CaCl<sub>2</sub> @ 3% (7.64) followed by in treatment T<sub>1</sub> CaCl<sub>2</sub> @ 1% (6.11). the fruit with control treatment could not reached up to last days of storage because maximum fruit were rotted at the that stage and further observations could not take. Similar result found in Bapirao (2015) [8] use different chemicals and oil emulsion in on shelf life in sweet orange. Bisen *et al.* (2012) [10] who recorded the organoleptic value of taste decreases with the advancement of storage period in all treatments.

**Table 2:** Effect of postharvest treatments on colour and appearance of sweet orange

Notations	Treatment	Colour and appearance			
		0 days	7 days	14 days	21 days
T <sub>0</sub>	Control	8.50	6.15	0.00	0.00
T <sub>1</sub>	CaCl <sub>2</sub> @ 1%	8.50	7.88	6.42	6.11
T <sub>2</sub>	CaCl <sub>2</sub> @ 3%	8.50	8.24	7.71	7.64
T <sub>3</sub>	GA <sub>3</sub> @ 0.05%	8.50	6.92	5.78	4.97
T <sub>4</sub>	GA <sub>3</sub> @ 0.1%	8.50	7.26	5.84	5.31
T <sub>5</sub>	KMnO <sub>4</sub> @ 1%	8.50	7.75	5.95	5.53
T <sub>6</sub>	KMnO <sub>4</sub> @ 2%	8.50	7.81	6.07	5.77
T <sub>7</sub>	Marigold Extract @ 4%	8.50	6.33	5.72	4.93
T <sub>8</sub>	Turmeric Mixture @ 4%	8.50	7.69	6.03	5.88
T <sub>9</sub>	<i>Aloe vera</i> @ 75%	8.50	7.88	6.08	6.07
	SE (m)±	NS	0.188	0.026	0.017
	C.D. at 5%	NS	0.557	0.076	0.05

## 2.2 Flavour

The data recorded at 7 days interval in respect sensory evaluation of flavour content of sweet orange fruit as influenced by different postharvest treatments are presented as scale-score content in Table 3

It is evident from data in Table 3 that at initial days, all the treatments showed non-significant effect in flavour. At 7 days of storage, maximum flavour was recorded in T<sub>2</sub> CaCl<sub>2</sub> @ 3% (8.61), followed by in treatments T<sub>1</sub> CaCl<sub>2</sub> @ 1% (7.91). The minimum flavour was recorded in control T<sub>0</sub> control treatment (6.22). After 14 days of storage, maximum flavour was recorded in treatment T<sub>2</sub> CaCl<sub>2</sub> @ 3% (7.75) followed by in treatment T<sub>1</sub> CaCl<sub>2</sub> @ 1% (7.71). After 21 days of storage, maximum flavour was recorded in treatment T<sub>2</sub> CaCl<sub>2</sub> @ 3% (7.65) followed by in treatment T<sub>1</sub> CaCl<sub>2</sub> @ 1% (7.62). The fruit with control treatment could not reached up to last days of storage because maximum fruit were rotted at the that stage and further observations could not take. Similar result found in Bapirao (2015)<sup>[8]</sup>. Bisen *et al.* (2012)<sup>[10]</sup> who recorded the organoleptic value of taste decreases with the advancement of storage period in all treatments.

**Table 3:** Effect of postharvest treatments on flavour of sweet orange

Notations	Treatment	Flavour			
		0 days	7 days	14 days	21 days
T <sub>0</sub>	Control	8.25	6.22	0.00	0.00
T <sub>1</sub>	CaCl <sub>2</sub> @ 1%	8.26	7.91	7.71	7.62
T <sub>2</sub>	CaCl <sub>2</sub> @ 3%	8.25	8.61	7.75	7.65
T <sub>3</sub>	GA <sub>3</sub> @ 0.05%	8.24	6.95	7.66	7.54
T <sub>4</sub>	GA <sub>3</sub> @ 0.1%	8.25	7.77	7.67	7.56
T <sub>5</sub>	KMnO <sub>4</sub> @ 1%	8.26	7.79	7.68	7.58
T <sub>6</sub>	KMnO <sub>4</sub> @ 2%	8.26	7.80	7.69	7.59
T <sub>7</sub>	Marigold Extract @ 4%	8.25	6.49	7.53	6.49
T <sub>8</sub>	Turmeric Mixture @ 4%	8.25	7.55	7.57	7.55
T <sub>9</sub>	<i>Aloe vera</i> @ 75%	8.25	7.82	7.70	7.61
	SE (m)±	NS	0.226	0.05	0.152
	C.D. at 5%	NS	0.672	0.170	0.452

## 2.3 Texture

The data recorded at 7 days interval in respect sensory evaluation of texture of sweet orange fruit as influenced by different postharvest treatments are presented as scale-score content in Table 4

It is evident from data in Table 4 that at initial days, all the treatments showed non-significant effect in texture. At 7 days of storage, maximum texture was recorded in T<sub>2</sub> CaCl<sub>2</sub> @ 3% (7.92), followed by in treatments T<sub>1</sub> CaCl<sub>2</sub> @ 1% (7.85). The minimum texture was recorded in control T<sub>0</sub> control treatment (6.65). After 14 days of storage, maximum texture was recorded in treatment T<sub>2</sub> CaCl<sub>2</sub> @ 3% (7.70) followed by in treatment T<sub>1</sub> CaCl<sub>2</sub> @ 1% (7.63). After 21 days of storage, maximum texture was recorded in treatment T<sub>2</sub> CaCl<sub>2</sub> @ 3% (6.88) followed by in treatment T<sub>1</sub> CaCl<sub>2</sub> @ 1% (6.80). The fruit with control treatment could not reached up to last days of storage because maximum fruit were rotted at the that stage and further observations could not take. Similar result found in Bapirao (2015)<sup>[8]</sup>. Bisen *et al.* (2012)<sup>[10]</sup> who recorded the organoleptic value of taste decreases with the advancement of storage period in all treatments.

**Table 4:** Effect of postharvest treatments on texture of sweet orange

Notations	Treatment	Texture			
		0 days	7 days	14 days	21 days
T <sub>0</sub>	Control	8.55	7.65	0.00	0.00
T <sub>1</sub>	CaCl <sub>2</sub> @ 1%	8.54	7.85	7.63	6.80
T <sub>2</sub>	CaCl <sub>2</sub> @ 3%	8.55	7.92	7.70	6.88
T <sub>3</sub>	GA <sub>3</sub> @ 0.05%	8.55	7.72	6.89	6.58
T <sub>4</sub>	GA <sub>3</sub> @ 0.1%	8.54	7.75	6.99	6.60
T <sub>5</sub>	KMnO <sub>4</sub> @ 1%	8.54	7.80	7.56	6.70
T <sub>6</sub>	KMnO <sub>4</sub> @ 2%	8.56	7.82	7.58	6.74
T <sub>7</sub>	Marigold Extract @ 4%	8.55	7.70	6.79	6.55
T <sub>8</sub>	Turmeric Mixture @ 4%	8.54	7.79	7.55	6.67
T <sub>9</sub>	<i>Aloe vera</i> @ 75%	8.54	7.83	7.60	6.77
	SE (m)±		0.057	0.136	0.095
	C.D. at 5%		0.169	0.404	0.283

## 2.4 Taste

The data recorded at 7 days interval in respect sensory evaluation of taste of sweet orange fruit as influenced by different postharvest treatments are presented as scale-score content in Table 5

It is evident from data in Table 5 that at initial days, all the treatments showed non-significant effect in taste. At 7 days of storage, maximum taste was recorded in T<sub>2</sub> CaCl<sub>2</sub> @ 3% (7.82), followed by in treatments T<sub>1</sub> CaCl<sub>2</sub> @ 1% (7.80). The minimum taste was recorded in control T<sub>0</sub> control treatment (7.72). After 14 days of storage, maximum taste was recorded in treatment T<sub>2</sub> CaCl<sub>2</sub> @ 3% (7.68) followed by in treatment T<sub>1</sub> CaCl<sub>2</sub> @ 1% (7.63). After 21 days of storage, maximum taste was recorded in treatment T<sub>2</sub> CaCl<sub>2</sub> @ 3% (6.75) followed by in treatment T<sub>1</sub> CaCl<sub>2</sub> @ 1% (6.68). The fruit with control treatment could not reached up to last days of storage because maximum fruit were rotted at the that stage and further observations could not take. Similar result found in Bapirao (2015)<sup>[8]</sup>. Bisen *et al.* (2012)<sup>[10]</sup> who recorded the organoleptic value of taste decreases with the advancement of storage period in all treatments.

**Table 5:** Effect of postharvest treatments on taste of sweet orange

Notations	Treatment	Taste			
		0 days	7 days	14 days	21 days
T <sub>0</sub>	Control	8.20	7.72	0.00	0.00
T <sub>1</sub>	CaCl <sub>2</sub> @ 1%	8.20	7.80	7.63	6.68
T <sub>2</sub>	CaCl <sub>2</sub> @ 3%	8.21	7.82	7.68	6.75
T <sub>3</sub>	GA <sub>3</sub> @ 0.05%	8.21	7.74	6.72	5.87
T <sub>4</sub>	GA <sub>3</sub> @ 0.1%	8.20	7.75	6.76	5.93
T <sub>5</sub>	KMnO <sub>4</sub> @ 1%	8.20	7.77	7.55	6.52
T <sub>6</sub>	KMnO <sub>4</sub> @ 2%	8.21	7.78	7.58	6.54
T <sub>7</sub>	Marigold Extract @ 4%	8.20	7.73	6.69	5.72
T <sub>8</sub>	Turmeric Mixture @ 4%	8.20	7.76	7.55	6.44
T <sub>9</sub>	<i>Aloe vera</i> @ 75%	8.20	7.79	7.60	7.61
	SE (m)±		0.014	0.038	0.089
	C.D. at 5%		0.042	0.112	0.266

## 2.5 Overall acceptability

The data recorded at 7 days interval in respect sensory evaluation of overall acceptability of sweet orange fruit as influenced by different postharvest treatments are presented as scale-score content in Table 6

It is evident from data in Table 6 that at initial days, all the treatments showed non-significant effect in of overall acceptability. At 7 days of storage, maximum of overall acceptability was recorded in T<sub>2</sub> CaCl<sub>2</sub> @ 3% (7.71), followed by in treatments T<sub>1</sub> CaCl<sub>2</sub> @ 1% (7.67). The

minimum of overall acceptability was recorded in control T<sub>0</sub> control treatment (7.60). After 14 days of storage, maximum of overall acceptability was recorded in treatment T<sub>2</sub> CaCl<sub>2</sub> @ 3% (7.45) followed by in treatment T<sub>1</sub> CaCl<sub>2</sub> @ 1% (7.25). After 21 days of storage, maximum of overall acceptability was recorded in treatment T<sub>2</sub> CaCl<sub>2</sub> @ 3% (6.78) followed by in treatment T<sub>1</sub> CaCl<sub>2</sub> @ 1% (6.74). the fruit with control treatment could not reached up to last days of storage because maximum fruit were rotted at the that stage and further observations could not take. Similar result found in Bapirao (2015) [8], Bisen *et al.* (2012) [10] who recorded the organoleptic value of taste decreases with the advancement of storage period in all treatments.

**Table 6:** Effect of postharvest treatments on overall acceptability of sweet orange

Notations	Treatment	Overall acceptability			
		0 days	7 days	14 days	21 days
T <sub>0</sub>	Control	8.34	7.60	0.00	0.00
T <sub>1</sub>	CaCl <sub>2</sub> @ 1%	8.34	7.67	7.25	6.74
T <sub>2</sub>	CaCl <sub>2</sub> @ 3%	8.35	7.71	7.45	6.78
T <sub>3</sub>	GA <sub>3</sub> @ 0.05%	8.35	7.62	6.84	5.84
T <sub>4</sub>	GA <sub>3</sub> @ 0.1%	8.34	7.63	6.88	5.90
T <sub>5</sub>	KMnO <sub>4</sub> @ 1%	8.34	7.65	7.11	6.49
T <sub>6</sub>	KMnO <sub>4</sub> @ 2%	8.34	7.67	7.15	6.56
T <sub>7</sub>	Marigold Extract @ 4%	8.33	7.61	6.65	5.77
T <sub>8</sub>	Turmeric Mixture @ 4%	8.34	7.64	7.04	7.47
T <sub>9</sub>	<i>Aloe vera</i> @ 75%	8.34	7.66	7.20	6.68
	SE (m)±	NS	0.015	0.058	0.077
	C.D. at 5%	NS	0.045	0.173	0.227

## Conclusion

The findings of present investigation, it can conclude that the fruit treated with the CaCl<sub>2</sub> @ 3% (T<sub>2</sub>) were recorded maximum shelf-life days recorded at CaCl<sub>2</sub> @ 3% (21.26%) Followed by CaCl<sub>2</sub> @ 1% (20.40) days minimum shelf life (T<sub>0</sub>) control (10.35) days was recorded. Maximum Colour and appearance (7.64) flavour (7.65) texture (6.88) taste (6.75) overall acceptability (6.78) in CaCl<sub>2</sub> @ 3%.

## References

- Acharya B, Joshi B, Regmi R, Poudel N. Effect of plant extracts and packaging materials on prolonging shelf life and maintaining quality of mandarin (*Citrus reticulata* Blanco). *Int J Horticult Agric Food Sci*. 2020;4(2):29-35.
- Adetunji CO, Fawole OB, *et al.* Effect of edible coating from *Aloe vera* gel on *Citrus sinensis* during ambient storage. *J Agric Res Dev*. 2012;11(1):34-41.
- Amerine MA, Pangborn RM, Roessler EB. Principles of Sensory Evaluation of Food. New York: Academic Press; 1965. p. 1-602.
- Anonymous. Area, production and productivity of citrus in India. *Indian Horticult Database*. 2022. p. 1-58.
- Badawy FM, Eman AA, Zaid A, Esaraa, Hussein ME. Cracking and fruit quality of Manfalouty pomegranate as affected by pre-harvest chitosan, calcium chloride and gibberellic acid spraying. *Middle East J Agric Res*. 2019;8(3):873-882.
- Bakhla R, Joseph AV, Topno S. Effect of edible coating on shelf-life enhancement of papaya (*Carica papaya* L.) at ambient conditions. *Int J Plant Soil Sci*. 2023;35(14):385-393.
- Bangarusamy U. Postharvest losses in fruits and vegetables in India. *Indian Food Packer*. 2001;55(6):142-146.
- Bapurao KA. Studies on postharvest application of chemical and oil emulsions on shelf life, storability and quality of sweet orange (*Citrus sinensis* Osbeck) cv. Nucellar [MSc thesis]. Parbhani: Vasantrao Naik Marathwada Krishi Vidyapeeth; 2015. p. 42-92.
- Bhardwaj RL, Sen NL, Mukherjee S. Effect of benzyl adenine on the physio-chemical characteristics and shelf life of mandarin cv. Nagpur Santra. *Indian J Horticult*. 2005;62(2):181-183.
- Bisen A, Pandey SK, Patel N. Effect of skin coatings on prolonging shelf life of kagzi lime fruits (*Citrus aurantifolia* Swingle). *J Food Sci Technol*. 2012;49(6):753-759.
- Chadha KL. Handbook of Horticulture. Vol. 1. New Delhi: Indian Council of Agricultural Research; 2009. p. 446-450.
- Hassan ZH, Lesmayati S, Qomariah R, Hasbianto A. Effect of wax coating applications and storage temperatures on the quality of tangerine citrus (*Citrus reticulata* var. Siam Banjar). *Int Food Res J*. 2014;21(2):641-648.
- Hirwarale A, Manvar V, Vaidya N, Sakhare S, Gohade G. Study on profile of sweet orange growers. *Pharma Innov J*. 2023;12(1):1442-1444.
- Kakade P, Chavan B, Kakde A, Jadhav S. Effect of different chemicals along with wax on physical parameters and shelf life of sweet orange cv. Nucellar. *Indian J Agric Allied Sci*. 2021;7(4):102-107.
- Lakshmi BG, Reddy TV. Effect of post-harvest application of growth regulators and chemicals on shelf life and quality of sweet orange (*Citrus sinensis* L. Osbeck). *Karnataka J Agric Sci*. 2008;21(3):427-429.
- Ransingh RK, Sharma KJ, Goyal RK. Effect of oil emulsion and precooling on shelf life of mango cv. Amrapali. *Haryana J Horticult Sci*. 2003;32(1-2):54-55.
- Singh P, Kumar S, Maji S, Kumar S, Yadav Y. Effect of calcium chloride on postharvest changes in papaya fruits. *Asian J Horticult*. 2013;7(1):113-117.