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

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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 replications. Experiment treatment were T_0 Control, T_1 CaCl2 1%, T_2 CaCl2 3%, T_3 GA3 0.05%, GA3 0.1%, T_5 KMnO4 1%, T_6 KMnO4 2%, T_7 Marigold Extract 4%, T_8 Turmeric mixture 4%, T_9 *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 CaCl2 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) [11]. 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) [13].

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) [14]. 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 6th 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) [4].

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.

Pharmacologically, various parts of the plant have antioxidants [11], antidiabetic [12], Anticholesterol and antihypertensive [13], anti-malarial [14], anthelmintic [15], anti-viral [16], and antibacterial [17, 18] activities.

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) [7].

Potassium permanganate (KMnO4) 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 KMnO4 retarded the ripening of many fruits. CaCl2 with based coating are supportive to coating are supporting to maintain firmness and reduce physiology weight loss**.**GA_3 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 deseing with 10 treatment T_0 control T_1 $CaCl_2$ @ 1%, T_2 CaCl2 @ 3%T_3 GA3 @ 0.05%, T_4 GA3 @ 0.1%, T_5 KMnO4 @ 1%, T_6 KMnO4 @ 2% T_7 Marigold Extract @ 4%, T_8 Turmeric mixture @ 4% and T_9 *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 inboxes.

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 (I-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_2 (CaCl2 3%) was observed maximum shelf life (21.26) followed by Treatment T_1 (CaCl2 1%) (20.40) at 21 days storage period. The treatment T_0 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 coatings on shelf life of sweet orange

Notations	Treatment	Shelf life (Days)
T_0	Control	10.35
T_1	CaCl2 @ 1%	20.40
T_2	CaCl2 @ 3%	21.26
T_3	GA3 @ 0.05%	18.49
T_4	GA3 @ 0.1%	18.60
T_5	KMnO4 @ 1%	19.27
T_6	KMnO4 @ 2%	19.50
T_7	Marigold Extract @ 4%	16.02
T_8	Turmeric Mixture @ 4%	16.80
T_9	*Aloe vera* @ 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_2 CaCl2 @ 3% (8.24), followed by in treatments T_1 CaCl2 @ 1% (7.88). The minimum colour and appearance was recorded in control T_0 control treatment (6.15). After 14 days of storage, maximum colour and appearance was recorded in treatment T_2 CaCl2 @ 3% (7.71) followed by in treatment T_1 CaCl2 @ 1% (6.42). After days of storage, maximum colour and appearance was recorded in treatment T_2 CaCl2 @ 3% (7.64) followed by in treatment T_1 CaCl2 @ 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 coatings on colour and appearance of sweet orange

Notations	Treatment	Colour and appearance			
		0 days7	days14 days21 days		
T_0	Control	8.50	6.15	0.00	0.00
T_1	CaCl2 @ 1%	8.50	7.88	6.42	6.11
T_2	CaCl2 @ 3%	8.50	8.24	7.71	7.64
T_3	GA3 @ 0.05%	8.50	6.92	5.78	4.97
T_4	GA3 @ 0.1%	8.50	7.26	5.84	5.31
T_5	KMnO4 @ 1%	8.50	7.75	5.95	5.53
T_6	KMnO4 @ 2%	8.50	7.81	6.07	5.77
T_7	Marigold Extract @ 4%	8.50	6.33	5.72	4.93

T_8	Turmeric Mixture @ 4%	8.50	7.69	6.03	5.88
T_9	*Aloe vera* @ 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_2 CaCl2 @ 3% (8.61), followed by in treatments T_1 CaCl2 @ 1% (7.91). The minimum flavour was recorded in control T_0 control treatment (6.22).After 14 days of storage, maximum flavour was recorded in treatment T_2 CaCl2 @ 3% (7.75) followed by in treatment T_1 CaCl2 @ 1% (7.71).After 21 days of storage, maximum flavour was recorded in treatment T_2 CaCl2 @ 3% (7.65) followed by in treatment T_1 CaCl2 @ 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) [8]. Bisen *et al*. (2012) [10] who recorded the organoleptic value of taste decreases with the advancement of storage period in all treatments.

Table 3: Effect of postharvest coatings on flavour of sweet orange

Notations	Treatment		Flavour		
		0 days	7 days	14 days	21 days
T_0	Control	8.25	6.22	0.00	0.00
T_1	CaCl2 @ 1%	8.26	7.91	7.71	7.62
T_2	CaCl2 @ 3%	8.25	8.61	7.75	7.65
T_3	GA3 @ 0.05%	8.24	6.95	7.66	7.54
T_4	GA3 @ 0.1%	8.25	7.77	7.67	7.56
T_5	KMnO4 @ 1%	8.26	7.79	7.68	7.58
T_6	KMnO4 @ 2%	8.26	7.80	7.69	7.59
T_7	Marigold Extract @ 4%	8.25	6.49	7.53	6.49
T_8	Turmeric Mixture @ 4%	8.25	7.55	7.57	7.55
T_9	*Aloe vera* @ 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_2 CaCl2 @ 3% (7.92), followed by in treatments T_1 CaCl2 @ 1% (7.85). The minimum texture was recorded in control T_0 control treatment (6.65).After 14 days of storage, maximum texture was recorded in treatment T_2 CaCl2 @ 3% (7.70) followed by in treatment T_1 CaCl2 @ 1% (7.63). After 21 days of storage, maximum texture was recorded in treatment T_2 CaCl2 @ 3% (6.88) followed by in treatment T_1 CaCl2 @ 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) [8]. Bisen *et al*. (2012) [10] 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_0	Control	8.55	7.65	0.00	0.00
T_1	$CaCl_2$ @ 1%	8.54	7.85	7.63	6.80
T_2	$CaCl_2$ @ 3%	8.55	7.92	7.70	6.88
T_3	GA_3 @ 0.05%	8.55	7.72	6.89	6.58
T_4	GA_3 @ 0.1%	8.54	7.75	6.99	6.60
T_5	$KMnO_4$ @ 1%	8.54	7.80	7.56	6.70
T_6	$KMnO_4$ @ 2%	8.56	7.82	7.58	6.74
T_7	Marigold Extract @ 4%	8.55	7.70	6.79	6.55
T_8	Turmeric Mixture @ 4%	8.54	7.79	7.55	6.67
T_9	*Aloe vera* @ 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_2 CaCl2 @ 3% (7.82), followed by in treatments T_1 CaCl2 @ 1% (7.80). The minimum taste was recorded in control T_0 control treatment (7.72). After 14 days of storage, maximum taste was recorded in treatment T_2 CaCl2 @ 3% (7.68) followed by in treatment T_1 CaCl2 @ 1% (7.63).After 21 days of storage, maximum taste was recorded in treatment T_2 CaCl2 @ 3% (6.75) followed by in treatment T_1 CaCl2 @ 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) [8]. Bisen *et al*. (2012) [10] who recorded the organoleptic value of taste decreases with the advancement of storage period in all treatments.

Table 5: Effect of postharvest coatings on taste of sweet orange

Notations	Treatment	Taste (0 days)	7 days	14 days	21 days
T_0	Control	8.20	7.72	0.00	0.00
T_1	$CaCl_2$ @ 1%	8.20	7.80	7.63	6.68
T_2	$CaCl_2$ @ 3%	8.21	7.82	7.68	6.75
T_3	GA_3 @ 0.05%	8.21	7.74	6.72	5.87
T_4	GA_3 @ 0.1%	8.20	7.75	6.76	5.93
T_5	$KMnO_4$ @ 1%	8.20	7.77	7.55	6.52
T_6	$KMnO_4$ @ 2%	8.21	7.78	7.58	6.54
T_7	Marigold Extract @ 4%	8.20	7.73	6.69	5.72
T_8	Turmeric Mixture @ 4%	8.20	7.76	7.55	6.44
T_9	*Aloe vera* @ 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_2 CaCl2 @ 3% (7.71), followed by in treatments T_1 CaCl2 @ 1% (7.67). Theminimum of overall acceptability was recorded in control T_0 control treatment (7.60). After 14 days of storage, maximum of overall acceptability was recorded in treatment T_2 CaCl2 @ 3% (7.45) followed by in treatment T_1 CaCl2 @ 1% (7.25).After 21 days of storage, maximum of overall acceptability was recorded in treatment T_2 CaCl2 @ 3% (6.78) followed by in treatment T_1 CaCl2 @ 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 coatings on overall acceptability of sweet orange

Notations	Treatment	Overall acceptability			
		0 days	7 days	14 days	21 days
T_0	Control	8.34	7.60	0.00	0.00
T_1	CaCl2 @ 1%	8.34	7.67	7.25	6.74
T_2	CaCl2 @ 3%	8.35	7.71	7.45	6.78
T_3	GA3 @ 0.05%	8.35	7.62	6.84	5.84
T_4	GA3 @ 0.1%	8.34	7.63	6.88	5.90
T_5	KMnO4 @ 1%	8.34	7.65	7.11	6.49
T_6	KMnO4 @ 2%	8.34	7.67	7.15	6.56
T_7	Marigold Extract @ 4%	8.33	7.61	6.65	5.77
T_8	Turmeric Mixture @ 4%	8.34	7.64	7.04	7.47
T_9	*Aloe vera* @ 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 CaCl2 @ 3% (T_2) were recorded maximum shelf-life days recorded at CaCl2 @ 3% (21.26%) Followed by CaCl2 @ 1% (20.40) days minimum shelf life (T_0) 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 CaCl2 @ 3%.

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