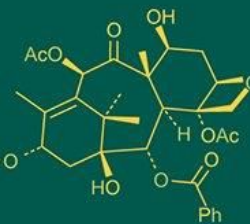
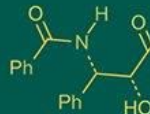
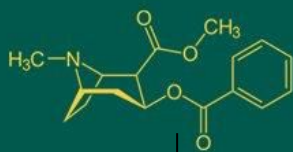


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Changes in textural properties of sweet orange cv. Phule Mosambi during storage

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Abstract

The study was performed in Factorial Completely Randomized Design to evaluate the interactive effect of chemicals (Salicylic Acid @ 400 ppm, Putrescine @ 100 ppm, Hexanal 0.02%; singly and in combination) and storage conditions (Ambient Condition: 24-30 °C, RH 47.50-74.00% and Cold storage: 12±2 °C, RH 90.00-95.00%) in three replications. The fruit firmness was found to be concomitantly decreased in all treatments with the progression of the storage period, irrespective of post-harvest treatments. The treatment with C₃ i.e. Hexanal 0.02% maintained the best fruit firmness under both storage conditions. The maximum shelf life was observed in C₃ i.e. Hexanal 0.02% under both storage conditions.

Keywords: Sweet orange, Phule Mosambi, firmness, hexanal

Introduction

Fruit firmness is a crucial index for checking the quality of fruit for storability and acceptance from the consumer's point of view which dictates its marketability (Valero *et al.*, 2003) [11]. The loss of firmness concomitantly results in greater extent of spoilage making it easier for the entry of pathogens. Due to the fact that citrus is a non-climacteric fruit, the post-harvest softening of the fruit is mostly connected with the loss of water from the peel, which rises with maturity and senescence (Spiegel-Roy and Goldschmidt, 1996; Kawada *et al.*, 1979) [9, 6]. Whilst citrus has a good reserve of pectin, the dissolution of the membranal pectin into soluble pectin is fairly slow in maturing citrus fruit. However, the malonic acid content is high which is a strong indicator of tissue senescence (Eaks and Sinclair, 1980; Monselise, 1977) [3, 7]. Citrus fruit softening is also due to invasion of the peel by pathogens that secrete enzymes which degrades the cell-wall (Eckert and Eaks, 1989) [4]. Citrus fruit firmness is highly dependent on the storage condition especially humidity, temperature of lower range with higher relative humidity is ideal for maintaining the firmness owing to lesser metabolic reactions (Wardowski *et al.*, 2006) [12].

Methodology

The experiment was carried out at Post-harvest Technology Laboratory, Department of Horticulture, MPKV, Rahuri, during 2022-2023. The investigation was conducted in Factorial Completely Randomized Design in three replications with two factors: Factor-A: Chemicals (Salicylic Acid @ 400 ppm, Putrescine @ 100 ppm, Hexanal 0.02%; singly and in combination); Factor-B: Storage conditions (Ambient Condition: 24-30 °C, RH 47.50-74.00% and Cold storage: 12 ± 2 °C, RH 90.00-95.00%)

The firmness of fresh Sweet orange fruit was measured using an Instron Universal Testing Instrument (Make: Shimadzu, Japan; Model: AX-G) and expressed as Newton (N).

Results and Discussion

The data with respect to firmness of sweet orange fruits as influenced by different post-harvest chemical dipping and storage conditions have been presented in Table 1. The fruit firmness was found to be concomitantly decreased in all treatments with the progression of the storage period, irrespective of post-harvest treatments.

The firmness of stored sweet orange fruits was found to be significantly influenced by the post-harvest chemical dipping but continuously decreased as the storage progressed.

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On 5th day of storage, the chemical dipping had a non-significant effect on the firmness of stored sweet orange fruit during storage. The firmness ranged between 22.87 N and 23.83 N, the highest firmness was observed in C₃ *i.e.* Hexanal 0.02% (23.83 N) whereas the least was recorded in C₇ *i.e.* Control (Untreated) (22.87 N). On 15th day of storage, firmness of sweet orange had significant variation during storage. The maximum firmness was observed in C₃ *i.e.* Hexanal 0.02% (21.69 N) which was at par with C₄ *i.e.* Salicylic Acid @ 400 ppm + Putrescine @ 100 ppm, C₁ *i.e.* Salicylic Acid @ 400 ppm and C₂ *i.e.* Putrescine @ 100 ppm (20.99 N, 20.77 N, 20.03 N respectively) while the least was recorded in C₇ *i.e.* Control (Untreated) (18.93 N). On 30th day of storage, firmness of sweet orange was significantly influenced by the chemicals. The treatment C₃ *i.e.* Hexanal 0.02% recorded highest firmness (17.95 N) whereas the least (13.78 N) was observed in treatment C₆ *i.e.* Putrescine @ 100 ppm + Hexanal 0.02%. On 45th day of storage, fruit treated with C₄ *i.e.* Salicylic Acid @ 400 ppm + Putrescine @ 100 ppm showed the highest firmness (15.32 N) and was at par with C₄ *i.e.* Salicylic Acid @ 400 ppm + Putrescine @ 100 ppm (14.91 N) and C₂ *i.e.* Putrescine @ 100 ppm (14.83 N) whereas fruits of C₇ *i.e.* Control (Untreated) recorded the least (10.38 N). On 60th day of storage, the fruit of treatment C₆ *i.e.* Putrescine @ 100 ppm + Hexanal 0.02% and C₇ *i.e.* Control (Untreated) were discarded due to spoilage and overall unacceptability. The highest firmness was recorded in C₃ *i.e.* Hexanal 0.02% (12.72 N) and was at parity with C₄ *i.e.* Salicylic Acid @ 400 ppm + Putrescine @ 100 ppm (12.20 N) while the least (10.43 N) was observed in C₂ *i.e.* Putrescine @ 100 ppm. On 65th day of storage, only the fruit treated with C₃ *i.e.* Hexanal 0.02% and C₄ *i.e.* Salicylic Acid @ 400 ppm + Putrescine @ 100 ppm remained with firmness of 10.69 N and 10.34 N respectively, each of which differed significantly from the other.

The firmness of stored sweet orange fruits was found to be significantly influenced by the storage conditions. On 15th and 30th day of storage, firmness of fruit stored under ambient conditions (S₁) was 19.47 N and 13.51 N respectively. At the end of storage period at ambient conditions, fruit firmness decreased from 24.09 to 10.23 N. On 68th day, the fruit in cold storage (S₂) were discarded due to unacceptable fruit quality. Cold storage was significantly superior and recorded a minimal decrease of firmness of 24.09 to 10.45 N in a span of 68 days upon the conclusion of the storage period.

The interactive effect of the post-harvest chemical dipping and storage conditions was found to be non-significant up to the 20th day of storage. The rate of decrease in fruit firmness was more accelerated in the fruit stored at ambient conditions as compared to that of the fruits stored in cold storage. On 5th day of storage, fruit firmness was found to be non-significantly influenced by the combined effect of the chemical dipping and storage conditions. The highest firmness was recorded in C₃S₂ *i.e.* Hexanal 0.02% at cold storage *i.e.* (23.94 N) while the least was recorded in C₇S₁ *i.e.* Control (Untreated) at ambient conditions (22.63 N). On 15th day of storage, fruit firmness was found to be non-significantly influenced by chemical and storage conditions. The highest firmness was recorded in C₃S₂ *i.e.* Hexanal 0.02% at cold storage *i.e.* (21.96 N) while the least was recorded in C₇S₁ *i.e.* Control (Untreated) at ambient conditions (17.80 N). On 30th day of storage, effect of chemical and storage conditions showed significant

influence on fruit firmness of sweet orange. The treatment combination C₇S₁ *i.e.* Control (Untreated) at ambient conditions was discarded due to spoilage and was not acceptable. The treatment combination C₃S₂ *i.e.* Hexanal 0.02% at cold storage recorded highest firmness (18.81 N) and exhibited parity with C₄S₂ *i.e.* Salicylic Acid @ 400 ppm + Putrescine @ 100 ppm in cold storage (18.54 N), C₂S₂ *i.e.* Salicylic Acid @ 400 ppm + Hexanal 0.02% in cold storage (18.08 N), C₁S₂ *i.e.* Salicylic Acid @ 400 ppm in cold storage (18.05 N) and C₆S₂ *i.e.* Putrescine

@ 100 ppm + Hexanal 0.02% in cold storage (18.01 N). The treatment combination C₆S₁ *i.e.* Putrescine @ 100 ppm + Hexanal 0.02% at ambient conditions recorded the least (10.24 N). On 45th day of storage, fruits treated with C₃S₂ *i.e.* Hexanal 0.02% at cold storage showed highest firmness (15.64 N) which exhibited parity with C₄S₂ *i.e.* Salicylic Acid @ 400 ppm + Putrescine @ 100 ppm in cold storage (15.32 N) while fruits treated with C₃S₁ *i.e.* Hexanal 0.02% at ambient condition recorded the minimum (10.23 N). On 60th day of storage, the fruit of all treatments in S₁ in combination with different chemicals were discarded due to spoilage and were not acceptable. The highest firmness was recorded in C₃S₂ *i.e.* Hexanal 0.02% at cold storage (12.72 N) and was at par with C₄S₂ *i.e.* Salicylic Acid @ 400 ppm + Putrescine @ 100 ppm in cold storage (12.20 N) while the least was recorded in treatment combination of C₂S₂ *i.e.* Putrescine @ 100 ppm at cold storage (10.43 N). On 65th day of storage, only two out of the total treatment combinations remained *viz.* C₃S₂ *i.e.* Hexanal 0.02% at cold storage (10.69 N) and C₄S₂ *i.e.* Salicylic Acid @ 400 ppm + Putrescine @ 100 ppm at cold storage (10.34 N). In the beginning of storage period, no critical difference of fruit firmness was observed in between the different treatments. However, the difference was more evident as the storage study progressed. The firmness followed a decreasing trend as the study went on regardless of the treatment received. At the end of the study in the cold storage on 68th day, firmness of 10.45 N was recorded while the firmness of the untreated control under ambient condition recorded 11.23 N upon the conclusion of the storage period on 25th day of storage. This distinctively showed the superior effect of the treatments over the control.

The firmness of the fruit decreases gradually as a result of moisture loss in the inner fruit cells, which leads to the formation of intercellular spaces. Hexanal is an anti-senescent plant extract that inhibits the action of phospholipase D, thus the dipping of fruit in hexanal slowed down the ethylene stimulation and overall softening process (Karthika *et al.* 2015) [5]. This effect of hexanal on firmness was reported by Baltazari *et al.* (2019) [1]. The fungicidal property of Bavistin and the wax coating contributed greatly to the decrement of the loss of moisture as well as microbial inhibition by limiting the entry of invasive pathogens, as reported by Bhandari *et al.* (2020) [2] in sweet orange and Rokaya *et al.* (2016) [8] in mandarin. As the study duration prolonged, the firmness continually decreased across all treatments regardless of the treatment received, however the rate of decrease was much slower in the fruit stored in cold storage in comparison to the fruit stored in the ambient condition. The capability to maintain the firmness could be credited to the reduction of diffusion of gases through the fruit surface by the chemical dipping and wax coating delaying the fruit's metabolism (Valero and Serrano, 2010) [10].

Table 1: Effect of post-harvest treatments on firmness (N) of sweet orange fruits cv. Phule Mosambi during storage

Treatment	Initial Day			5 th Day			10 th Day			15 th Day			20 th Day		
	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled
Chemicals															
C ₁	24.15	24.04	24.09	23.62	23.39	23.50	21.86	22.16	22.01	20.54	21.01	20.77	18.67	19.54	19.10
C ₂	24.15	24.04	24.09	23.01	23.56	23.28	21.94	22.05	21.99	20.37	19.70	20.03	18.51	18.17	18.34
C ₃	24.15	24.04	24.09	23.90	23.76	23.83	22.79	22.87	22.83	21.44	21.95	21.69	20.37	20.46	20.41
C ₄	24.15	24.04	24.09	23.72	23.72	23.72	22.27	22.06	22.16	20.97	21.00	20.99	19.52	19.55	19.53
C ₅	24.15	24.04	24.09	23.23	23.49	23.36	21.31	22.10	21.70	19.97	19.54	19.75	18.17	18.10	18.13
C ₆	24.15	24.04	24.09	23.18	23.46	23.32	20.99	20.97	20.98	19.89	19.50	19.69	18.21	17.91	18.06
C ₇	24.15	24.04	24.09	22.76	22.99	22.87	21.11	20.99	21.05	19.19	18.68	18.93	15.98	16.61	16.29
SEm (±)				0.26	0.18	0.16	0.66	0.59	0.44	0.64	0.69	0.47	0.57	0.58	0.41
CD 1%				NS	NS	NS	NS	NS	NS	NS	NS	1.85	2.38	2.44	1.58
Storage															
S ₁	24.15	24.04	24.09	23.14	23.37	23.26	21.35	21.38	21.37	19.70	19.24	19.47	17.35	17.12	17.24
S ₂	24.15	24.04	24.09	23.54	23.58	23.56	22.16	22.38	22.27	20.97	21.15	21.06	19.62	20.15	19.88
SEm (±)				0.14	0.10	0.08	0.35	0.32	0.24	0.34	0.37	0.25	0.37	0.38	0.27
CD 1%				NS	NS	NS	NS	NS	NS	NS	1.56	0.99	1.27	1.31	0.85
AxB															
C ₁ S ₁	24.15	24.04	24.09	23.51	23.11	23.31	21.13	21.40	21.27	20.32	20.16	20.24	18.18	18.31	18.25
C ₂ S ₁	24.15	24.04	24.09	22.49	23.48	22.99	21.47	21.39	21.43	19.47	18.36	18.92	16.90	16.10	16.50
C ₃ S ₁	24.15	24.04	24.09	23.78	23.67	23.72	22.71	22.83	22.77	20.90	21.96	21.43	19.74	20.08	19.91
C ₄ S ₁	24.15	24.04	24.09	23.60	23.62	23.61	21.91	21.63	21.77	20.20	20.46	20.33	18.64	18.56	18.60
C ₅ S ₁	24.15	24.04	24.09	23.12	23.44	23.28	21.25	21.34	21.30	19.42	18.20	18.81	17.26	16.04	16.65
C ₆ S ₁	24.15	24.04	24.09	23.19	23.36	23.28	20.65	20.68	20.66	19.33	18.20	18.77	17.25	16.27	16.76
C ₇ S ₁	24.15	24.04	24.09	22.33	22.93	22.63	20.35	20.41	20.38	18.26	17.34	17.80	13.51	14.46	13.99
C ₁ S ₂	24.15	24.04	24.09	23.73	23.66	23.70	22.58	22.91	22.75	20.76	21.85	21.31	19.15	20.77	19.96
C ₂ S ₂	24.15	24.04	24.09	23.52	23.64	23.58	22.42	22.70	22.56	21.26	21.04	21.15	20.12	20.24	20.18
C ₃ S ₂	24.15	24.04	24.09	24.02	23.85	23.94	22.88	22.91	22.90	21.98	21.93	21.96	20.99	20.84	20.92
C ₄ S ₂	24.15	24.04	24.09	23.85	23.81	23.83	22.64	22.48	22.56	21.74	21.54	21.64	20.39	20.53	20.46
C ₅ S ₂	24.15	24.04	24.09	23.34	23.54	23.44	21.36	22.85	22.11	20.52	20.88	20.70	19.08	20.15	19.62
C ₆ S ₂	24.15	24.04	24.09	23.16	23.56	23.36	21.33	21.27	21.30	20.45	20.79	20.62	19.17	19.54	19.36
C ₇ S ₂	24.15	24.04	24.09	23.18	23.04	23.11	21.88	21.57	21.73	20.11	20.01	20.06	18.44	18.76	18.60
SEm (±)				0.37	0.26	0.22	0.94	0.84	0.63	0.91	0.98	0.67	0.80	0.82	0.57
CD 1%				NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

C₁: Salicylic Acid @ 400 ppmC₂: Putrescine @ 100 ppmC₃: Hexanal 0.02%C₄: Salicylic Acid @ 400 ppm + Putrescine @ 100 ppmC₅: Salicylic Acid @ 400 ppm + Hexanal 0.02%C₆: Putrescine @ 100 ppm + Hexanal 0.02%C₇: Control (Untreated)S₁: Ambient Condition (24-30°C, RH 47.50-74.00%)S₂: Cold storage (12 ± 2 °C, RH 90.00-95.00)

Treatment	25 th Day			30 th Day			35 th Day			40 th Day			45 th Day		
	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled
A. Chemicals															
C ₁	17.68	17.97	17.82	15.68	16.50	16.09	14.72	15.11	14.91	12.94	13.43	13.18	14.12	15.36	14.74
C ₂	16.56	16.93	16.74	15.14	15.48	15.31	13.77	13.82	13.79	16.51	16.48	16.50	14.31	15.34	14.83
C ₃	19.03	19.38	19.20	17.79	18.12	17.95	16.33	16.76	16.54	14.60	15.19	14.89	12.77	13.10	12.93
C ₄	18.08	17.79	17.93	16.62	16.71	16.66	14.96	15.04	15.00	13.39	13.46	13.43	15.01	15.62	15.32
C ₅	16.07	16.95	16.51	15.03	15.27	15.15	13.37	13.97	13.67	15.87	16.32	16.10	14.67	15.15	14.91
C ₆	16.37	15.93	16.15	13.66	13.90	13.78	16.14	15.75	15.95	15.50	15.58	15.54	14.64	13.96	14.30
C ₇	14.06	14.38	14.22	16.55	16.02	16.29	14.25	14.77	14.51	12.87	12.34	12.61	10.32	10.44	10.38
SEm (±)	0.34	0.21	0.20	0.37	0.25	0.22	0.22	0.29	0.19	0.10	0.18	0.14	0.24	0.14	0.13
CD 1%	1.43	0.90	0.79	1.56	1.08	0.87	0.94	1.23	0.74	0.46	0.81	0.56	1.02	0.67	0.54
B. Storage															
S ₁	14.89	15.19	15.04	13.47	13.56	13.51	12.06	12.30	12.18	10.87	11.46	8.38	10.19	10.27	4.09
S ₂	18.78	18.90	18.84	17.65	18.09	17.87	16.62	16.91	16.77	15.71	15.78	15.75	14.06	14.54	14.30
SEm (±)	0.18	0.11	0.11	0.21	0.15	0.12	0.14	0.18	0.10	0.08	0.15	0.07	0.34	0.14	0.07
CD 1%	0.76	0.48	0.42	0.90	0.62	0.46	0.60	0.78	0.40	0.37	0.66	0.30	1.61	0.67	0.29
C. AxB															
C ₁ S ₁	16.46	16.38	16.42	14.12	14.13	14.13	12.94	12.54	12.74	10.37	10.34	10.36	-	-	-
C ₂ S ₁	14.06	14.79	14.43	12.24	12.84	12.54	10.25	10.06	10.16	-	-	-	-	-	-
C ₃ S ₁	18.07	19.26	18.67	16.90	17.29	17.10	14.69	15.64	15.17	12.24	13.61	12.93	10.19	10.27	10.23
C ₄ S ₁	16.95	16.23	16.59	14.92	14.67	14.79	12.34	12.37	12.36	10.01	10.44	10.23	-	-	-
C ₅ S ₁	14.09	14.34	14.22	12.55	12.02	12.28	10.10	10.89	10.50	-	-	-	-	-	-
C ₆ S ₁	13.77	13.66	13.72	10.09	10.40	10.24	-	-	-	-	-	-	-	-	-
C ₇ S ₁	10.81	11.65	11.23	-	-	-	-	-	-	-	-	-	-	-	-
C ₁ S ₂	18.89	19.56	19.23	17.23	18.87	18.05	16.50	17.67	17.09	15.51	16.51	16.01	14.12	15.36	14.74
C ₂ S ₂	19.06	19.06	19.06	18.04	18.11	18.08	17.28	17.58	17.43	16.51	16.48	16.50	14.31	15.34	14.83
C ₃ S ₂	19.98	19.49	19.74	18.68	18.94	18.81	17.96	17.87	17.92	16.95	16.76	16.86	15.34	15.93	15.64
C ₄ S ₂	19.20	19.34	19.27	18.32	18.75	18.54	17.58	17.70	17.64	16.77	16.49	16.63	15.01	15.62	15.32
C ₅ S ₂	18.05	19.56	18.80	17.51	18.52	18.01	16.64	17.04	16.84	15.87	16.32	16.10	14.67	15.15	14.91
C ₆ S ₂	18.96	18.19	18.58	17.23	17.40	17.31	16.14	15.75	15.95	15.50	15.58	15.54	14.64	13.96	14.30
C ₇ S ₂	17.30	17.10	17.20	16.55	16.02	16.29	14.25	14.77	14.51	12.87	12.34	12.61	10.32	10.44	10.38
SEm (±)	0.48	0.30	0.28	0.52	0.36	0.32	0.31	0.40	0.27	0.14	0.25	0.20	0.24	0.17	0.15
CD 1%	2.02	1.28	1.11	2.20	1.52	1.23	1.33	1.75	1.05	0.64	1.14	0.79	1.16	0.72	0.59

C₁: Salicylic Acid @ 400 ppmC₂: Putrescine @ 100 ppmC₃: Hexanal 0.02%C₄: Salicylic Acid @ 400 ppm + Putrescine @ 100 ppmC₅: Salicylic Acid @ 400 ppm + Hexanal 0.02%C₆: Putrescine @ 100 ppm + Hexanal 0.02%C₇: Control (Untreated)S₁: Ambient Condition (24-30°C, RH 47.50-74.00%)S₂: Cold storage (12 ± 2 °C, RH 90.00-95.00)

Treatment	50 th Day			55 th Day			60 th Day			65 th Day			68 th Day		
	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled
A. Chemicals															
C ₁	13.05	14.78	13.92	11.26	12.05	11.66	10.83	10.25	10.54	-	-	-	-	-	-
C ₂	13.27	14.33	13.80	11.29	12.65	11.97	10.29	10.57	10.43	-	-	-	-	-	-
C ₃	14.79	14.73	14.76	13.78	13.44	13.61	12.67	12.76	12.72	10.86	10.52	10.69	10.62	10.28	10.45
C ₄	14.44	14.33	14.39	13.54	13.07	13.31	12.28	12.11	12.20	10.55	10.13	10.34	-	-	-
C ₅	13.02	14.18	13.60	12.36	12.75	12.56	10.77	10.74	10.75	-	-	-	-	-	-
C ₆	12.63	11.99	12.31	10.16	10.54	10.35	-	-	-	-	-	-	-	-	-
C ₇	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SEm (±)	0.22	0.21	0.15	0.27	0.22	0.17	0.20	0.12	0.12	0.08	0.06	0.05	-	-	-
CD 1%	1.15	1.10	0.65	1.44	1.13	0.75	1.16	0.67	0.53	NS	NS	0.31	-	-	-
B. Storage															
S ₁	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S ₂	13.53	14.06	13.80	12.07	12.42	12.24	11.37	11.29	11.33	10.71	10.33	10.52	10.62	10.28	10.45
SEm (±)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CD 1%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. AxB															
C ₁ S ₁	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C ₂ S ₁	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C ₃ S ₁	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C ₄ S ₁	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C ₅ S ₁	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C ₆ S ₁	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C ₇ S ₁	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C ₁ S ₂	13.05	14.78	13.92	11.26	12.05	11.66	10.83	10.25	10.54	-	-	-	-	-	-
C ₂ S ₂	13.27	14.33	13.80	11.29	12.65	11.97	10.29	10.57	10.43	-	-	-	-	-	-
C ₃ S ₂	14.79	14.73	14.76	13.78	13.44	13.61	12.67	12.76	12.72	10.86	10.52	10.69	10.62	10.28	10.45
C ₄ S ₂	14.44	14.33	14.39	13.54	13.07	13.31	12.28	12.11	12.20	10.55	10.13	10.34	-	-	-
C ₅ S ₂	13.02	14.18	13.60	12.36	12.75	12.56	10.77	10.74	10.75	-	-	-	-	-	-
C ₆ S ₂	12.63	11.99	12.31	10.16	10.54	10.35	-	-	-	-	-	-	-	-	-
C ₇ S ₂	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SEm (±)	0.22	0.21	0.15	0.27	0.22	0.17	0.20	0.12	0.12	0.08	0.06	0.05	-	-	-
CD 1%	1.15	1.10	0.65	1.44	1.13	0.75	1.16	0.67	0.53	NS	NS	0.31	-	-	-

C₁: Salicylic Acid @ 400 ppmC₂: Putrescine @ 100 ppmC₃: Hexanal 0.02%C₄: Salicylic Acid @ 400 ppm + Putrescine @ 100 ppmC₅: Salicylic Acid @ 400 ppm + Hexanal 0.02%C₆: Putrescine @ 100 ppm + Hexanal 0.02%C₇: Control (Untreated)S₁: Ambient Condition (24-30 °C, RH 47.50-74.00%)S₂: Cold storage (12 ± 2 °C, RH 90.00-95.00)

Conclusion

The fruit firmness of sweet orange fruits was found to be decreased significantly as the storage period prolonged in all treatments irrespective of storage conditions. The treatment with C₃ i.e. Hexanal 0.02% maintained the best fruit firmness under both storage conditions. The highest shelf life of sweet orange fruit (68 days) was recorded in C₃S₂ i.e. Hexanal 0.02% stored in cold storage. The minimum shelf life (28 days) was recorded in C₇S₁ i.e. control (untreated) + stored under ambient condition.

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