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Virkar AM
Ph.D. Scholar, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, Maharashtra, India

Garande VK
Associate Professor of Horticulture, (Pomology) Zonal Agriculture Research station Ganeshkhind, Pune, Maharashtra, India

Extension of shelf life of minimally processed of sweet orange (*Citrus sinensis* Osbeck) cv. Phule mosambi

Virkar AM and Garande VK

Abstract

An investigation on “Extension of shelf life of minimally processed of sweet orange (*Citrus sinensis* Osbeck) cv. Phule Mosambi” was carried out during February 2019 to December 2020 at laboratory of Postharvest Technology, Department of Horticulture, MPKV, Rahuri, Dist. Ahmednagar. The research study included two experiments. In the experiment, the design followed was FCRD (Factorial Completely Randomized Design) with factorial concept with two replications per treatment.

The effect of different chemicals, packaging materials and storage conditions on quality and shelf of minimally processed sweet orange cv. Phule Mosambi. The experiment was laid out with consisting of three factors i.e.

Factor A: Chemical treatments (Citric acid-0.5%, 1%, 1.5%, Ascorbic acid- 0.5%, 1%, 1.5%, Chitosan-0.1%, 0.2%, 0.3% and Untreated control.).

Factor B: Packaging materials (Punnet, PP bags and NSBB).

Factor C: Storage conditions (Ambient temperature and Cold storage at 12 ± 2 °C and 85% RH) laid out in factorial completely randomized design (FCRD) in two replications with total sixty different treatment combinations. The minimally processed sweet orange segment were analysed for physio-chemical parameters at an interval of two days. The data revealed that, the lowest PLW, titratable acidity, total microbial count were recorded in C₉P₃S₂ i.e. Chitosan 0.3% + NSBB + Cold storage (12 ± 2 °C) (9.10%, 0.36%, 0.33 CFU/g, respectively) followed by C₉P₂S₂ i.e. Chitosan 0.3% + Poly propylene bags + Cold storage (9.80%, 0.38%, 0.65 CFU/g, respectively) while the maximum retention of TSS, total sugars, reducing sugars, non-reducing sugars ascorbic acid, TSS to acidity ratio and organoleptic score for colour, flavour, taste, appearance, overall acceptability noticed in C₉P₃S₂ (10.23⁰Brix, 7.12%, 4.47%, 2.65%, 53.66 mg/100g, 28.21, 8.16, 8.34, 8.55, 8.26, 8.22, respectively) at the end of on 5th day of storage under cold storage conditions (12 ± 2 °C and 85.00% RH). From concluded that sweet orange segments pre-treated with chitosan @ 0.3% i.e. C₉P₃S₂ packed in Nano-silver based bags with 2% vents and stored at cold storage (12 ± 2 °C) was found to be the best treatment for extension of shelf life of minimally processed sweet.

Keywords: Shelf life, segments, minimally, chemical, Citrus

Introduction

Sweet orange (*Citrus sinensis* Osbeck.) belongs to family Rutaceae and originated from Southern China. Sweet orange is considered as most vital fruit crop of citrus group with their healthful nature multifold nutrition and its medicinal properties have made them so important. Now in India sweet orange is widely distributed and naturalized in sub-tropical zone. The market of minimally processed foods has grown rapidly in recent years due to the health welfares and suitability associated with these foods. Its growth has increased the awareness regarding microbiological and physiological aspects associated with the quality. The consumerism tendency depends on multi-factors as nutritional value, simplicity, safety and convenience. All these characteristics must be considered in minimal processing. Minimally processed foods have formed the well-established market and engulf the capital investment. Temperature has a direct relationship with the freshness and metabolic reactions of a minimally processed product (Brecht, 1996) [12]. The life span of MP products is influenced by temperature. The integrity of the cold chain system from the supplier to the end-user is the critical component in achieving maximum shelf life, quality and food safety. All minimally processed products are highly perishable and demonstrate rapid postharvest quality degradation over time under ambient storage (Shewfelt, 1987) [13]. Degradation of quality is primarily due to respiration and ripening process which eventually resulted in subsequent tissue senescence as energy stores are depleted, water loss via transpiration, decay and mould growth and mechanical damage (Marita 1996) [14].

Corresponding Author:
Virkar AM
Ph.D. Scholar, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, Maharashtra, India

The use of modified atmosphere packaging will undoubtedly play a major role in overall preservation for highly perishable products. The minimally processed fruit market continues to expand both for the food service and retail markets.

Methodology: Experiment was carried out at Post-harvest Technology Laboratory, Department of Horticulture, MPKV, Rahuri, during 2019-22 consisting of three factors i.e.

Factor A: Chemical treatments (Citric acid- 0.5%, 1%, 1.5%, Ascorbic acid- 0.5%, 1%, 1.5%, Chitosan-0.1%, 0.2%, 0.3% and Untreated control.),

Factor B: Packaging materials (Punnet, PP bags and NSBB) and

Factor C: Storage conditions (Ambient temperature and Cold storage at 12 ± 2 °C and 85% RH) laid out in factorial completely randomized design (FCRD) in two replications with total sixty different treatment combinations.

Result and Discussion

Physical parameters

Physiological loss in weight (%)

The data presented in Table 4.14 revealed that, PLW (%) of minimally processed segments in general increased with advancement of the storage period. Fig.14

Individual effect of different chemicals found significant with respect to Physiological loss in weight (%). Maximum increase in Physiological loss in weight (%) were recorded up to 2th days in C10 (3.17%) (Untreated control) and lowest in 5th days in C9 Chitosan (5.79%) as a result of chemical treatments. C3 (7.71%) recorded maximum increase in Physiological loss in weight (%) followed by (7.57%) C8 and minimum in C₉ (3.81%). On 4th day C3 and C₁ reported maximum Physiological loss in weight (%) (7.71%) followed by (7.08%) at 4th day. On 5th day only segments treated with C9 (Chitosan 0.3%) could remain in storage with 5.79% PLW.

Packaging materials resulted significant variation in data with respect to Physiological loss in weight (%) during storage except at 2th, 4th and 5th day. Increase in Physiological loss in weight (%) was maximum in P1 and P₂ as compare to P3. At the end of storage life Physiological loss in weight (%) observed in P2, P1 and P3 was 2.85, 2.54 and 2.05%, 6.45, 5.98 and 5.35, 7.52, 6.57 and 6.28% (2nd, 4th and 5th day) respectively.

Cold storage was found superior as it recorded minimum increase in PLW. At end of storage (5th day), segments under cold storage (S2) recorded 5.80% PLW.

Physiological loss in weight (%) was varied significantly with different storage conditions. Increase in Physiological loss in weight (%) was found very fast in S2 than S1. Physiological loss in weight (%) content of segments found increased from 5.26 to 6.59% within 4th days at ambient temperature, whereas

in cold storage Physiological loss in weight (%) decreased from 00.00 to 5.80% up to the 5th day.

The interaction between different chemicals and packaging materials revealed significant variation in Physiological loss in weight (%). Interaction effect on Physiological loss in weight (%) could be recorded up to 5th days and only three (treatments) the segments treated with C9P1, C9P2 and C9P3 were remained acceptable up to 5th days.

Among all interactions C9P1, C9P2 and C9P3 performed best at it exhibited maximum extend the shelf life in Physiological loss in weight (%) throughout the storage period. On 5th three treatments retained lowest Physiological loss in weight (%) (5.25, 5.74 and 4.28%).

The data regarding Physiological loss in weight (%) was varied significantly with interaction effect of chemicals and storage conditions throughout the storage period. Interaction effect of chemicals with ambient temperature could be recorded up to 4th days due to further loss shelf life. Segments treated with C3S1 revealed maximum increase in Physiological loss in weight (%) and recorded higher (9.32%) Physiological loss in weight (%) at the end of storage life. Interaction effect of chemicals with cold storage could be recorded up 5th days. Interaction C9S2 was found superior as it recorded highest Physiological loss in weight (%) on 5th day (5.27%). Only the segments treated with C9S2 maintained its acceptability up to 5th day with 5.27% of Physiological loss in weight (%).

Two factor interactions between packaging material and storage conditions revealed significant and non-significant effect on Physiological loss in weight (%). Segments packed in different packaging material and stored at ambient storage revealed faster increase in Physiological loss in weight (%) as compare to that of the cold storage. P3S₂ performed best under both storage conditions which recorded (6.00 to 6.93%) than other packaging materials.

Three factor interactions effect of chemicals, packaging materials and storage conditions revealed non-significant variation in Physiological loss in weight (%) throughout the storage period. Segments stored in ambient conditions exhibited faster increase in Physiological loss in weight (%) than cold storage irrespective of the chemicals and packaging material. Interaction effect could be recorded up to 4th days due to further loss of shelf life of segments. Interaction C1P2S1 found excellent to record maximum increase and retained higher Physiological loss in weight (%) (11.60%) at the end of storage. Physiological loss in weight (%) content of segments stored in cold storage could recorded up to 5th days. On 2th, 4th and 5th day C6P3S2 and C9P3S2 (1.47, 2.63 and 4.29%) reported higher Physiological loss in weight (%). Only the segments treated with same treatment combination were lasted up to 5th day with (4.29%) of Physiological loss in weight (%).

Table 1: Effect of different postharvest treatments on PLW (%) of minimal segment cv. Phule mosambi during storage.

Treatment	Initial days			2 DAS			4 DAS			5 DAS		
	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled	Trial 1	Trial 2	Pooled
C1	0.00	0.00	0.00	2.07	2.73	2.40	5.07	9.10	7.08	0.00	0.00	0.00
C2	0.00	0.00	0.00	1.80	2.93	2.37	4.93	8.63	6.78	0.00	0.00	0.00
C3	0.00	0.00	0.00	2.07	2.53	2.30	7.17	8.25	7.71	0.00	0.00	0.00
C4	0.00	0.00	0.00	2.01	2.90	2.46	4.67	5.63	5.15	0.00	0.00	0.00
C5	0.00	0.00	0.00	2.07	3.27	2.67	4.77	8.07	6.42	0.00	0.00	0.00
C6	0.00	0.00	0.00	1.99	2.73	2.36	5.13	8.57	6.85	0.00	0.00	0.00
C7	0.00	0.00	0.00	2.10	2.73	2.42	5.27	6.20	5.73	0.00	0.00	0.00

C8	0.00	0.00	0.00	2.13	2.78	2.46	6.57	8.57	7.57	0.00	0.00	0.00
C9	0.00	0.00	0.00	1.65	2.83	2.24	3.59	4.04	3.81	5.35	6.12	5.79
C10	0.00	0.00	0.00	3.13	3.20	3.17	0.00	0.00	0.00	0.00	0.00	0.00
S.E (m) (±)	-	-	-	0.17	0.17	0.17	0.33	0.60	0.49	0.03	0.03	0.03
CD at 1%	-	-	-	0.64	NS	NS	1.24	2.27	1.80	0.12	0.11	0.11
P1	0.00	0.00	0.00	2.15	2.93	2.54	5.09	6.87	5.98	6.14	7.00	6.57
P2	0.00	0.00	0.00	2.30	3.41	2.85	5.30	7.60	6.45	7.16	7.87	7.52
P3	0.00	0.00	0.00	1.86	2.25	2.05	4.20	6.51	5.35	5.76	6.80	6.28
S.E (m) (±)				0.09	0.09	0.09	0.18	0.33	0.27	0.02	0.02	0.02
CD at 1%				0.35	0.35	0.34	0.68	NS	NS	0.06	NS	0.06
S1	0.00	0.00	0.00	2.44	2.61	2.52	5.25	7.94	6.59	0.00	0.00	0.00
S2	0.00	0.00	0.00	1.77	3.12	2.44	4.48	6.05	5.26	5.38	6.23	5.80
S.E (m) (±)				0.08	0.08	0.08	0.15	0.27	0.22	0.01	0.01	0.01
CD at 1%				0.28	0.29	NS	0.56	1.02	0.81	0.03	0.03	0.03
C1P1	0.00	0.00	0.00	2.10	2.90	2.50	7.00	6.20	6.60	0.00	0.00	0.00
C1P2	0.00	0.00	0.00	2.20	3.50	2.85	4.50	13.60	9.05	0.00	0.00	0.00
C1P3	0.00	0.00	0.00	1.90	1.80	1.85	3.70	7.50	5.60	0.00	0.00	0.00
C2P1	0.00	0.00	0.00	2.00	2.90	2.45	5.10	9.80	7.45	0.00	0.00	0.00
C2P2	0.00	0.00	0.00	1.80	3.80	2.80	5.70	8.60	7.15	0.00	0.00	0.00
C2P3	0.00	0.00	0.00	1.60	2.10	1.85	4.00	7.50	5.75	0.00	0.00	0.00
C3P1	0.00	0.00	0.00	2.10	2.80	2.45	7.20	8.81	8.01	0.00	0.00	0.00
C3P2	0.00	0.00	0.00	2.00	2.60	2.30	8.82	8.64	8.73	0.00	0.00	0.00
C3P3	0.00	0.00	0.00	2.10	2.20	2.15	5.50	7.30	6.40	0.00	0.00	0.00
C4P1	0.00	0.00	0.00	1.71	3.11	2.41	4.50	6.50	5.50	0.00	0.00	0.00
C4P2	0.00	0.00	0.00	2.40	2.89	2.65	4.90	5.50	5.20	0.00	0.00	0.00
C4P3	0.00	0.00	0.00	1.94	2.69	2.31	4.60	4.90	4.75	0.00	0.00	0.00
C5P1	0.00	0.00	0.00	2.10	3.10	2.60	5.00	7.20	6.10	0.00	0.00	0.00
C5P2	0.00	0.00	0.00	2.30	4.00	3.15	5.10	9.90	7.50	0.00	0.00	0.00
C5P3	0.00	0.00	0.00	1.80	2.70	2.25	4.20	7.10	5.65	0.00	0.00	0.00
C6P1	0.00	0.00	0.00	2.10	2.90	2.50	6.20	10.50	8.35	0.00	0.00	0.00
C6P2	0.00	0.00	0.00	2.20	3.70	2.95	5.20	8.90	7.05	0.00	0.00	0.00
C6P3	0.00	0.00	0.00	1.67	1.60	1.63	4.00	6.30	5.15	0.00	0.00	0.00
C7P1	0.00	0.00	0.00	2.10	2.64	2.37	5.80	5.90	5.85	0.00	0.00	0.00
C7P2	0.00	0.00	0.00	2.40	3.37	2.88	6.00	7.10	6.55	0.00	0.00	0.00
C7P3	0.00	0.00	0.00	1.80	2.19	2.00	4.00	5.60	4.80	0.00	0.00	0.00
C8P1	0.00	0.00	0.00	2.00	2.64	2.32	6.10	9.40	7.75	0.00	0.00	0.00
C8P2	0.00	0.00	0.00	2.30	3.40	2.85	8.80	9.40	9.10	0.00	0.00	0.00
C8P3	0.00	0.00	0.00	2.10	2.30	2.20	4.80	6.90	5.85	0.00	0.00	0.00
C9P1	0.00	0.00	0.00	1.77	2.79	2.28	4.00	4.39	4.20	4.87	5.63	5.25
C9P2	0.00	0.00	0.00	1.65	3.12	2.39	4.00	4.31	4.16	5.38	6.10	5.74
C9P3	0.00	0.00	0.00	1.53	2.57	2.05	2.78	3.41	3.09	3.89	4.67	4.28
C10P1	0.00	0.00	0.00	3.50	3.54	3.52	0.00	0.00	0.00	0.00	0.00	0.00
C10P2	0.00	0.00	0.00	3.70	3.74	3.72	0.00	0.00	0.00	0.00	0.00	0.00
C10P3	0.00	0.00	0.00	2.20	2.31	2.26	0.00	0.00	0.00	0.00	0.00	0.00
S.E (m) (±)				0.29	0.30	0.29	0.57	1.05	0.84	0.05	0.05	0.05
CD at 1%				NS	NS	NS	2.15	3.93	3.12	0.20	0.19	0.19
C1S1	0.00	0.00	0.00	2.27	2.47	2.37	5.07	10.80	7.93	0.00	0.00	0.00
C1S2	0.00	0.00	0.00	1.87	3.00	2.43	5.07	7.40	6.23	0.00	0.00	0.00
C2S1	0.00	0.00	0.00	2.07	1.60	1.83	5.13	9.80	7.47	0.00	0.00	0.00
C2S2	0.00	0.00	0.00	1.53	4.27	2.90	4.73	7.47	6.10	0.00	0.00	0.00
C3S1	0.00	0.00	0.00	2.40	1.13	1.77	8.81	9.84	9.32	0.00	0.00	0.00
C3S2	0.00	0.00	0.00	1.73	3.93	2.83	5.53	6.67	6.10	0.00	0.00	0.00
C4S1	0.00	0.00	0.00	2.33	2.80	2.57	5.53	6.80	6.17	0.00	0.00	0.00
C4S2	0.00	0.00	0.00	1.70	2.99	2.34	3.80	4.47	4.13	0.00	0.00	0.00
C5S1	0.00	0.00	0.00	2.47	3.33	2.90	5.80	9.47	7.63	0.00	0.00	0.00
C5S2	0.00	0.00	0.00	1.67	3.20	2.43	3.73	6.67	5.20	0.00	0.00	0.00
C6S1	0.00	0.00	0.00	2.27	2.87	2.57	6.07	9.00	7.53	0.00	0.00	0.00
C6S2	0.00	0.00	0.00	1.71	2.60	2.16	4.20	8.13	6.17	0.00	0.00	0.00
C7S1	0.00	0.00	0.00	2.47	2.85	2.66	5.60	8.27	6.93	0.00	0.00	0.00
C7S2	0.00	0.00	0.00	1.73	2.62	2.18	4.93	4.13	4.53	0.00	0.00	0.00
C8S1	0.00	0.00	0.00	2.47	2.22	2.35	6.47	10.87	8.67	0.00	0.00	0.00
C8S2	0.00	0.00	0.00	1.80	3.33	2.57	6.67	6.27	6.47	0.00	0.00	0.00
C9S1	0.00	0.00	0.00	1.85	3.07	2.46	4.01	4.54	4.27	0.00	0.00	0.00
C9S2	0.00	0.00	0.00	1.46	2.59	2.02	3.18	3.53	3.35	5.11	5.43	5.27
C10S1	0.00	0.00	0.00	3.80	3.77	3.79	0.00	0.00	0.00	0.00	0.00	0.00
C10S2	0.00	0.00	0.00	2.47	2.62	2.54	0.00	0.00	0.00	0.00	0.00	0.00
S.E (m) (±)				0.24	0.24	0.24	0.47	0.85	0.69	0.04	0.04	0.04

CD at 1%				NS	0.91	0.89	1.76	3.21	2.55	0.17	0.16	0.15
P1S1	0.00	0.00	0.00	2.49	2.66	2.58	5.49	7.95	6.72			
P1S2	0.00	0.00	0.00	1.80	3.20	2.50	4.69	5.79	5.24	5.60	6.70	6.15
P2S1	0.00	0.00	0.00	2.66	3.09	2.88	6.08	9.15	7.61			
P2S2	0.00	0.00	0.00	1.93	3.73	2.83	4.53	6.04	5.28	6.17	7.70	6.93
P3S1	0.00	0.00	0.00	2.16	2.08	2.12	4.18	6.71	5.45			
P3S2	0.00	0.00	0.00	1.57	2.41	1.99	4.22	6.30	5.26	5.10	6.90	6.00
S.E (m) (±)				0.13	0.13	0.13	0.26	0.47	0.38	0.03	0.05	0.03
CD at 1%				NS	NS	NS	NS	NS	NS	0.09	NS	0.09
C1P1S1	0.00	0.00	0.00	2.40	1.60	2.00	6.60	5.20	5.90	0.00	0.00	0.00
C1P1S2	0.00	0.00	0.00	1.80	4.20	3.00	7.40	7.20	7.30	0.00	0.00	0.00
C1P2S1	0.00	0.00	0.00	2.20	4.20	3.20	4.40	18.80	11.60	0.00	0.00	0.00
C1P2S2	0.00	0.00	0.00	2.20	2.80	2.50	4.60	8.40	6.50	0.00	0.00	0.00
C1P3S1	0.00	0.00	0.00	2.20	1.60	1.90	4.20	8.40	6.30	0.00	0.00	0.00
C1P3S2	0.00	0.00	0.00	1.60	2.00	1.80	3.20	6.60	4.90	0.00	0.00	0.00
C2P1S1	0.00	0.00	0.00	2.40	1.80	2.10	4.80	11.20	8.00	0.00	0.00	0.00
C2P1S2	0.00	0.00	0.00	1.60	4.00	2.80	5.40	8.40	6.90	0.00	0.00	0.00
C2P2S1	0.00	0.00	0.00	2.20	1.60	1.90	6.60	9.00	7.80	0.00	0.00	0.00
C2P2S2	0.00	0.00	0.00	1.40	6.00	3.70	4.80	8.20	6.50	0.00	0.00	0.00
C2P3S1	0.00	0.00	0.00	1.60	1.40	1.50	4.00	9.20	6.60	0.00	0.00	0.00
C2P3S2	0.00	0.00	0.00	1.60	2.80	2.20	4.00	5.80	4.90	0.00	0.00	0.00
C3P1S1	0.00	0.00	0.00	2.40	1.40	1.90	9.20	10.23	9.71	0.00	0.00	0.00
C3P1S2	0.00	0.00	0.00	1.80	4.20	3.00	5.20	7.40	6.30	0.00	0.00	0.00
C3P2S1	0.00	0.00	0.00	2.20	1.00	1.60	10.84	10.48	10.66	0.00	0.00	0.00
C3P2S2	0.00	0.00	0.00	1.80	4.20	3.00	6.80	6.80	6.80	0.00	0.00	0.00
C3P3S1	0.00	0.00	0.00	2.60	1.00	1.80	6.40	8.80	7.60	0.00	0.00	0.00
C3P3S2	0.00	0.00	0.00	1.60	3.40	2.50	4.60	5.80	5.20	0.00	0.00	0.00
C4P1S1	0.00	0.00	0.00	2.00	2.95	2.47	5.80	8.20	7.00	0.00	0.00	0.00
C4P1S2	0.00	0.00	0.00	1.41	3.28	2.34	3.20	4.80	4.00	0.00	0.00	0.00
C4P2S1	0.00	0.00	0.00	3.00	2.99	3.00	5.80	6.40	6.10	0.00	0.00	0.00
C4P2S2	0.00	0.00	0.00	1.80	2.79	2.30	4.00	4.60	4.30	0.00	0.00	0.00
C4P3S1	0.00	0.00	0.00	2.00	2.48	2.24	5.00	5.80	5.40	0.00	0.00	0.00
C4P3S2	0.00	0.00	0.00	1.88	2.90	2.39	4.20	4.00	4.10	0.00	0.00	0.00
C5P1S1	0.00	0.00	0.00	2.60	3.40	3.00	5.80	8.40	7.10	0.00	0.00	0.00
C5P1S2	0.00	0.00	0.00	1.60	2.80	2.20	4.20	6.00	5.10	0.00	0.00	0.00
C5P2S1	0.00	0.00	0.00	2.60	3.80	3.20	6.80	11.80	9.30	0.00	0.00	0.00
C5P2S2	0.00	0.00	0.00	2.00	4.20	3.10	3.40	8.00	5.70	0.00	0.00	0.00
C5P3S1	0.00	0.00	0.00	2.20	2.80	2.50	4.80	8.20	6.50	0.00	0.00	0.00
C5P3S2	0.00	0.00	0.00	1.40	2.60	2.00	3.60	6.00	4.80	0.00	0.00	0.00
C6P1S1	0.00	0.00	0.00	2.60	3.00	2.80	8.00	10.60	9.30	0.00	0.00	0.00
C6P1S2	0.00	0.00	0.00	1.60	2.80	2.20	4.40	10.40	7.40	0.00	0.00	0.00
C6P2S1	0.00	0.00	0.00	2.40	3.80	3.10	5.80	9.20	7.50	0.00	0.00	0.00
C6P2S2	0.00	0.00	0.00	2.00	3.60	2.80	4.60	8.60	6.60	0.00	0.00	0.00
C6P3S1	0.00	0.00	0.00	1.80	1.80	1.80	4.40	7.20	5.80	0.00	0.00	0.00
C6P3S2	0.00	0.00	0.00	1.53	1.40	1.47	3.60	5.40	4.50	0.00	0.00	0.00
C7P1S1	0.00	0.00	0.00	2.40	3.09	2.74	5.00	7.40	6.20	0.00	0.00	0.00
C7P1S2	0.00	0.00	0.00	1.80	2.20	2.00	6.60	4.40	5.50	0.00	0.00	0.00
C7P2S1	0.00	0.00	0.00	2.80	3.34	3.07	7.20	9.80	8.50	0.00	0.00	0.00
C7P2S2	0.00	0.00	0.00	2.00	3.40	2.70	4.80	4.40	4.60	0.00	0.00	0.00
C7P3S1	0.00	0.00	0.00	2.20	2.12	2.16	4.60	7.60	6.10	0.00	0.00	0.00
C7P3S2	0.00	0.00	0.00	1.40	2.27	1.84	3.40	3.60	3.50	0.00	0.00	0.00
C8P1S1	0.00	0.00	0.00	2.20	2.27	2.24	5.40	13.40	9.40	0.00	0.00	0.00
C8P1S2	0.00	0.00	0.00	1.80	3.00	2.40	6.80	5.40	6.10	0.00	0.00	0.00
C8P2S1	0.00	0.00	0.00	2.60	2.60	2.60	8.80	11.20	10.00	0.00	0.00	0.00
C8P2S2	0.00	0.00	0.00	2.00	4.20	3.10	8.80	7.60	8.20	0.00	0.00	0.00
C8P3S1	0.00	0.00	0.00	2.60	1.80	2.20	5.20	8.00	6.60	0.00	0.00	0.00
C8P3S2	0.00	0.00	0.00	1.60	2.80	2.20	4.40	5.80	5.10	0.00	0.00	0.00
C9P1S1	0.00	0.00	0.00	1.94	2.85	2.39	4.31	4.89	4.60	0.00	0.00	0.00
C9P1S2	0.00	0.00	0.00	1.60	2.74	2.17	3.70	3.89	3.79	5.79	5.78	5.79
C9P2S1	0.00	0.00	0.00	1.80	3.34	2.57	4.56	4.79	4.67	0.00	0.00	0.00
C9P2S2	0.00	0.00	0.00	1.51	2.91	2.21	3.45	3.84	3.64	5.76	5.70	5.73
C9P3S1	0.00	0.00	0.00	1.80	3.03	2.41	3.17	3.94	3.56	0.00	0.00	0.00
C9P3S2	0.00	0.00	0.00	1.27	2.11	1.69	2.38	2.88	2.63	3.78	4.81	4.29
C10P1S1	0.00	0.00	0.00	4.00	4.28	4.14	0.00	0.00	0.00	0.00	0.00	0.00
C10P1S2	0.00	0.00	0.00	3.00	2.80	2.90	0.00	0.00	0.00	0.00	0.00	0.00
C10P2S1	0.00	0.00	0.00	4.80	4.28	4.54	0.00	0.00	0.00	0.00	0.00	0.00
C10P2S2	0.00	0.00	0.00	2.60	3.20	2.90	0.00	0.00	0.00	0.00	0.00	0.00

C10P3S1	0.00	0.00	0.00	2.60	2.76	2.68	0.00	0.00	0.00	0.00	0.00	0.00
C10P3S2	0.00	0.00	0.00	1.80	1.87	1.83	0.00	0.00	0.00	0.00	0.00	0.00
S.E (m) (±)				0.41	0.42	0.42	0.81	1.48	1.19	0.11	0.15	0.13
CD at 1%				NS	1.57	NS	3.05	5.56	4.41	0.33	0.45	0.39

C1: Citric acid (0.5%)

C2: Citric acid (1%)

C3: Citric acid (1.5%)

C4: Ascorbic acid (0.5%)

C5: Ascorbic acid (1%)

C6: Ascorbic acid (1.5%)

C7: Chitosan (0.1%)

C8: Chitosan (0.2%)

C9: Chitosan (0.3%)

C10: Control

P1: Punnet

P2: Polypropylene bag

P3: Nano silver based bag

S1: Room temperature

S2: Cold storage (12±2)

Conclusion

From the experiment on effect of different chemicals, packaging materials and storage conditions on quality and shelf life of minimally processed sweet orange cv. Phule mosambi it can be concluded that, chemicals, packaging material and storage conditions improves the quality and shelf life of minimally processed segments. The physiological loss in weight (%), spoilage (%) and titratable acidity (%) contents were found minimum while juice content (%), wt. of juice (g), wt. of pomace (g) and overall acceptability were found maximum in minimally processed sweet orange cv. Phule Mosambi in the treatment combination of C9P3S2 (Chitosan 0.3% + NSB bag) + Cold storage (12±2 °C and 90% RH) at the end of storage life. The biochemical constituents such as TSS, TSS and acidity ratio, total sugars and ascorbic acid content were found maximum while the lowest total microbial count noticed in the treatment combination of C9P3S2 (Chitosan 0.3% + NSB bag) + Cold storage (12±2 °C and 90% RH) at the end of storage life.

The shelf life of minimally processed segment cv. Phule Mosambi could be extended up to 3 days at ambient temperature and 5 days at cold storage (12±2 °C and 90% RH) when treated with Chitosan @ 0.3% and packed in Nano silver base bags.

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