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Combined effects of giberellic acid (GA_3) and paraffin wax with modified atmospheric packaging (MAP) during storage at ambient temperature on Sweet orange fruit (*Citrus sinensis*)

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Abstract
Sweet orange (*Citrus sinensis* O. cv. Nucellar) fruit harvested at physiological stage of maturity light green stage were treated to GA_3 100 ppm and paraffin wax (6 and 12%) and there combination The treated and air dried fruits were kept in 100 gauge polythene bags of 5% ventilation and without ventilation, were kept in corrugated fibre board box (CFB). These boxes were kept in laboratory at room temperature. The observations on physico-chemical changes in fruits were recorded at 7 days interval up to 49 days at room temperature (27$\pm$ 2 ^{0}C) and humidity (60-70%). Most of the physiological and biochemical changes during storage and ripening were affected by GA_3 and paraffin wax in a dose dependent manner. The gradually increase in total soluble solids (TSS) content and reduced change in the titratable acidity and ascorbic acid content showed the effectiveness of GA_3 and paraffin wax in retarding fruit ripening. A significant reduction in the decay incidence of GA_3 and paraffin wax treated fruit was observed under the storage condition. The fruits treated with the treatment T_1 $GA_3$100 ppm in combination with 6% wax, wrapped in 100 gauge polyethylene bags stored at ambient temperature prolonged storage life of sweet orange cv. Nucellar up to 49th day with retained desirable quality, colour, flavour, taste and overall acceptability.

Keywords: sweet orange, shelf life, giberellic acid, paraffin wax, MAP, organoleptic evaluation

1. Introduction
Citrus is one of the important fruit crops grown though out the world. It is made up of many species that vary in importance due to different climatic zones. The ancestral species of citrus fruit apparently originate in South East Asia between China, Eastern India and the islands of pacific coast from which they spread to Arabia, Middle East, Southern Europe and Mediterranean regions. The citrus fruits are produced in all tropical and subtropical areas of the world. Brazil is the largest producer of oranges followed by USA. Oranges are the second largest fruit grown and processed in the world. Orange is the 3rd largest producing fruit in India after mango and banana.

The area under this fruit crops is increasing rapidly as a result of dynamic employment guarantee scheme launched by Government of Maharashtra (India) for fruit crops. However, there are heavy post-harvest losses of fruits since it has shortest shelf life of 5-7 days. It is necessary to increase the shelf life to utilize the huge production for processing into value added products and for exports with sufficient storage period in domestic as well as international market. Singh and Chundawat (1991) [20] have tried giberellic acid (GA3) successfully for extension of shelf life of kesar mangoes. Ahmed and Khan (1987) [1] and Ladaniya (2003) [10] reported increase in shelf life of sweet oranges with special reference to Nucellar cultivar GA3 and fungicide and wrapping with low density polyethylene (LDPE) bags are scanty. Ventilated polyethylene bags reduce waterless while fungicides minimized rotting in stored mosambi fruits. Pre and post-harvest fungicide application have been found to reduce decay effectively in mosambi orange. Efforts have been made in this investigation to extend shelf life of sweet oranges with low cost technology like GA_3, fungicide, liquid paraffin wax and wrapping with LDPE bags, in modified atmospheric packaging (MAP).

Materials and Methods

1 Preparation for experiment

A Source and handling of fruits

Fresh Sweet orange (cv. Nucellar) fruits were harvested at physiological stage of maturity from commercial orchards at village Shelgaon Tahasil Badnapur District Jalna. Well matured, uniform sized, greenish yellow and healthy fruit were harvested to undertake the experiment. All the malformed, sun scorched and cankered fruits were rejected. The selected fruits packed in corrugated fiber boxes (CFB) and brought carefully to the experimental laboratory of Horticulture, Department of Horticulture, Marathwada Krishi Vidyapeeth, Parbhani. Then the fruits were washed with the tap cold water for removal of field heat and allowed to air dry and subjected to various treatments viz. T_0 (Control –plain water dip), T_1 (MAP with cent + GA_3 100 ppm + 6% wax), T_2 (MAP with cent + GA_3 100 ppm + 12% wax), T_3 (MAP with cent + GA_3 100 ppm), T_4 (MAP with vent + 6% wax), T_5 (MAP with vent + 12% wax), T_6 (MAP without vent + GA_3 100 ppm + 6% wax), T_7 (MAP without vent + GA_3 100 ppm + 12% wax), T_8 (MAP without vent + GA_3 100 ppm), T_9 (MAP without vent + 12% wax), T_{10} (MAP without vent + 6% wax).

B Preparation of chemical solutions and storage condition

Required quantity of chemicals was dissolved in distilled water. Two litre solution of each chemical was prepared for each treatment. GA_3 was first dissolved in alcohol and then added to distilled water to make up the volume up to two litre solution. For preparation of 6% wax solution 120 ml liquid paraffin wax was dissolved in luke warm distilled water and make up volume of two litre for preparation of 12% wax solution, 240 ml of liquid paraffin wax was dissolved in luke warm distilled water and make up volume two litre air dried fruit were dipped separately in each solution for five minutes as per the treatments. Wax treated fruits were rolled on the table for circulation of wax. The treated and air dried fruits were kept in 100 gauge polythene bags of 5% ventilation and without ventilation. As per the treatments and were kept in corrugated fibre board box, newspaper were used as cushioning material to line inside the CFB boxes. These boxes were kept in laboratory at room temperature. The observations on physico-chemical changes in fruits were recorded at 7 days interval up to 49 days at room temperature (27$\pm$ 2 ^{0}C) and humidity (60-70%), initial observation was recorded before placing the fruits in boxes. Eighteen fruits were selected for each treatment and replicated three.

2. Observations

a. Physical parameters

Physiological Loss In weight of fruits (%)

The physiological loss in weight of fruits was calculated by subtracting the average weight of fruit from the initial weight of corresponding fruits in 7 days interval and calculated in percentage.

$$PLW = \frac{\text{Initial weight of fruit} - \text{weight of fruit in 7 days interval}}{\text{Initial weight of fruit}} \times 100$$

Decaying incidence

Percentage of decay incidence was obtained from the number of fruit that showed signs of decay over the initial number of fruit. The per cent decay was recorded after the 7th day of storage period and cumulative decay including storage and ripening was expressed as a percentage.

Shelf life

At 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.

Sensory evaluation

The treated fruits were evaluated for TSS, acidity and ascorbic acid as per standard procedures of Ranganna (2000) [14] the treated fruits were also evaluated for sensory quality for colour, flavour, taste and overall acceptability by a semi trained panel of 10 judges on a 9-possssint hedonic scale (I-extremely dislike and 9-extremely like) in accordance with method suggested by Amerine *et al.* (1965) [2]. On the basis of overall acceptability score and further evaluated for sensory quality by using the score sheet developed by Kapse B.M., (1976) [8].

b. Biochemical parameters

Total soluble solids (TSS) content of sweet orange juice was determined by using with digital hand Refractometer (Model Pal-3, Atago make, Tokyo, Japan) and expressed as degree brix.

Titratable acidity was determined by volumetric method as per standard procedure. The juice was titrated against 0.1N sodium hydroxide (NaOH) using phenolphthalein as an indicator to faint pink end point. The percent titratable acidity was calculated by the following formula and result was recorded in percent acidity as citric acid.

$$\text{Acidity} = \frac{\text{Titre x Normality of alkali x Eq. wt. of acid x volume made up}}{\text{Wt/volume of sample x vol. of aliquot taken for estimation}} \times 100$$

Ascorbic acid was determined by the method as per standard procedure. The juice was diluted with 3 metaphosphoric acid and titrated against 2,6dichlorophenol indophenols dye to a faint pink end point the ascorbic acid content of juice was calculated by the following formula and result was recorded as milligram of ascorbic acid per 100 ml juice.

$$(\text{mg}/100\text{g}) = \frac{\text{Ascorbic acid Titre value X dye factor X vol. made up}}{\text{Weight of sample X aliquot of sample}} \times 100$$

Dye factor = 0.5 (Titre with standard ascorbic acid solution)

Statistical analysis

The statistical analysis of data recorded in respect of all above parameters was done for interpretation of results following standard methods. (Gomez and Gomez, 1984) and data were statistically analyzed by the method of Panse and Sukhatme (1985) [13] and the significance was drawn at 5% level of probability.

3. Results and Discussion

Table 1: Effect of post-harvest treatments during ambient temperature storage on changes in physiological loss in weight of sweet orange.

Treatment	Physiological loss in weight of fruit (%)						
	Storage days						
	7	14	21	28	35	42	49
T_0	11.03	20.33	33.33	-	-	-	-
T_1	1.23	0.98	4.39	6.74	8.13	9.10	10.99
T_2	2.78	4.27	6.31	8.41	10.25	11.11	12.82
T_3	1.98	3.60	4.62	7.53	8.94	10.87	11.22
T_4	2.02	3.80	4.76	7.77	9.31	10.16	11.43
T_5	2.78	4.42	6.49	8.88	10.29	11.34	12.90
T_6	1.48	3.28	4.51	7.12	8.62	9.93	11.08
T_7	2.70	4.44	6.70	8.56	10.92	11.21	12.97
T_8	2.14	3.66	4.76	7.84	9.04	10.74	11.63
T_9	2.22	0.84	4.83	7.90	9.40	10.82	11.83
T_{10}	2.98	4.64	6.81	8.94	10.96	11.51	13.03
SE ±	0.08	0.01	0.05	0.04	0.12	0.02	0.03
CD at 5%	0.25	0.04	0.02	0.01	0.37	0.08	0.11

3.1. Effect of GA_3 and paraffin wax on physiological loss in weight (PLW)

The data pertaining to physiological loss in weight (PLW) of sweet orange fruit as influenced by the different post-harvest treatments expressed in terms of percentage were recorded at 7 days interval up to 49th days of storage and are presented in Table 1 indicate that, different treatments significantly influenced the percent weight loss of fruit during storage. The PLW of fruit was found increased with the advancement of storage in all the treatments. Untreated fruits could not reach up to the last stage of storage as fruits were completely rotted and hence further observations could not be taken. At final stage of storage, the rapid increased in PLW in fruits dipped in plain water T_0 (Control) Up to 21st day of storage period. However/when the fruits are treated with 100 ppm GA_3 +6% wax and wrapped in MAP with vents (T_1), the increase in PLW was significantly (10.99 per cent) lowest than rest of the treatments. The PLW was also found minimum (11.08 per cent) in fruits treated with GA_3 100 ppm + 6% wax and wrapped in MAP without vents. The low PLW was recorded in wrapped fruits which might be due to the packaging material which has arrested the loss of moisture from fruit due to evaporation.

Significantly minimum per cent loss in weight (10.99 per cent)at the 49th day of storage was recorded in the treatment T_1 - MAP with vents + GA_3 100 ppm + 6% wax, however it was at par with the treatment T_6 (11.08) - MAP without vents + GA_3 100 ppm + 6% wax. Whereas significantly maximum loss in weight of fruit (13.03 per cent) was observed in the treatment T_{10} - MAP without vents + 12% wax. The GA_3 act as antisencence agent while wax restricts stomata opening and due to combined effect of these, the PLW might have been decreased considerably in fruits treated with these. Ladaniya (2003) [10] studied the shelf life of selected packed Sweet orange fruits in heat shrinkable film (LDPE) and stored the fruits in CFB Boxes at 25 ± and 40-45% RH. He observed the weight loss of 1.60% in fruits wrapped in LDPE over the unwrapped control fruits (25.51%). Similarly Sakhale *et al*., (2009) [17] have also reported that the GA_3 treatment in Kesar mangoes at 100 ppm concentration coupled with 8% calcium chloride and 500 ppm bavistin proved to be beneficial for desirable sensorial quality parameters and better extended shelf life with least incidence of disease.

During the storage the physiological losses in weight of fruit mainly consist of the loss of moisture through evapo-transpiration and the consumption of carbohydrates in respiration. Sweet orange fruits treated with wax emulsion and in combination with GA_3 100 ppm a wrapped in MAP with vents or without vents found effective in reducing the physiological loss in weight of fruit during storage. This might be happened due to the retardation of evapotranspiration losses of moisture from wax coated fruits by affecting the opening of stomata's and lenticels. Similarly Tariq *et al*., (2001) [21] reported higher weight loss in unwashed fruits and washed and all sealed were lower in weight loss than unwrapped fruits.

Table 2: Effect of post-harvest treatments during ambient temperature storage on changes in Decaying percentage of sweet orange.

Treatment	Decaying (%)							Shelf life in days
	Storage days							
	7	14	21	28	35	42	49	
T_0	6.70	21.33	--	--	--	--	--	8.00
T_1	0.00	1.23	2.24	3.32	4.68	6.62	9.28	44.33
T_2	2.86	3.32	5.04	7.20	9.33	13.33	16.23	33.33
T_3	0.00	1.64	2.76	3.81	5.32	7.28	10.68	37.00
T_4	0.00	1.68	3.08	3.98	5.81	7.82	10.81	36.66
T_5	2.93	3.86	5.23	7.89	9.86	13.97	16.38	31.33
T_6	0.00	1.68	2.88	3.69	5.20	6.71	10.20	40.66
T_7	2.96	3.89	6.12	8.08	10.50	13.00	16.38	31.00
T_8	0.00	2.88	5.10	6.67	9.34	11.12	13.00	34.33
T_9	0.00	2.91	5.16	6.69	9.81	11.43	13.44	33.00
T_{10}	2.86	3.81	6.14	7.89	11.24	14.23	16.89	30.00
SE ±	0.93	0.09	0.07	0.11	0.11	0.16	0.03	0.73
CD at 5%	0.27	0.27	0.21	0.33	0.33	0.48	0.10	2.03

3.2. Effect of GA_3 and paraffin wax on decay incidence

From the table 2 it was evident that, percent decay loss of fruits as influenced by different post-harvest treatment was found increased with the advancement of storage in all treatment during storage. Decay loss of fruits was noticed after 7th days of storage in the treatments T_0 - Control, T_2 (2.86) - MAP with vents + GA_3 100 ppm +12% wax, T_5 (2.93) - MAP with vents + 12% wax and T_{10} (2.86) - MAP with vents +12% Wax in which decay loss of fruits was observed at 14thday of storage, the minimum decay loss of fruit was recorded in the treatment T_1 (9.28) - MAP with vents +GA_3 100 ppm +6% wax and T_6 (10.20) - MAP without vents + GA_3 100 ppm + 6% wax significantly maximum decay loss of sweet orange fruits was noticed in the treatments. T_{10} (16.89) - MAP without vents + GA_3 100 ppm + 12% wax, T_5 (16.38%) - MAP with vents + $GA_3$100 ppm + 12% wax at 49th day of storage.

The data shows that per cent decay loss of fruit was significantly influenced by different post-harvest treatments during storage period. It was also observed that the untreated fruits were completely spoiled after 8 days during ambient temperature storage. Whereas the fruits treated with GA_3 100 ppm, 6% and 12% wax and wrapped in MAP without vents were decayed in treatment T_{10} (16.89 per cent), T_7 (16.38), T_5 (16.38 per cent), T_2 (16.23 per cent) during ambient temperature storage.

3.3. Effect of GA_3 and paraffin wax on shelf life.

The data revealed that, the shelf life of sweet orange fruit was significantly influenced by different post-harvest treatments. The treatment T_1 - MAP with vents + GA_3 100 ppm + 6% wax was found to be significantly superior over other treatments in respect of shelf life and recorded maximum shelf life of 44.33 days followed by T_6 (40.66 days) - MAP without vents + GA_3 100ppm + 6% wax. Significantly the minimum shelf life of

sweet orange fruit (9.33 days) was recorded in the treatment T_0 - control followed by the treatment T_{10} (30.00 days) i.e. MAP without vents + 12% wax.

The effect of modified atmosphere packaging and atmosphere packaging and growth regulators (GA_3) and wax emulsion influencing various post-harvest characters of fruits were discussed earlier. From those findings it can be said that GA_3 100 ppm along with 6% wax emulsion were found to be effective in increasing the shelf life sweet orange fruit. These findings are in conformity with the earlier results in respect of MAP Shashi Bhushan *et al*. (2002) [19] in kiwifruit, M.S. Ladaniya (2003) [10] in sweet orange fruit and S. Sahoo and P.S. Munshi (2004) [16] in sapota fruits. In respect of GA_3 Goraksingh (1987) [6] in guava and Kahlon and Uppal (2003) in mango fruits. In respect of wax emulsion Khushal. Singh *et al*. (1988) [9] in kinnow, Dashora (1988) [4] and Tarkase and Desai (1988) [22] in mosambi.

Table 3: Effect of post-harvest treatments during ambient temperature storage on changes in Total soluble solids of sweet orange

Treatment	Total soluble solids (%)							
	Storage days							
	0	**7**	**14**	**21**	**28**	**35**	**42**	**49**
T_0	10.20	11.96	12.43	--	--	--	--	--
T_1	10.20	10.22	10.42	10.58	10.82	10.94	11.00	11.22
T_2	10.20	10.31	10.58	10.83	11.04	11.24	11.40	12.02
T_3	10.20	10.47	10.55	10.64	10.91	11.18	11.38	11.90
T_4	10.20	10.53	10.55	10.76	10.94	11.11	11.40	12.00
T_5	10.20	10.50	10.60	10.84	11.02	11.24	11.59	12.10
T_6	10.20	10.29	10.46	10.63	10.86	11.07	11.22	11.50
T_7	10.20	10.35	10.52	10.80	10.91	11.26	11.60	12.01
T_8	10.20	10.20	10.59	10.70	10.92	11.15	11.34	12.10
T_9	10.20	10.28	10.63	10.80	10.94	11.16	11.60	12.08
T_{10}	10.20	10.47	10.58	10.84	10.98	11.30	11.64	12.14
SE ±	0.002	0.03	0.02	0.04	0.04	0.02	0.01	0.03
CD at 5%	NS	0.08	0.06	0.14	0.13	0.07	0.03	0.14

3.4. Effect of GA_3 and paraffin wax on decay incidence total soluble solids (TSS).

Effect of post-harvest treatments on sweet orange fruits during storage at room temperature (Table 3). Total soluble solids content of sweet orange fruit was significantly influenced by the different post-harvest treatments during storage. Initially there was no more difference was observed in case of TSS content of fruits, but with the advancement of storage TSS content of fruit was found increased trends in all treatments. At the 49th days of storage significantly the minimum TSS content of fruit (11.22 percent) was found in the treatment T_1 - MAP with vents + GA_3 100 ppm + 6% wax followed by T_6 (11.50) - MAP without vents + GA_3 100 ppm + 6% wax and T_3 (11.90 percent) - MAP with vents + GA_3 100 ppm, whereas the maximum TSS content of fruit (12.14 percent) in treatment T_{10} - MAP without vents + GA_3 100 ppm +12% wax.

As the juice contains mainly water and total soluble solids these two factors are complementary in nature. Reduction in water content due to dehydration simultaneously increases the TSS of fruit. These results are in conformity with the result of Ransingh *et al.,* (2003) [15]. The sweet orange being non climacteric fruits do not show any marked variation in ethylene production and respiration and hence no marked changes in TSS content were recorded in fruits during different treatments. Ahmed and Khan (1987) [1] studied the effect of waxing and stored cellophane lined boxes and reported lesser increase in TSS and greater decrease in total solids (TS) in waxed mandarin compared to unwaxed ones. Dipping in $GA_3$100 ppm and wax emulsion and further wrapping with LDPE (Modified Atmosphere Packaging) resulted a significant decrease in PLW and increase in the TSS of sweet orange in present study which are fairly coincided with the reports of Ahmed and khan (1987) [1] and Tariq *et al*. (2001) [21].

Table 4: Effect of post-harvest treatments during ambient temperature storage on changes in acidity of sweet orange

Treatment	Acidity %							
	Storage days							
	0	**7**	**14**	**21**	**28**	**35**	**42**	**49**
T_0	0.60	0.61	0.53	0.45	-	-	-	-
T_1	0.60	0.57	0.57	0.55	0.51	0.52	0.50	0.49
T_2	0.60	0.57	0.57	0.52	0.53	0.48	0.46	0.45
T_3	0.60	0.57	0.56	0.55	0.53	0.49	0.48	0.46
T_4	0.60	0.56	0.56	0.54	0.52	0.50	0.49	0.47
T_5	0.60	0.60	0.58	0.56	0.54	0.47	0.46	0.44
T_6	0.60	0.58	0.58	0.55	0.56	0.59	0.49	0.49
T_7	0.60	0.60	0.61	0.55	0.53	0.47	0.45	0.40
T_8	0.60	0.60	0.60	0.55	0.53	0.48	0.47	0.46
T_9	0.60	0.60	0.59	0.55	0.53	0.46	0.47	0.46
T_{10}	0.60	0.60	0.60	0.54	0.12	0.46	0.43	0.43
SE ±	0.003	0.005	0.006	0.006	0.003	0.003	0.003	0.007
CD at 5%	NS	0.040	0.030	0.019	0.009	0.010	0.011	0.022

3.4. Effect of GA_3 and paraffin wax on titratable acidity

From the data in table 4, it was revealed that, the post-harvest treatments significantly influenced the acidity percentage of sweet orange fruit from 21 to 49th days of storage. Initially up to 21 days of storage there was minimum difference was observed in respect of acidity percentage among various treatments. The acidity percentage was found in decreasing trend in each treatment with the advancement of the storage. At 49th day storage, maximum acidity content (0.49 per cent) was recorded in the treatments T_1 (MAP with vents +GA_3 100 ppm +6% wax) followed by T_6 (0.49 per cent) MAP without vents +GA_3 100 ppm+ 6% wax recorded maximum acidity and minimum acidity content of fruit was observed in treatment T_{10} (0.43 per cent) - MAP without vents+ GA_3 100 ppm+12% wax. The titratable acidity decreased during storage which might be due to the utilization of organic acid as the respiratory substrate in respiratory process. The treatments T_1 and T_6 retained maximum acidity probably due to slower rate of respiration. These findings are in conformity with the findings of Ransingh *et.al*. (2003) [15] in mango in case of oil emulsion treatment. In respect of wax emulsion and LDPE similar results were recorded by Baskaran Revathy *et al*. (2002) [3] in Avocado fruits and Shashibhushan *et al*. (2002) [19] in Kiwifruits.

Table 5: Effect of post-harvest treatments during ambient temperature storage on changes in Ascorbic acid content of sweet orange.

Treatment	Ascorbic Acid %							
	Storage days							
	0	7	14	21	28	35	42	49
T_0	55.00	52.10	45.98	--	--	--	--	--
T_1	55.00	55.12	54.79	53.07	51.06	49.08	47.12	47.00
T_2	55.00	54.92	53.12	51.80	50.10	48.14	45.92	45.00
T_3	55.00	54.14	54.10	52.08	50.06	46.17	44.23	44.20
T_4	55.00	55.10	54.14	52.90	50.82	47.30	46.10	45.08
T_5	55.00	55.03	53.82	51.98	49.94	47.12	45.68	45.20
T_6	55.00	54.10	53.92	52.92	50.94	48.92	46.84	46.78
T_7	55.00	54.40	53.07	51.94	49.85	47.07	44.12	44.06
T_8	55.00	53.95	52.82	51.01	49.16	46.96	45.12	45.00
T_9	55.00	53.84	52.12	50.31	49.10	46.92	44.08	43.98
T_{10}	55.00	53.80	52.75	50.63	48.08	46.08	43.92	43.10
SE ±	0.05	0.02	0.04	0.14	0.03	0.19	0.08	0.08
CD at 5%	NS	0.06	0.12	0.43	0.09	0.58	0.25	0.26

3.5. Effect of GA_3 and paraffin wax on ascorbic acid content.

Ascorbic acid content of nucellar fruit was significantly influenced by different post-harvest treatments during storage (Table 5). Ascorbic acid of fruits recorded progressive decline storage at ambient temperature. Significantly maximum ascorbic acid content of fruit was recorded by the treatment T_1 (47.00 mg /100 ml juice) - MAP with vents + GA_3 100ppm + 6% wax whereas the minimum ascorbic acid content of fruit was recorded in the treatment T_{10} (43.10 mg/100 ml juice) - MAP without vents + GA_3 100 ppm + 12% wax. The treatment T_1 - MAP with vents + GA_3 100 ppm + 6% wax has shown least losses of ascorbic acid as compared to other treatments followed by treatment T_6 (MAP without vents + $GA_3$100 ppm + 6% wax). Loss in ascorbic acid content might be attributed to the process of oxidation and degradation of ascorbic acid content in the fruits. The fruits treated with GA_3 and wax emulsion and further wrapped with modified atmosphere packaging might have reduced the rate of oxidation and degradation of ascorbic acid by lowering down the rate of metabolic activities. Similar results in respect of GA_3 and 200 gauge polythene bags (MAP) were recorded by S. Sahoo and P.S. Munsi (2004) [16] in sapota, R.K. Sharma *et al.*(2007) [18] in kinnow fruits, and Lal G. *et al*. (2009) [11] in date fruits.

Table 6: Effect of post-harvest treatments during ambient temperature storage on changes in organoleptic evaluation of sweet orange.

Treatment	Colour				Taste				Flavour				Overall Acceptability			
	Storage days of sweet orange at ambient temperature															
	7	21	35	49	7	21	35	49	7	21	35	49	7	21	35	49
T_0	7.0	--	--	--	7.0	--	--	--	7.0	--	--	--	7.0	--	--	--
T_1	7.70	7.60	7.40	7.20	7.60	7.50	7.40	7.10	7.70	7.60	7.50	7.20	7.60	7.60	7.50	7.40
T_2	7.50	7.30	7.20	6.80	7.50	7.50	7.20	6.60	7.70	7.40	7.30	6.80	7.60	7.40	7.30	7.00
T_3	7.50	7.30	7.20	7.00	7.40	7.50	7.20	6.90	7.70	7.50	7.40	7.00	7.70	7.60	7.40	6.90
T_4	7.60	7.30	7.20	7.00	7.70	7.50	7.20	6.80	7.70	7.50	7.40	7.00	7.80	7.40	7.40	6.90
T_5	7.40	7.30	7.10	6.80	7.40	7.40	7.10	6.70	7.60	7.40	7.20	6.80	7.70	7.60	7.40	6.90
T_6	7.60	7.40	7.30	7.10	7.60	7.30	7.10	6.90	7.70	7.60	7.50	7.10	7.50	7.40	7.20	7.00
T_7	7.60	7.40	7.20	6.90	7.60	7.50	7.10	6.70	7.70	7.60	7.40	6.90	7.60	7.40	7.30	7.00
T_8	7.60	7.40	7.30	6.80	7.80	7.40	7.10	6.70	7.70	7.60	7.40	6.80	7.60	7.20	7.40	6.90
T_9	7.50	7.40	7.30	6.80	7.60	7.40	7.20	6.60	7.70	7.50	7.30	6.80	7.70	7.30	7.00	6.80
T_{10}	7.40	7.10	7.10	7.20	7.60	7.00	7.00	6.60	7.70	7.50	7.20	6.80	7.60	7.40	7.20	6.70
SE ±	0.03	0.03	0.08	0.07	0.08	0.07	0.08	0.05	0.10	0.10	0.10	0.10	0.08	0.07	0.08	0.08
CD at 5%	0.90	0.90	0.24	0.22	0.25	0.22	0.25	0.15	0.40	0.30	0.30	0.30	0.24	0.23	0.24	0.24

3.6. Effect of GA_3 and paraffin wax on organoleptic evaluation.

The quality of sweet orange fruit stored under room and low storage conditions was evaluated organoleptically for colour, flavour, taste and overall acceptability of sweet orange at regular interval of 7 days, presented in Table 6.

The score for colour was observed significantly higher (7.2) in the treatment T_1 i.e. MAP with vents + $GA_3$100ppm + 6% wax. However at par with treatment T_6 (7.1) but it was significantly superior over T_3 and T_4 (7.0 each) and all other treatments.

It was observed significantly higher (7.1) in the treatment T_1 - MAP with vents + GA3 100 ppm + 6% wax. However it was at par with T_6 (6.9) and T_3 (6.9) but it was significantly superior over all other treatments. It was observed significantly higher (7.2) in the treatment T_1 - MAP with vents + GA_3 100 ppm + 6% wax followed by the treatment T_6 (7.1 but it was significantly superior over all other treatments. The score for overall acceptability was observed significantly higher (7.4) in the treatment T_1 - MAP with vents + GA_3 100 ppm + 6% wax followed by the treatment T_6 (7.00) but it was significantly superior over all other treatments. The score for all the sensory attributes decreased gradually during storage period. The decrease in score for colour, flavour, taste and overall acceptability in all sensory attributes. There were consequently decrease in sensory quality score of fruits in date fruits was reported by Lal G. *et al*. (2009) [11]. Mishra B. and Khatkar B.S. (2009) [12] recorded least score on sensory scale due to incipient taste and off flavour.

Conclusion

Sweet orange is easily and cheaply available fruit widely accepted as raw and processed. It is well known for its nutritional and medicinal value. Results suggested that, the fruits treated with the treatment T_1 $GA_3$100 ppm in combination with 6% wax, wrapped in 100 gauge polyethylene bags stored at ambient temperature prolonged storage life up to 45 day with retained desirable quality, colour, flavour, taste and overall acceptability.

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