The Andhra Agric. J 62(3): 666-670, 2015

Changes in Physicochemical and Microbial Properties of Sweet Oranges from Harvest to Spoilage

M V Venkatesh, S Vishnuvardhan, R Lakshmipathy, D Bhaskara Rao
Department of Agricultural Process and Food Engineering, College of Agricultural Engineering, Bapatla 522101, Andhra Pradesh.

ABSTRACT

Freshly harvested sweet oranges were stored at ambient condition (R.H: 72-83%; Temperature: 26-29^{0}C) without any treatment and different Physico-chemical and microbial properties were studied during September, 2012-13 at Post Harvest Technology Centre, Agriculture college campus, Bapatla until quality deterioration was observed. Physiological Loss of Weight (PLW) increased gradually during the storage period. Average fruit weight decreased from 154.50 to 132.05g. Juice content of the fruit has been decreased from 46.28 to 34.38%. Firmness has been found declining initially up to 17 days, later it increased slightly due to desiccation resulting in drying or toughening of peel. Total Soluble Solids (TSS) has been increased from 7.50 to 9.24%. Reducing sugars increased from 1.22 to 2.32 %. Ascorbic acid content, total acidity, phenol content were found decreasing. Ascorbic acid content has been decreased from 38.55 to 27.42 mg/100g. Phenol content in juice has been increased from 16.49 to 17.43 mg/100g. Acidity has been decreased from 0.91 to 0.53 %. The surface microbial load showed a gradual raise in number of colonies during the storage period. Findings indicated that sweet oranges can be stored at ambient condition without any treatment up to 3 weeks with a minor loss of quality.

Key words : Ascorbic acid content, Phenol content, Reducing sugars, Sweet Orange, Storage, Surface microbial load, Titrable acidity.

Citrus fruits rank third in area and production after banana and mango in India with production share of 10% among major fruit crops grown in the country. Among citrus fruits, sweet orange is one of the important crops grown in the country. Sweet oranges are the second largest citrus fruits cultivated in the country with 12, 31,860 Metric tonnes of recent production (Kumar *et al*., 2012). Andhra Pradesh is the leading producer of citrus fruits (23.80%) and occupies first (46.78%) in overall production of sweet oranges produced in the country next to Maharashtra (Kumar *et al*., 2012). Among the citrus cultivars Sweet orange (*Citrus sinensis*) is the most prevalent citrus fruit in the state and is grown on an extensive scale, mandarin orange (*Citrus reticulate*), limes (*Citrus limon*) and Sour oranges are grown only to a limited extent. Sweet orange and acid lime plantations are found in several districts of Andhra Pradesh.

Sweet oranges have fairly high content of ascorbic acid and mostly utilized for consumption as fresh fruits. Sweet oranges can be kept for more than a week without any quality deterioration but they lose their marketable appearance if stored at ordinary conditions leading to low remunerative prices. In India, sweet oranges are marketed under hot and dry ambient conditions, leading to fruit desiccation, loss of juice, loss of weight and rapid deterioration in overall quality. The present communication reports of sweet orange grown in Andhra Pradesh with respect to different Physico-chemical and microbial changes during storage at ambient conditions.

MATERIAL AND METHODS

Sweet oranges were purchased from a fruit market, at Guntur, Andhra Pradesh in the month of September which were harvested a day before from the purchase. The fruits were transported to lab after packing in a paper board carton. The fruits were washed under tap water and shade dried at ambient conditions to remove surface moisture. The dried fruits are stored in plastic trays under ambient conditions (R.H: 72-83%; Temp: 25-29^{0}C) to maintain normal room condition. Fruits were evaluated on alternate days for different

Table 1. Post Harvest Physicochemical parameters of sweet orange fruits stored under ambient conditions (R.H= 72-83%; Temp = 25-29^{0}C).

Day	PLW (%)	Firmness (Kg)	TSS (%)	pH	Ascorbic Acid Content (mg/100g)	Acidity (%)	Phenols (mg/100g)	Reducing Sugars (%)	Decay %
1	0.00	8.84	7.57	3.6	38.55	0.91	16.49	1.22	0
3	0.54	8.61	7.74	3.6	37.12	0.84	17.09	1.28	0
5	1.20	6.80	8.14	3.8	35.84	0.78	17.17	1.28	0
7	1.49	6.03	8.17	3. 8	34.27	0.78	17.17	1.31	5
9	4.53	5.98	8.34	3.9	32.12	0.73	17.26	1.36	5
11	7.93	5.92	8.34	4.0	32.84	0.67	17.26	1.38	5
13	8.74	5.80	8.34	4.2	29.98	0.64	17.26	1.47	5
15	9.82	5.73	8.57	4.1	28.83	0.62	17.34	1.53	5
17	10.52	5.66	8.84	4.2	28.68	0.59	17.43	2.01	5
19	12.56	7.13	9.04	4.3	28.60	0.56	17.43	2.13	7.5
21	13.80	7.36	9.04	4.3	27.42	0.53	17.43	2.32	7.5

physiological and microbial parameters like physiological loss of weight (PLW), firmness, juice content, TSS, p^H, titrable acidity, ascorbic acid content, reducing sugars, total phenol content and surface microbial flora.

Temperature and relative humidity of storage room was recorded daily using a digital hygrometer and thermometer. The firmness of fruit was measured using a hand held penetrometer (Fruit firmness tester) until peel is punctured with round plunger head (8mm). Each fruit was punctured at two places 90^0 apart and maximum puncture force was recorded in kg. Mass of the fruits was recorded on daily basis using a digital weighing balance (precision ±5g) to determine the average fruit mass. The PLW of the fruit was calculated on the initial weight basis. Fruits were cut into two halves and juice was extracted with a domestic reamer and weighed for juice content. Total soluble solids content of juice was determined using a hand refractometer (Erma refractometer) and correction at 20^{o}C was applied; p^H was measured using a digital p^H meter; whereas total acidity, reducing sugars and ascorbic acid (Vitamin-C) contents were determined by using titrimetric methods (Ranganna, 2010). Total phenol content was measured using calorimetric method (Sadasivam and Manickam, 2009). Surface microbial load was calculated by following spread plate technique for fungal and bacterial load separately.

RESULTS AND DISCUSSION

Results were presented in table 1. The fruits retained wholesome appearance during the entire storage period of 21 days at ambient conditions. In the first 2 weeks of storage, the taste and flavour remained comparable. The average fruit weight and juice content decreased gradually during the period. The reduction in weight loss in fruits might be attributed to higher evapo-transpiration and respiration rates due to metabolic activities and similar results were reported by the Singh and Sharma (2011) on Kinnow fruits. Fruit firmness is the most crucial factor in determining the post harvest quality of the fruit. The firmness of the fruit followed a declining trend and later increased gradually due to desiccation of fruit resulting in toughening or thickening of peel. But the fruit tissue inside the peel became soft gradually; softening of fruits was caused either by break down of insoluble proto pectin into soluble pectin or by cellular disintegration leading to increased membrane permeability. Mahajan *et al*., (2005) reported similar results of firmness in case of Kinnow fruits. Variation of PLW and firmness was shown in fig. 1. TSS of juice had increased slowly due to loss of moisture. It appeared that increase in total soluble solids is a built in process in ageing of sweet orange fruits and may be due to the breakdown of complex carbohydrates. Variation in juice content and TSS was shown in fig. 2. Ascorbic acid content and

Fig. 1. Effect on Firmness and Physiological loss of weight during of sweet oranges stored under ambient condition (R.H = 72-83%; temp = 26-29^{0}C) for a period of 21 days.

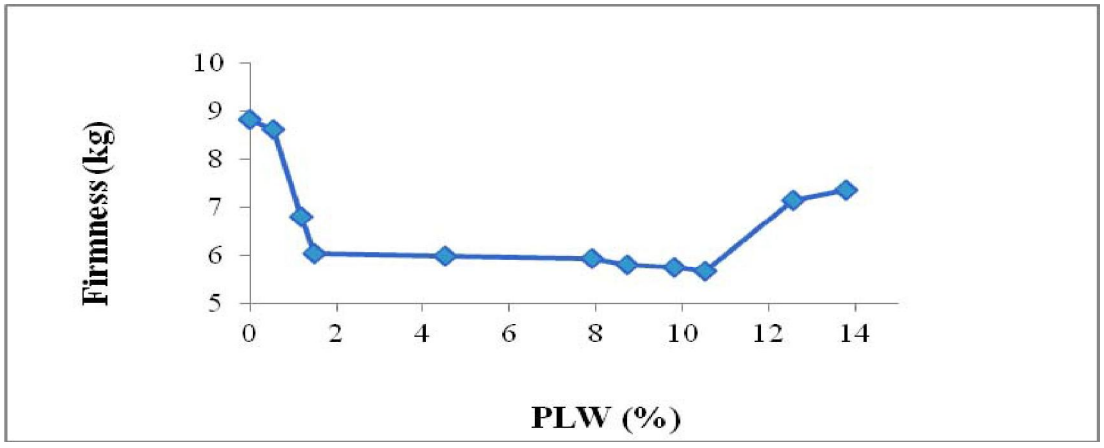

Fig. 2. Effect on Juice content and Total soluble solids of sweet oranges stored under ambient condition (R.H = 72-83%; temp = 26-29^{0}C) for a period of 21 days.

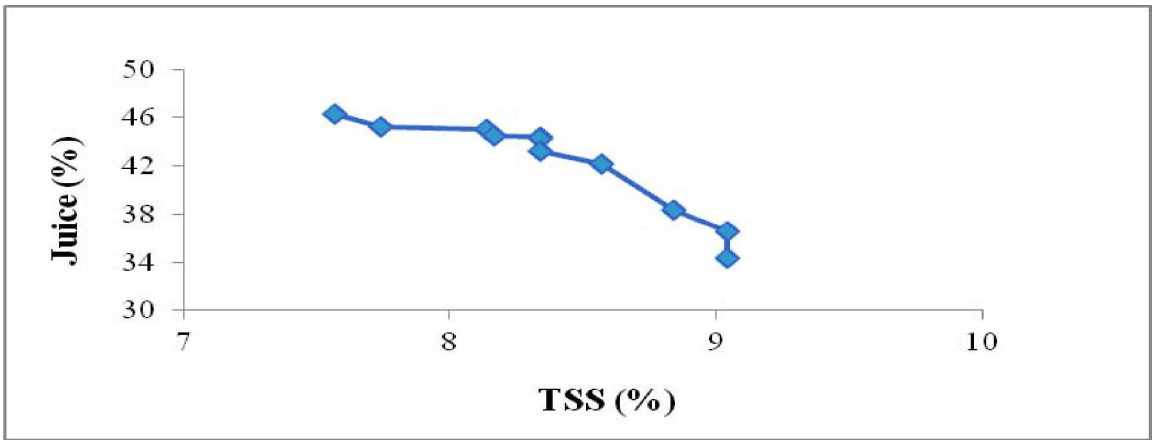

Fig. 3 Effect on Titrable acidity of sweet oranges stored at ambient condition (R.H = 72-83%; temp = 26-29^{0}C) for a period of 21 days.

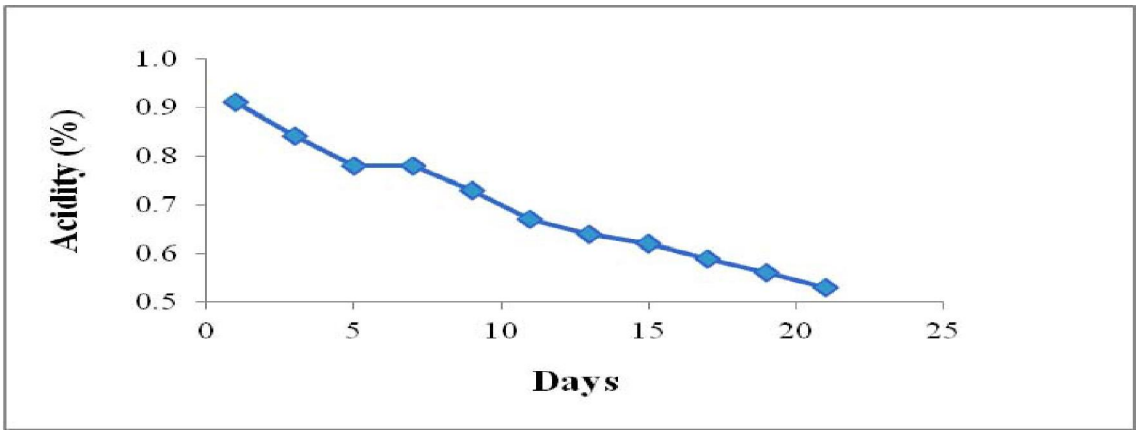

Fig. 4. Effect on Reducing sugars and Ascorbic acid content of sweet oranges stored at ambient condition (R.H = 72-83%; temp = 26-29^{0}C) for a period of 21 days.

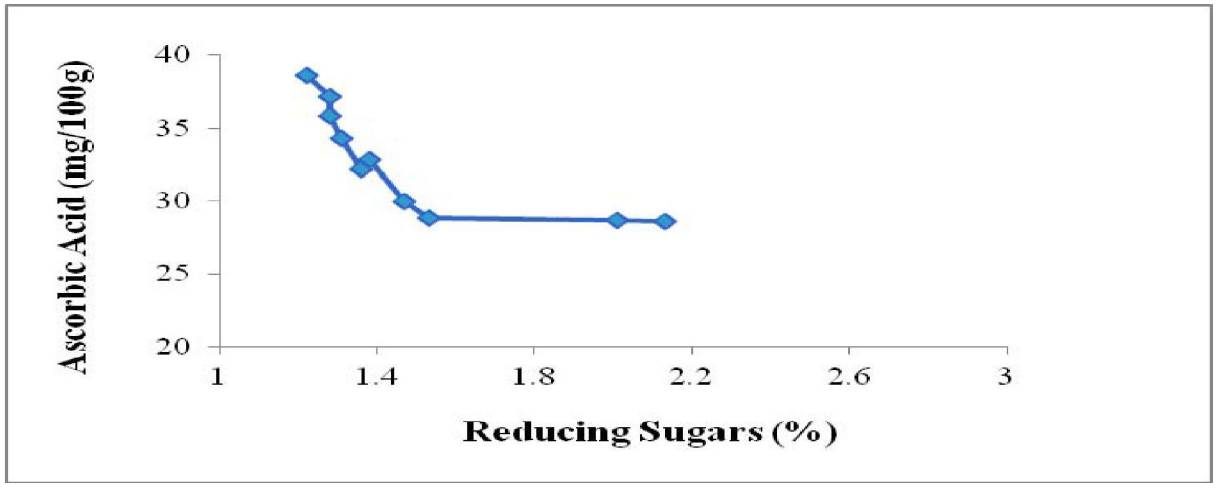

Table 2. Surface microbial load of sweet orange under ambient conditions (R.H= 72-83%; Temp = 25-29^{0}C) for a period of 21 days.

Day	Surface Microbial Load (Cfu/cm^2)	
	Bacteria	Fungi
1	165	12
3	317	18
5	545	22
7	564	24
9	610	27
11	716	38
13	1275	44
15	2620	57
17	4352	62
19	7850	93
21	9954	148

Titrable acidity followed a declining trend during the storage period. Decrease in acidity might be due to the utilization of organic acids in respiration process and it coincided with the results reported by Jawandha *et al*., (2009) in case of Kinnow mandarins. Variation of acidity during the storage period was shown in fig. 3. Phenols in juice showed a minor increase during the storage. The increase in phenol content of juice tissue was likely to be influenced by increased synthesis of anthocyanin and carotenoids which were of polyphenol in nature and results were in agreement with the research results of Ram *et al*., (2004) on Kinnow mandarins.

There was a slight increase in the reducing sugars content due to hydrolysis of polysaccharides and concentration of juice as a result of dehydration. Results were in agreement with the work of Ghorai *et al*., (1998) on Kinnow Mandarin juice. Variation in reducing sugars and ascorbic acid content was shown in fig. 4. The Decay % of 7.5% was observed by the end of storage period. Surface microbial load increased during storage period (Table 2). It might be due to weakening of the defence system against microbial attack. Post harvest pathogens like Aspergillus, pencillium, geocladium and fusarium species were identified mostly.

SUMMARY AND CONCLUSION

Fruit weight and firmness of the fruit were the main indices for deterioration of fruit quality which declined slowly under ambient storage condition may be attributed due to higher transpiration and respiration rates. TSS, phenol content and reducing sugars were found to be increasing and acidity of juice, ascorbic acid content decreased during the storage period. Microbial load and fruit decay increased gradually during the storage period. It can be concluded from the above discussion that sweet oranges can be stored safely with a little deterioration in quality under ambient conditions (R.H: 72-83%; temp: 26-29^{0}C) for a period of 3 weeks.

LITERATURE CITED

Ghorai K and Khurdiya D S 1998 Storage of heat processed kinnow mandarin juice, *Journal of food science and technology*, 35(5): 422-424.

Jawandha S K, Randhawa JS and Gil P P S 2009 Effect of HDPE packaging with edible oil and wax coating on storage quality of kinnow mandarin, Journal *of Food Science and Technology*, 46(2): 169-171.

Kumar B, Mistry N C, Singh B and Gandhi C P 2012 Commodity wise Status (Chap 2) in Indian Horticulture Database 2011, Published by National Horticulture Board, Ministry of Agriculture, Gurgaon. P: 55

Mahajan B V C, Dhatt A S and Sandhu K S 2005 Effect of different post harvest treatments on the storage life of kinnow, *Journal of Food Science and Technology*, 42(4): 296-299.

Ram L, Godara R K, Sharma R K and Siddique S 2004 Primary and secondary metabolite changes of kinnow mandarin fruits during different stages of maturity. *Journal of Food Science and Technology,* 41(3): 337-340.

Ranganna S 2010 Proximate constituents (chap 1), Vitamins (chap 5) in Handbook of analysis and quality control for fruit and vegetable products, Published by Mc Graw Hill education private limited. P: 9-16, 105-106.

Sadasivam S and Manickam A 2008 Phenolics (chap 8) in Biochemical methods, Published by New age International publishers. P: 203-204

Singh D and Sharma R R 2011 Beneficial effects of pre-harvest carbendazim and calcium nitrate sprays in kinnow (Citrus nobilis × C. deliciosa) storage. *Indian Journal of Agricultural Sciences*, 81 (5): 470- 472.

(Received on 15.06.2013 and revised on 25.03.2014)