ijPPHT International Journal of Processing and Post Harvest Technology
Volume 3 | Issue 1 | June, 2012 | 59-64
RESEARCH PAPER

Studies on the effect of different storage conditions on the quality and shelf life of kokum (*Garcinia indica* Choisy) fruits

■ G.P. RAORANE, A.G. DESAI, N.A. NALAGE AND S.S. BHOSALE

SUMMARY : The kokum fruits stored at ambient temperature recorded the maximum PLW. The shelf life of fruits stored at ambient temperature, cool chamber + waxol 12 per cent and cold storage + waxol 12 per cent was 5, 15 and 28 days, respectively. The shrivelling and the spoilage started from 3rd day at ambient temperature, 5th day of storage at cool chamber and 7th day of storage at cold storage. The shrivelling was the maximum in the fruit stored at ambient temperature, followed by cool chamber while cold storage did not show any shrivelling. Moreover, spoilage (microbial) was the maximum at ambient temperature, as compared to other storage conditions (Cool chamber and cold storage). The moisture content of kokum fruits decreased throughout the storage. The maximum decrease in moisture content was observed in the fruits stored at ambient temperature and the minimum in the fruits stored at cold storage and treated with waxol-0-12 per cent. The minimum retention of moisture content in kokum fruits was observed in fruits stored at cold storage with perforated polythene (80.44%) at the end of shelf life. The total soluble solids increased at the end of storage period irrespective of storage conditions. The fruits stored at ambient temperature recorded the maximum T.S.S. (14.17^{0}B) followed by cool chamber and cold storage (14.05 and 13.61^{0}B, respectively). The total sugars of kokum fruits increased at the end of storage period, irrespective of storage conditions. The fruits stored at ambient temperature recorded the maximum reducing and the total sugars followed 6.53 and 14.23 per cent, respectively by cool chamber (4.38 and 14.09%) and cold storage (4.42 and 14.05), respectively. Titrable acidity of the kokum fruits declined throughout the storage period at all storage conditions. The fruit stored at cool chamber and treated with waxol-0-12 per cent recorded the maximum acidity (3.53%), followed by the fruits at cool chamber (3.45%) and at ambient temperature storage (3.18%). Ascorbic acid of kokum fruits showed a continuous decline trend during storage at all storage conditions. The maximum retention of ascorbic acid was in the fruits stored in cold storage and placed in perforated polythene bag (5.34 mg/100g), followed by the fruits of cold storage treated with wax (4.92 mg/100 g) and cool chamber fruits treated with wax (4.87 mg/100 g). The ambient temperature stored fruits showed poor retention of ascorbic acid (2.86 mg/100 g).

Key Words : Storage, Quality, Shelf Life and Kokum

How to cite this paper : Raorane, G.P., Desai, A.G., Nagale, N.A. and Bhosale, S.S. (2012). Studies on the effect of different storage conditions on the quality and shelf life of kokum (*Garcinia indica* Choisy) fruits *Internat. J. Proc. & Post Harvest Technol.,* **3** (1) : 59-64.

Research chronicle : Received : *16.02.2012;* Sent for revision : *01.04.2012;* Accepted : *23.04.2012*

Kokum (*Garcinia indica* Choisy) belongs to the genus *Garcinia*, which is large genus of polygamous evergreen trees and shrubs native of Asia, Southern Africa and Polynesia (Anthony, 1997). The scientific name *Garcinia* is derived from Garcias, who described it in 1974 (Subash Chandran, 1996). The genus belongs to a botanical family clusiaceae, which consists of tropical trees, lianes (vines) and herbs.

Storage is one of the most important aspect of the post harvest handling of fruits.The main object of storage of fresh fruits is to extend period of availability. A substantial quality of fruits go waste in our country due to lack of proper storage facility. As the fruits are living entities and under go physiological and bio-chemical changes after harvest.The purpose of storage is to control the rate of transpiration, respiration, ripening and also many undesirable bio-chemical

MEMBERS OF THE RESEARCH FORUM

Author for Correspondence :
G.P. RAORANE, Agriculture Collge, BARAMATI (M.S.) INDIA

Coopted Authors:
A.G. DESAI, B.S. Konkan Krishi Vidyapeeth, Dapoli, RATNAGIRI (M.S.) INDIA

N.A. NALAGE AND S.S. BHOSALE, Ratnai College of Agriculture, AKLUJ (M.S.) INDIA

changes and diseases infection. The loss of perishable fruits can be prevented by controlling the post-harvest environmental conditions of temperature and relative humidity.

EXPERIMENTAL METHODS

For this study the ripe kokum fruits were selected. The experimental details are given below.

- Replications : Three
- Design : Factorial C.R.D.
- Treatments : Nine
  - T_1 - Ambient storage
  - T_2 - Ambient temperature + Fruits packed in perforated polythene packaging
  - T_3 - Ambient storage + Waxol 12 per cent
  - T_4 - Cool chamber
  - T_5 - Cool chamber + Fruits packed in perforated polythene packaging
  - T_6 - Cool chamber + Waxol 12 per cent
  - T_7 - Cold storage (13 ± ^{0}C and 86% R.H.)
  - T_8 - Cold storage + Fruits packed in perforated polythene packaging
  - T_9 - Cold storage + Waxol 12 per cent

For this study 35 fruits per treatment per replication were observed. The observations on daily temperature and humidity were recorded at every storage condition. Physiological loss in weight and recorded and chemical (characters) composition of fruits-were determined as methods by-moisture percentage (Ranganna, 1977),total soluble solids (A.O.A.C., 1980), sugars (Ranganna, 1986), acidity (A.O.A.C., 1980), ascorbic acid (Ranganna1, 986), anthocyanins (Ranganna, 1986),

Ripening and spoilage pattern :

The number of fruits shriveled and spoiled due to disease incidence at 2 days interval were observed. The shelf life of fruit was recorded on the basis of extent of PLW and spoilage up to 15 per cent.

EXPERIMENTAL FINDINGS AND ANALYSIS

The results of the present study as well as relevant discussions have been presented under following sub heads:

Chemical composition:

Moisture: (Table 1)

The moisture content decreased under all the storage treatments in the similar manner, irrespective of the years of study. The decline in moisture from fruits during storage could be attributed to the loss of moisture through respiration and the transpiration. Similar findings were also reported by Shinde (1993) and Raut (1999) in sapota.

It could be seen that the moisture content showed non-significant variation within the treatments. By and large it is seen that the moisture content of the kokum fruits was lower (less loss as compared to the original value of the fruit) at various treatments of cold storage than at ambient temperature treatments during both the years of study. This could be owing to the lower temperature and the high humidity at both the cool and the cold storage, as compared to ambient temperature. The observations are in line with the findings reported by Naik (1985). Raut (1999) at ambient temperature, cool and cold storage of sapota and Nair (1986) at ambient temperature and cool storage of kokum fruits.

The analysis of the data indicated that all the storage treatments differed significantly from each other with respect to moisture content of the kokum fruits. The higher moisture content in kokum fruits stored at T_9 treatment closely followed by T_8 and T_7 treatments of cold storage could be attributed to low temperature and high humidity at cold storage which could be have been responsible for lower rate of respiration and the transpiration leading to higher retention of the moisture. Similar observations were also reported by Raut (1999) in sapota fruits at cold storage.

The significantly lowest moisture content of kokum fruits stored at ambient temperature could be attributed to the maximum temperature and the minimum humidity resulting into the maximum loss of moisture through the accelerated rate of respiration and the transpiration. The observations analogous to these findings were also reported by Raut (1999) in sapota and Nair (1986) in kokum fruits, Mali (1999) in papaya, Sawant (2000) in jackfruit and Asagekar (2002) in pineapple stored at ambient temperature.

Total soluble solids

The data revealed to the changes in the total soluble solids of kokum fruits during storage are presented in Table 1. It is seen from the data that in general there was increase in T.S.S. content of kokum fruits during storage, irrespective of the treatments. These results are analogous to the findings reported by Mali (1999) in papaya.

The statistical analysis of data showed significant variation within the treatments. The kokum fruits stored at ambient temperature (T_1) exhibited T.S.S. significantly maximum (14.17^{0}B) followed by cool chamber (14.05^{0}B) (T_4) and cold storage (13.61^{0}B) (T_7). The significantly minimum (12.08^{0}B) T.S.S. was observed in treatment T_2 which was at par with the treatment T_3, T_5, T_6, T_8 and T_9.The maximum T.S.S. content of the kokum fruits at ambient temperature conditions might be due to the favourable temperature and the humidity levels leading to the maximum hydrolysis of the starch into sugars.

The observations identical to these findings were also reported by Raut (1999) and Shinde (1993) in sapota. Moreover, the perforated polythene wrapping, waxol and the lower temperature at cool and cold storage might have slightly hindered the process of hydrolysis of starch into sugars. These observations are in accordance with the reports of Joshi (1994) in kokum fruits and Gole (1986) in mango. The maximum T.S.S. recorded at ambient temperature storage of kokum as compared to other storage conditions could be attributed to maximum loss of moisture during storage results in higher concentration of T.S.S. The identical observations were reported by Mali (1999) in papaya.

Titrable acidity:

The titrable acidity (Table 1)of the kokum fruit was found to decline continuously upto the end of shelf life, irrespective of storage treatments and the years of study. The observations in accordance with these findings were also reported by Raut (1999) in sapota, Sahani (1994) in mango, Sawant (1989) in sapota and Mali (1999) in papaya.

Further, the different storage treatments were found to differ non-significantly from each other. The acidity of the kokum fruits stored in the cold storage (T_7, T_8 and T_9) were more, as compared to their storage in ambient temperature conditions. This could be attributed to the low temperature and the high humidity, which could have been responsible for reduction in the rate of respiration leading to less utilization and degradation of organic acids during storage. The identical observations were also reported by Krishnamurthy *et al.* (1960), Joshi and Roy (1985) in mango.

The slower decrease in the acidity during cool and cold storage fruits wrapped in perforated polythene and the wax coated fruits, as compared to the ambient temperature could possibly due to low temperature and the high humidity prevalent at these conditions, which slowered down the rate of degradation of organic acids. It appears from the review that no such work has been reported so far in kokum fruits.

Ascorbic acid (Table 1):

The ascorbic acid content of kokum fruits declined throughout the storage period, irrespective of storage conditions treatments and the years of study. Similar observations were also reported by Mali (1999) in papaya.

The data further revealed that the fruits stored under all the storage treatments showed significant differences with respect to the ascorbic acid content during both the years of study. However, the ascorbic acid content of the kokum fruits stored at T_9 treatment was significantly the maximum. The treatments T_7 and T_8 were found to be at par with each other. Significantly maximum ascorbic acid content was found in treatment T_9 (5.34). Further the treatments T_3 and T_4 were found to be at par with each other.

The decline in ascorbic acid content at ambient temperature storage condition could possibly due to its degradation during this period. The similar results were also reported by Mali (1999) in papaya and Raut (1999) in Sapota.

Further treatment T_9 at cold storage accorded the best retention of ascorbic acid, followed by T_8 and T_7 treatments which appeared due to low temperature and high humidity prevalent at these conditions resulting in minimum degradation of ascorbic acid.

Reducing sugars and the total sugars:

The data regarding the reducing sugars and the total sugars of kokum fruits during storage treatments are presented in Table 1. The content of reducing sugars and the total sugars

Table 1 : Moisture percentage, total soluble solids, acidity, ascorbic acid, reducing sugar and the total sugar of kokum fruits stored at different storage conditions

Sr. No.	Treatments	Moisture (%)		Total soluble solids (^{0}B)		Acidity (%)		Ascorbic acid (mg/100g)		Reducing sugar (%)		Total sugar (%)	
		Before storage	After storage	Before storage	After storage	Before storage	After storage	Before storage	After storage	Before storage	After storage	Before storage	After storage
1.	T_1	81.41	77.51	13.11	14.17	3.50	3.18	12.43	2.86	5.22	6.53	12.42	14.23
2.	T_2	81.41	77.86	13.11	12.08	3.50	3.20	12.43	3.21	5.22	6.25	12.42	14.02
3.	T_3	81.41	78.91	13.11	12.30	3.50	3.34	12.43	3.73	5.22	6.13	12.42	14.62
4.	T_4	81.41	78.44	13.11	14.05	3.50	3.45	12.43	3.97	5.22	4.38	12.42	14.09
5.	T_5	81.41	78.90	13.11	13.38	3.50	3.43	12.43	4.19	5.22	4.87	12.42	13.18
6.	T_6	81.41	79.24	13.11	12.20	3.50	3.53	12.43	4.78	5.22	4.48	12.42	13.58
7.	T_7	81.41	79.68	13.11	13.61	3.50	3.38	12.43	4.87	5.22	4.60	12.42	14.05
8.	T_8	81.41	80.60	13.11	12.95	3.50	3.30	12.43	4.92	5.22	4.75	12.42	14.50
9.	T_9	81.41	80.44	13.11	12.86	3.50	3.35	12.43	5.34	5.22	4.42	12.42	14.05
	Avg.	81.41	79.01	13.11	12.92	3.50	3.47	12.43	4.21	5.22	5.15	12.42	14.31
	S.E.$\pm$	0.55	0.62	1.62	0.347	0.227	0.362	0.173	0.036	0.087	0.293	0.005	0.272
	C.D. (P=0.05)	NS	1.72	NS	0.960	NS	NS	NS	0.101	NS	0.810	NS	NS

NS=Non-significant

was less initially, which increased during storage period, irrespective of storage treatments. The increase in sugar content appeared to be due to conversion of starch into sugars during storage. The sugars in kokum fruits did not show much variation, when stored at different storage conditions with different treatments.

However, the cold storage conditions have shown better retention of the sugars and at the ambient temperature storage the sugars were the maximum. The fruits stored at ambient temperature showed high reducing and the total sugars content than their storage either at cool or cold storage. The minimum reducing and the total sugar content were recorded in kokum fruits stored at T_9 treatment, followed by T_8 and T_7. This could be due to prevailing low temperature and high humidity lowering the rate of respiration and transpiration. The observations are in confirmation with the reports of Mali (1999) in papaya, Sawant (2000) in jackfruit and Asagekar (2002) in pineapple.

Physiological loss in weight:

The data related to the physiological loss in weight of kokum fruits during storage are presented in Table 2. It could be revealed from this table that PLW increased continuously till the end of storage period, irrespective of storage conditions and the years of study. The continuous increase in PLW values at all storage conditions could be due to loss of moisture from the fruits through respiration and the transpiration. The observations in accordance with these findings were also reported by Gole (1986) in mango, Mali (1999) and Raut (1999) in papaya and sapota, respectively. Asgekar (2002) in pineapple and Sawant (2000) in jackfruit also recorded similar observations.

The statistical analysis of the data indicated the significant differences with respect to the PLW among the storage continuous under study. The fastest and the maximum increase in PLW was observed at ambient temperature storage.

Further, the kokum fruits at T_9 treatment showed the minimum physiological loss in weight and maximum shelf-life, as compared to cool chamber and ambient temperature storage. The low temperature and high humidity prevalent in cold storage and the wax coating treatment might have brought about the reduction in PLW by reducing the moisture loss through decrease in respiration and transpiration rate. Gole (1986) reported similar observations while working on cold storage of Alphonso mango, Joshi (1994) also made similar observations in wax treated kokum fruits.

Shrivelling and the spoilage pattern of kokum fruits:

The data regarding the shrivelling and the spoilage of kokum fruits stored under ambient temperature, big size cool chamber and the cold storage are presented in Table 3. It could be seen that the shrivelling and the spoilage was found to be the fastest at ambient temperature. This could be due to the maximum temperature (28.30^{0}C) and the minimum humidity (77%) at ambient temperature storage, which could have been at the optimum level for the fastest shrivelling. The accelerated rate of moisture loss must have been responsible for the shrivelling. The favourable temperature and the humidity at ambient temperature storage might have also been responsible for the rotting of ripe kokum fruits resulting into low shelf life. Identical observations were also reported by Shinde (1993) and Raut (1999) in sapota and Joshi (1994) in kokum.

The fruits stored at treatment T_9 showed the slowest rate of shrivelling and the spoilage. This could be due to the minimum biosynthesis of ethylene (ripening hormone) because of low temperature and the wax layer resulting into slowest rate of ripening of the kokum fruits. The spoilage of kokum fruits was the minimum at cold storage and in wax layered fruits, which could be due to low temperature prevailing at the cold storage, retarding the growth of the micro-organism responsible for the spoilage. These observations are the first report in kokum.

Table 2 : Physiological loss in weight of kokum fruits stored at different storage conditions

Sr. No.	Treatments	3rd day	5th day	7th day	9th day	11th day	13th day	15th day	17th day	19th day	23th day	27th day	31th day
1.	T_1	6.45	15.26	----	----	----	----	-----	-----	-----	-----	-----	-----
2.	T_2	3.32	7.46	10.47	13.41	15.22	----	-----	-----	-----	-----	-----	-----
3.	T_3	2.85	4.39	6.65	10.35	12.36	14.31	15.03	-----	-----	-----	-----	-----
4.	T_4	2.85	4.99	7.24	9.86	12.00	13.89	15.18	-----	-----	-----	-----	-----
5.	T_5	2.82	4.69	7.51	10.41	12.37	14.31	15.15	-----	-----	-----	-----	-----
6.	T_6	2.44	3.90	5.45	7.47	9.20	11.48	15.56	15.09	-----	-----	-----	-----
7.	T_7	3.60	----	6.31	----	8.72	----	11.04	-----	13.42	15.06	-----	-----
8.	T_8	3.51	----	5.54	----	7.55	----	9.51	-----	11.52	13.41	15.29	-----
9.	T_9	1.47	----	3.48	----	5.45	----	7.89	-----	9.75	11.42	13.69	15.29
	Avg.	3.25	4.52	8.84	5.72	9.20	6.00	9.52	-----	3.85	4.34	3.22	1.68
	S.E.	0.260	0.200	0.340	0.057	0.244	0.0527	0.067	0.00	0.049	0.284	0.0224	0.216
	C.D. (P=0.05)	0.720	0.554	0.940	0.176	0.676	1.458	0.187	0.00	0.136	0.786	0.061	0.059

Table 3 : The shrivelling and the spoilage of kokum fruits stored at different storage conditions

Tr. No.	Parameters	3rd day	5th day	7th day	9th day	11th day	13th day	15th day	17th day	19th day	23rd day	27th day	31st day
T_1	Shrivelled	4.17	13.43	16.77	21.01	27.70	30.38	41.00	60.38	-----	-----	-----	-----
	Diseased	1.72	2.94	7.50	14.00	20.33	26.00	31.83	36.00	-----	-----	-----	-----
T_2	Shrivelled	0.00	-----	-----	-----	-----	-----	2.95	-----	-----	-----	-----	-----
	Diseased	-----	-----	-----	2.94	7.23	11.62	14.70	-----	-----	-----	-----	-----
T_3	Shrivelled	-----	2.56	5.60	13.18	-----	-----	-----	-----	-----	-----	-----	-----
	Diseased	-----	-----	2.63	2.69	-----	-----	-----	-----	-----	-----	-----	-----
T_4	Shrivelled	-----	-----	1.35	2.34	3.40	7.25	9.95	-----	-----	-----	-----	-----
	Diseased	-----	-----	-----	1.34	3.48	4.47	6.94	-----	-----	-----	-----	-----
T_5	Shrivelled	-----	-----	-----	1.41	3.48	6.49	9.98	-----	-----	-----	-----	-----
	Diseased	-----	-----	-----	-----	2.20	6.01	7.45	-----	-----	-----	-----	-----
T_6	Shrivelled	-----	-----	-----	-----	2.20	6.01	7.45	-----	-----	-----	-----	-----
	Diseased	-----	-----	-----	-----	2.17	4.17	8.33	-----	-----	-----	-----	-----
T_7	Shrivelled	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	Diseased	-----	-----	1.42	2.15	3.05	5.60	-----	8.17	10.25	13.25	15.00	-----
T_8	Shrivelled	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	Diseased	-----	-----	1.25	2.25	3.65	5.15	7.25	8.45	11.37	13.25	16.00	-----
T_9	Shrivelled	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	Diseased	-----	-----	1.25	2.17	3.17	5.17	6.33	7.15	8.00	10.42	12.32	14.95

Summary and conclusion:

The kokum fruits stored at ambient temperature recorded the maximum PLW. The shelf life of fruits stored at ambient temperature, cool chamber + waxol 12 per cent and (cold storage + waxol 12 per cent) was 5, 15 and 28 days, respectively.

Further, the shrivelling and the spoilage started from 3rd day at ambient temperature, 5th day of storage at cool chamber and 7th day of storage at cold storage. The shrivelling was the maximum in the fruit stored at ambient temperature, followed by cool chamber while cold storage did not show any shrivelling. Moreover, spoilage (microbial) was the maximum at ambient temperature, as compared to other storage conditions (cool chamber and cold storage).

The moisture content of kokum fruits decreased throughout the storage. The maximum decrease in moisture content was observed in the fruits stored at ambient temperature and the minimum in the fruits stored at cold storage and treated with waxol-0-12 per cent. The minimum retention of moisture content in kokum fruits was observed in fruits stored at cold storage with perforated polythene (80.44%) at the end of shelf life.

The total soluble solids increased at the end of storage period irrespective of storage conditions. The fruits stored at ambient temperature recorded the maximum T.S.S. (14.17^0B) followed by cool chamber and cold storage (14.05 and 13.61^0B, respectively).

The total sugars of kokum fruits increased at the end of storage period, irrespective of storage conditions. The fruits stored at ambient temperature recorded the maximum reducing and the total sugars followed 6.53 and 14.23 per cent, respectively by cool chamber (4.38 and 14.09 per cent) and cold storage (4.42 and 14.05), respectively.

Titrable acidity of the kokum fruits declined throughout the storage period at all storage conditions. The fruit stored at cool chamber and treated with waxol-0-12 per cent recorded the maximum acidity (3.53%), followed by the fruits at cool chamber (3.45%) and at ambient temperature storage (3.18%).

Ascorbic acid of kokum fruits showed a continuous decline trend during storage at all storage conditions. The maximum retention of ascorbic acid was in the fruits stored in cold storage and fruits treated with waxol (T_9)(5.34 mg/100g), followed by the fruits stored in cold storage and fruits packed in perforated polythene packaging (T_8) (4.92 mg/100 g) and cool chamber fruits treated with wax (4.87 mg/100 g). The ambient temperature stored fruits showed poor retention of ascorbic acid (2.86 mg/100 g).

LITERATURE CITED

A.O.A.C. (1980). *Official methods of analysis*. Association of Official Analytical Chemists. 13th Edn. WASHINGTON, U.S.A., 218 pp.

Anthony, J.I.X. (1997). *Garcinia indica* - A natural fat regulating Beverage. *Beverage & Food World*, **24**(3) : 24-25.

Asgekar, M.A. (2002). Studies on physico-chemical composition, some aspects of post harvest handling and processing of pineapple (*Ananas comosus* L. Merr.) cv. Kew fruits. M.Sc. (Ag.) Hort., Thesis Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, M.S. (INDIA).

Gole, R.S. (1986). Studies on fruit development and some aspects of post-harvest handling of mango (*Mangifera indica* L.) fruits. M.Sc. (Ag.) Hort., Thesis Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, M.S. (INDIA).

Joshi, A.B. (1994). Studies on some aspects of post harvest handling and processing of kokum (Garcinia Choisy) fruits. M.Sc. (Agri.) Thesis Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, M.S. (INDIA).

Joshi, G.D. and S.K. Roy (1985). Effect of integrated post-harvest handling on biochemical changes in Alphonso mango fruits. *Prog. Hort.,* **17**(1): 56-63.

Krishnamurthi, S., Randhawa, G.S. and Nair, P.C.S (1960). Growth studies in some citrus species under subtropical conditions. *Indian J. Hort.*, **17**(3-4): 171-189.

Mali, P.C. (1999). Studies on maturity indices and some aspects of post harvest handling and processing of papaya (*Carisa papaya* L.) cv. RED LADY. M.Sc. (Ag.) Hort. Thesis Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, M.S. (INDIA).

Naik, S.R. (1985). Studies on physico-chemical changes in Alphonso and Ratna mango (*Mangifera indica* L.) fruits during growth, development and storage. M.Sc. (Ag.) Thesis, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, RATNAGIRI, M.S. (India).

Nair, G.R. (1986). Studies on maturity indices and post harvest technology of kokum (*Garcinia indica* Choisy). M.Sc. (Ag.) Hort., Thesis Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, M.S. (INDIA).

Ranganna, S. (1986). Plant Pigments, In : *Handbook of analysis and quality control for fruit and vegetable products*. 2nd Ed., Tata McGraw-Hill Publishing Co. Ltd., NEW DELHI, India. pp. 83-104.

Ranganna, S. (1986). Vitamins, In : *Handbook of analysis and quality control for fruit and vegetable products*. 2nd Ed., Tata McGraw Hill Publishing Co. Ltd., NEW DELHI, India. pp. 594-645.

Ranganna, S. (1997). *Manual of analysis of fruits and avegetables products*. Tata MC GRAW. Hill Publishng Company, Ltd., NEW DELHI, India. pp. 1-3.

Raut, U.V. (1999). Studies on maturity indices, harvesting integrated post harvest handling and processing of sapota (*Manilkara achras* (Mill.) Forsberg) cv. KALLIPATTI (1999). Ph.D. (Ag.) Hort., Thesis Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, M.S. (INDIA).

Sahani, C.K., Khurdiya, D.S. and Dalal, M.A. (1994). Effect of ripening aids on the quality of Amarpalli mango. *Maharashtra J. Hort.,* **8**(1): 72-77.

Sawant, S.B. (2000). Studies on maturity indices and some aspects of post harvest handling and processing of jackfruit (*Artocarypus heterophyllus* Lam.). M.Sc. (Ag.) Hort. Thesis, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, M.S. (INDIA).

Sawant, V.S. (1989). Studies on post harvest handling and preservation of sapota [*Manilkara achras* (Mills) Forsberg] fruit cv. KALIPATTI M.Sc. (Ag.) Thesis, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, M.S. (INDIA).

Shinde, V.S. (1993). Studies on some aspects of post harvest handling and processing of sapota (*Manilkara achras* (Mill.) Forsberg) fruit var. Kalipatti. M.Sc. (Ag.) Thesis Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, M.S. (INDIA).

Subash Chandran, M.D. (1996). Nature Watch. The Kokum Tree. Resonance, pp. 86-89.

●●●●●