ISSN 2229-5518

A Study on Shelf life Extension of Carambola Fruits

Ashok Rathod., Shoba, H, Chidanand, D.V

Abstract -The freshly harvested Carambola (Averrhoa Carambola L.) fruits were packed in different packaging matrials like high density polyethylene (HDPE) with a 1% and 2% ventilation with a pretreatment 2 % CaCl2 stored at ambient and also in refrigerated conditions the temperature was in the range of 18.0 to 21.0 0 C and Relative humidity of about 86 per cent. To evaluate the storage condition and pretreatment on Carambola fruits. The result showed that, the Carambola fruits stored in 200 gauge HDPE polyethylene bag with 1 % ventilation stored at refrigerated temperature conditions and pretreatment with 2 % CaCl2 showed an encouraging result with respect to biological properties and organoleptic evaluation when compared with the other treatments.

Index Terms— Carambola fruit, Pretreatments, Packaging, Shelf life, Storage, Storage temperatures, Ventilation.

1. INTRODUCTION

Carambola (*Averrhoa Carambola* L.) belongs to the family Oxalidaceae and is often called as 'Star fruit' or 'five finger' fruit. The fruit is believed to have originated in Southeast Asia, Indonesia or Malaysia, but it is now cultivated throughout the tropics and subtropics of the world. The major Carambola producing countries are China, Taiwan, Malaysia, Thailand, Pakistan, Indonesia, Australia, West Indies and USA (Bose *et al.*, 2002). In India, it is distributed in Uttar Pradesh, Karnataka, Assam, West Bengal, Madhya Pradesh, Bihar and Tamil Nadu (Srivastava and Rajput, 2003). The fruit is non-climacteric and rich in reducing sugars, ascorbic acid and minerals such as K, Ca, Mg and P (Bose *et al.,* 2002). Oxalic acid and tannins are believed to strongly influence the taste. Ripe fruits of sweet form of Carambola contain both oxalic acid (0.16%) and malic acid (0.06%), whereas, fruits of the sour form contain only oxalic acid ranging from 1.0 per cent in unripe fruits to 0.51 per cent in ripe. Sugars present in both types vary largely in glucose with moderate quantities of fructose and traces of sucrose. The fruit also contains amino acids such as serine, glutamic acid and alanine (Charles *et al.,* 1985). Carambola is mainly used in food preparation and has good medicinal properties. Carambola serves as an excellent garnish and unripe fruits can be used as vegetables. Dried Carambola makes delicious snacks and length wise slices of Carambola fruit are used for canning to export (Anon, 2003). It is required that fruits have to be preserved fresh and make available throughout the year to fulfill the human dietary requirements. As the fruits being living entities, their metabolic activities continue even after harvest with a sum total effect on their degrading quality and composition.

* [1,2, 3] AICRP on Post Harvest Technology Scheme
*University of Agricultural Sciences, Bangalore-560065
*shobhahugar@gmail.com

By and large, the type and intensity of the post harvest physiological activity and the kind of fruit determine to a large extent, the storage life of the produce. During storage, the produce deteriorates in quality due to physiological activities such as respiration and loss of moisture. They are susceptible to microbial spoilage leading to changes in their structure, texture, colour and appearance. All these factors individually or in combination affect shelf life. Therefore, in the present study, an attempt was made mainly to extend shelf life.

2. MATERIALS AND METHODS

2.1 Procurement of raw material

Carambola fruit was grown in Department of Horticulture, University of Agricultural Sciences, GKVK, Bangalore. Well developed riped fruits were harvested and brought to the laboratory. These fruits were subjected to different treatments on the day of harvest and taken for studies.

2.2 Preparation of polyethylene bags for packaging

Bags made of 200 gauge thick high density polyethylene (HDPE) measuring 20 X 25cm were used. Circular holes of 5.00 mm diameter were punched into the polyethylene bags. The number of holes made was 20 in case of 1 per cent ventilation and 40 in case of 2 per cent ventilation. These holes were made equidistance from each other at a pitch of 40 mm.

2.3 Preparation of Carambola fruit for storage studies

Uniformly matured carambola fruits were selected for the experiments around 300 g of fruits were accurately weighed and packed into the perforated HDPE bags and the bags were hot sealed using a heat sealing machine. Such packed samples were kept for storage studies according to specified treatments.

2.4 Storage conditions

The storage studies were conducted under ambient conditions in the laboratory on the floor of a well ventilated room and also in refrigerated conditions the temperature was in the range of 18.0 to 21.0 ^{0} C and Relative humidity of about 86 per cent.

2.5 Stastical analysis

The data obtained in 3 replications were subjected to Stastical analysis by Completely Randamised Design (CRD) as suggested by Gomez and Gomez (1984).The critical difference value at 5% level of probability was used for comparison among treatment means

Treatments

T_1: Storing of Carambola fruits in 200 gauge HDPE pol ethylene bag with1 % ventilation + ambient conditions.

T_2: Storing of Carambola fruits in 200 gauge HDPE polyethylene bag with 2 % ventilation + ambient conditions.

T_3: Storing of Carambola fruits in 200 gauge HDPE polyethylene bag with 2 % ventilation + refrigeratedconditions.

T_4: Storing of Carambola fruits in 200 gauge HDPE polyethylene bag with 1 % ventilation + ambient conditions + 2 % calcium chloride.

T_5: Storing of Carambola fruits in 200 gauge HDPE polyethylene bag with 1 % ventilation + refrigerated conditions + 2 % calcium chloride.

3. RESULTS AND DISCUSSION

3.1 Physical Properties

Samples of fresh Carambola fruits were subjected to measurement of physical properties. Variation in all of these parameters was observed from fruit to fruit. The carambola fruit weight varied from 111 gm to 96 gm with a mean value of 103 gm. The fruit length varied from 5.7 cm to 4.5 cm with a mean value of 5.1 cm. The diameter of fruit was calculated by measuring the circumferences and dividing it by numerical value of Π (3.14). The highest calculated diameter was 5.3 cm where as the least calculated diameter was 4.1 cm and average diameter was 4.7 cm. These results are comparable to findings of Srivastava and Rajput (2003).The specific gravity of Carambola fruits was measured by water displacement method and it ranged from 0.96 to 0.99 with average value of 0.98.

3.2 Proximate Composition

Freshly extracted pulp of Carambola fruits was subjected to various tests in order to determine its chemical composition. The total soluble solid was 8.2 ^{0}B. Acidity was measured as 2.23 per cent and pH value was recorded as 2.92. The total sugar was found to be in tune of 3.10, reducing sugar and non reducing sugar were 2.69 per cent and 0.41 per cent respectively Table 2. These results on composition are in line with the findings of Srivastava and Rajput (2003) and Rajput *et. al.*, (2004). The protein content wasrecorded as 0.81 per cent and crude fiber content was 0.70 per cent. This is supported by USDA, (2003), which stated that Carambola fruits contain lower amount of crude protein (0.6 per cent) and crude fiber (0.7 per cent) Table 2.

3.3 Physiological loss in weight (PLW) in per cent

PLW is a strong indicator of storage deterioration, loss of freshness and quality in case of fresh produce like Carambola fruits. In the present study Carambola fruits with different treatments were subjected to periodical weight loss determination during storage period of 21 days and per cent PLW values were calculated. As days of storage progressed the product continued to loose weight due to respiration. But, the rate of weight loss was found to be influenced by the storage conditions. The effects of various storage conditions are explained in following pages with details.

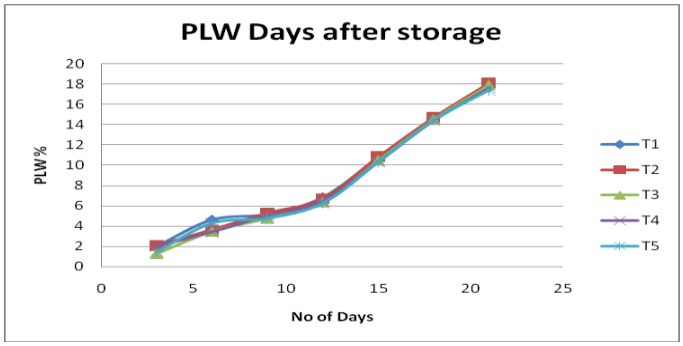

Fig 1: Physiological loss in weight of Carambola fruits under storage in different treatment (%)

3.4 Effect of Ventilation

The Carambola fruits, stored at refrigerated temperature and packed in 200 gauge HDPE polyethylene bags 1% ventilation and pretreated with 2% calcium chloride (T_5) had minimum loss in weight after all the days of storage. The next best treatment to reduce PLW was T_5 (storage of Carambola fruits packed in 200 gauge HDPE polyethylene bags 1% ventilation and pretreated with 2% calcium chloride at ambient conditions). It might be due to low temperature and modified atmosphere inside the package (Brar *et al.*, 2000 and Hemalatha *et al.*, 2001). Similar effects of reduced loss in weight of fruits packed in polyethylene bags has been reported by Okubo *et al.*, (1971), Bhatnagar *et al.*, (1985), Nakhasi *et al.*, (1991) and Lingaiah (1982) in tomato fruits. However fruits, irrespective of treatments recorded maximum loss in weight after storage of 21 days. It may be due to loss of moisture during storage coupled with evapo-transpiration of moisture content from

fruits (Kalra *et al*., 1989).

3.5 Effect of Temperature

Storage study was conducted under two conditions ambient (25-30 ^{O}C) and refrigerated (2-4^{O}C). It was observed that in all the treatments refrigerated storage (2-4^{O}C) had resulted in lesser weight loss leading to lower PLW when compared to ambient storage conditions. These results confirm the earlier results reported by Bhatnagar *et al.,* (1990) and Midon and Lam (1986). Low temperature is the best storage treatment for retarding all physiological and pathological deterioration. Low temperature reduces respiration and other metabolic activities (Faragher *et al.,* 1984a, Reid and Kofrauck, 1980) transpiration (Faragher *et al*., 1984b).

3.6 Effects of calcium chloride pretreatment

It was recorded that PLW of Carambola fluctuated between the treatments. The treatments with 1 per cent ventilation, and pretreated with 2% calcium chloride stored at refrigerated condition (2-4°C), showed minimum loss in weight after 21 days of storage when compared to other treatments (Fig.1). Similar results were reported on carrot and broccoli by Haydar Mohammad (1980), Poovaiah (1986) and Lakshmana (1990). Maximum weight loss was observed in the treatment (T_3) which was stored at ambient temperature in 200 gauge HDPE polyethylene bag with 2% ventilation and without any pretreatment with $CaCl_2$. This indicated maximum weight loss and hence quality deterioration in this treatment when compared to the others. Hence, it is clear that $CaCl_2$ treatment has yielded minimum weight loss indicating minimum quality deterioration. The physiological loss in weight was less in the fruits treated with $CaCl_2$. This may be due to maintenance of cell wall integrity, firmness and reduced respiration rate; it also might be due to lack of substrate availability for respiration. This is supported by the findings of Hayder (1980) and Lakshmana (1990) who reported the influence of Calcium in maintaining cell wall integrity, firmness and reduced respiration. Poovaiah (1986) reported that Calcium ion acted as protectant in reducing the rate of plant senescence and fruit ripening.

3.7 Total Soluble Solids

At the beginning of storage (Just after the harvest) the variation in Total Soluble Solids (TSS) content was not significant but later on there was a significant variation in the TSS (after 3 DAS to 21 DAS) (Fig.2). The value of Total Soluble Solids (TSS) irrespective of treatment showed an increasing trend throughout the storage period. This may be due to the increase in soluble solids content and total soluble sugars caused by hydrolysis of polysaccharides like starch, cellulose and pectin substances into simpler substances. These results are in line with the findings of Ingle *et al*., (1982b) and Kumbar and Desai (1986) who reported an increase in the TSS content of sapota fruits from harvest until ripening and later a decrease in TSS as the fruits started senescing. A similar view was also shared by Gautam and Chundawat (1990) in sapota fruits. Sen *et al*., (1982) reported that TSS content showed an increasing trend during the process ofripening of various cultivars of banana. In guava, Chundawat *et al*.,(1976) noticed an increasing in TSS up to four days of storage but a decline on further storage. Similar results were obtained in ber (Bal, 1982).

3.8 Titratable Acidity

The total titratable acidity was expressed in terms of citric acid as percentage on fresh fruit weight basis. At the beginning of storage the titratable acidity did not vary significantly. The values of titratable acidity irrespective of treatments decreased gradually over the period of storage except after 3 DAS (Fig.3). It increased initially from 4.45 per cent at 0 DAS to 4.64 per cent at 3 DAS and then decreased gradually upto 21 DAS (T_5). The variations in total titratable acidity of Carambola fruits caused by different post-harvest treatments during storage were statistically significant on all the days of observation (except after 3 DAS). The decrease in the total titratable acidity might be due to increase in the total sugar content of the fruits. At the time of maturity, fruits will be having higher amount of acidity, but as the fruits advance towards ripening, acid content will decrease. These results are in line with findings of Ingle *et al.,* (1981), who observed a decrease in acidity during ripening of sapota fruits.

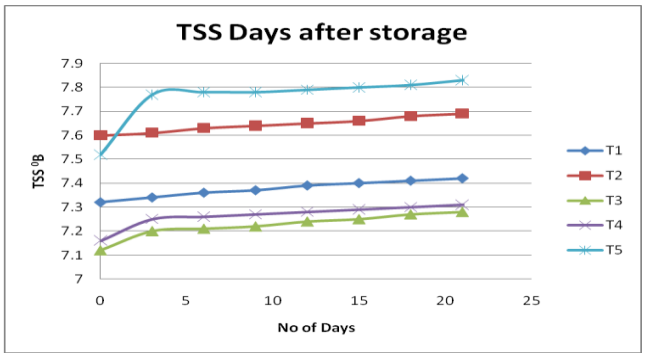

Fig 2: Total Soluble Solids of Carambola fruits of different treatments during storage duration (^{o} B)

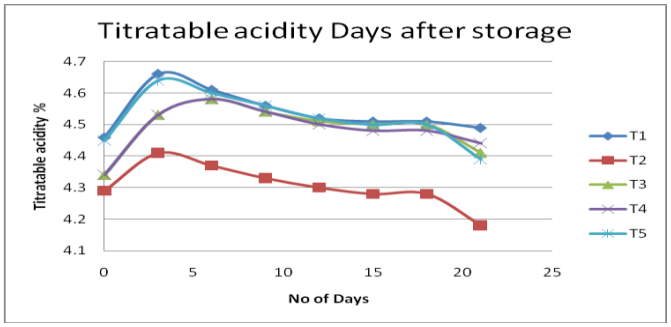

Fig 3: Titratable acidity of Carambola fruits of different treatments during storage duration (%)

3.9 Total Sugar

The sugar content of the fruits at the beginning (0 DAS) of storage was 9.54, 9.70, 9.78, 9.82 & 9.74 per cent in T_1, T_2, T_3, T_4 & T_5. The values of the total sugar content increased progressively with the advancement of storage period upto 21 days (Fig.5). This increase in the total sugar can be attributed to the fact that, the hydrolysis of polysaccharides during storage resulted in increase in total soluble sugar.

As the fruit advances towards ripening, starch, hemi cellulose, and organic acids get converted into various forms of sugar. These changes are largely dependent upon the condition of storage such as temperature, time and on the physical status of fruits. Generally the total sugar content increases from harvest till ripening and declines as senescence approaches once the fruit ripens, the sugars undergo metabolic transformation, both quantitatively and qualitatively (Pantastico, 1975). These findings on the total sugar are in line with the report of Sanjay (1996), who noticed an increasing trend with respect to reducing, non-reducing and total sugar content with advancement of storage period in sapota cv. Kalipatti under ambient storage.

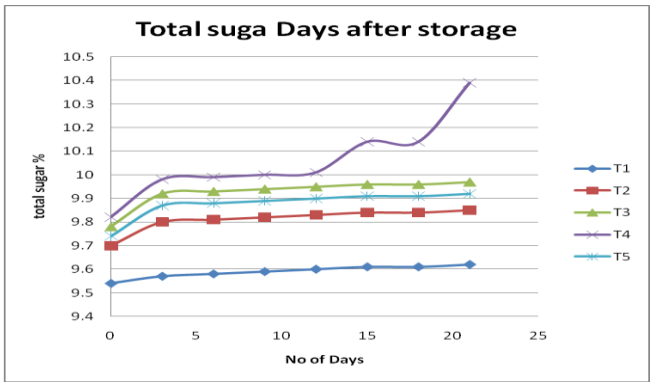

Fig 5: Total sugar of Carambola fruits of different treatments during storage duration (%)

4. Reducing Sugar

In general, the percentage of reducing sugar increased with advancement of storage period and this was indicated by increase in the values of reducing sugar from 8.32, 8.42, 8.57, 8.64 & 8.55 per cent at 0 DAS (T_1, T_2, T_3, T_4 & T_5) to 8.63, 8.77, 9.06, 9.04 & 8.97 per cent at 21 DAS, respectively (Fig.4). This may be attributed to the inversion of non-reducing sugars into reducing sugars caused by acids present in fruits. The rate of inversion was rapid initially in all the treatments, which may be due to availability of more substrate for inversion in initial stages. The increase in the total reducing sugar content is in line with the findings of Ingle *et al*., (1981) who reported an increase in reducing sugar content of sapota fruits during ripening.

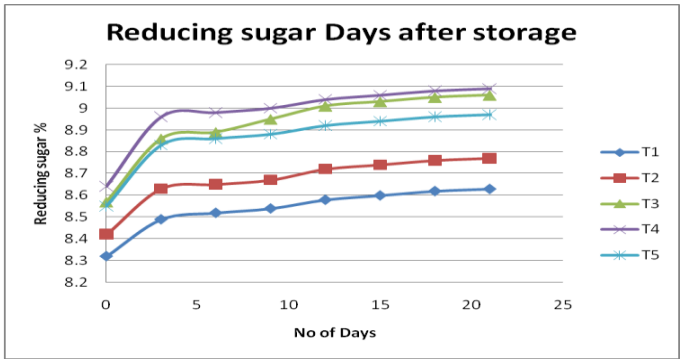

Fig 4: Reducing sugar of Carambola fruits of different treatments during storage duration (%)

4. Organoleptic evaluation of Carambola fruits

It is evident from the Table 3 that, the Carambola fruits stored in 200 gauge HDPE polyethylene bag with 1 % ventilation stored at refrigerated temperature conditions and pretreatment with 2 % $CaCl_2$ showed an encouraging result with respect to biological properties and organoleptic evaluation when compared with the other treatments.

5. CONCLUSION

The Carambola fruits stored in 200 gauge HDPE polyethylene bag with 1 % ventilation stored at refrigerated temperature conditions and pretreatment with 2 % $CaCl_2$ showed an encouraging result and the overall acceptability was 7.24 in case of T_5 where as it was 6.50 in case of T_3. This may be due to fact that combined effect of low temperature, pretreatment with $CaCl_2$ and ventilation helped in development of palatable colour, taste, flavour and texture of pulp. The Carambola fruits stored in 200 gauge HDPE polyethylene bag without ventilation at refrigerated temperature conditions are the best treatment for Carambola fruits to store up to 21 days

6. REFERENCES

[1] AOAC., 1970, Official method of Association of Official Agricultural Chemist, Washington D.C.

[2] BAL, J.S., 1982, A Study on biochemical changes during room and refrigerated storage of ber. Progressive Horticulture 14:158-161.

[3] BHATNAGAR, D.K., PANDITA, M.L. AND SRIVASTAVA, V.K., 1990, Effect of packing materials and storage conditions on fruit acceptability and weight loss of tomato. National workshop on post harvest management of fruits and vegetables, 14-16 March, Nagpur (India).

[4] BHATNAGAR, D.K., BATRA, BATRA, B.R. AND PANDAITA, M.L., 1985, Tomato fruit quality during storage as influenced by nitrogen doses and irrigation intensities, Haryana Agric. Univ. J. Res., 15: 206-216.

[5] BOSE, T.K., MITRA, S.K. AND SANYAL, D., 2002, Fruit: Tropical and Subtropical. Nayaudyog, III revised edition. 2: 78-596.

[6] BRAR, J.S., ARORA, S.K., KUMAR, J. AND BATRA, B.R., 2000, Effect of polythene packing on the shelf life of chilli (Capsicum annum L.) cv. Pusa Jwala. Haryana J. Hort. Sci. 29(3-4): 252-254.

[7] CHUNDAWAT, B.S., KALRA, R.L. AND GUPA, O.P., 1976, Post harvest Studies guava fruits. Effect of packing and storage period on the quality of fruit. Haryana J. Hort. Sci., 3: 130-134.

[8] FARAGHER, J.D., BOROCHOV, A., KEREN PAZ, V. AND HALEVY, A.H., 1984a. Changes in parameters of cell senescence in carnation flowers after cold storage. Scientia Hort., 22: 295-302.

[9] FARAGHER, J.D., BOROCHV. A, KEREN PAZ V., AND HALEVY, A.H., 1984b. Cold storage of rose flowers: Effect of cold storage and water loss on opening and vase life of Mercedes roses. Scientia Hort., 24: 369-378.

[10] GAUTAM, S.K. AND CHUNDAWAT, B.S., 1990, Post- harvest changes in sapota cv. Kalipatti II – Effect of various post–harvest treatments on physico-chemical attributes. Indian J. Hort., 47: 264-269.

[11] GOMEZ, A.K AND GOMEZ, A.A., 1984. Stastical procedure for agricultural research. Second edition, John Wiley and Sons, Singapore. P 680.

[12] HAYDAR MOHAMMAD, 1980, Effect of calcium and magnesium on cellwall and starch of dehydrated potato. J. Agric. Food Chem. 28: 383-391.

[13] HEMELATHA, G.,JAYAJASMINE, J. AND PONNUSWAMY, V., 2000, Pre-packaging studies in KKM-1 brinjal. Indian J. Nutrition and Dietics. 37(11):365-369.

[14] INGLE, G.S., KHEDKAR, D.M. AND DABHADE, R.S., 1981, Ripening studies in sapota fruit (Achras sapota l.). Indian Food Packer, 35: 42-45.

[15] INGLE, G.S., KHEDKAR, D.M. AND DABHADE, R.S., 1982b, Physico Chemical changes during growth of sapota fruits (Acras Sapota L.). Indian Food Packer, 36: 86-94.

[16] KALRA, C.L., KULKARNI, S.G., BEERH, O.P., SHARMA, T.C. AND SEGHAL, R.C., 1989. Studies on post harvest storage of green pea cultivars as influenced by pre-packaging. Indian Food Packer, 40: 18-22.

[17] KUMBAR, S.S. AND DESAI, U. T., 1986, Studies on the shelf life of sapota fruits. J. Maharastra Agric. Univ., 11: 184-187.

[18] LINGAIAH, H.B., 1982, Effect of precooling, waxing and prepackaging of field bean, bellpepper carrot and tomato on their shelf life and quality. M.Sc (Agri.) Thesis, Univ. Agric. Sci., Bangalore.

[19] LINGAIAH, H.B., HUDDAR, A.G., GOWDA, P.M. AND CHICKSUBBANNA, V., 1982, The influence of pre-cooling, waxing and pre-packaging on shelf life and quality of bell pepper. Proceedings of national seminar on the production technology of tomato and chillies. TNAU, Coimbatore: India. 157-159; 5 ref .

[20] MIDON, H. AND LAM, P. E., 1986, Pre-packaging and cool storage of low land lettuce. Malaysia Agric. J., 53(3): 151-159.

[21] NAKASHI, S., SCHLIMME, D. AND SOLOMOS, T., 1991, Storage potential of tomatoes harvested at the breaker stage using modified atmosphere packaging. J. Fd Sci., 56: 55-59.

[22] OKUBU, M., ISHII, K. AND UMEDA, K., 1971, Studies on the extension of shelf life of fresh fruits and vegetables VII. Effect of packaging with polythelene bags on the pigment content of tomato fruits. J. Japanese Soc. Hort. Sci., 40: 68-73.

[23] PANTASTICO, E.B., 1975, Post-harvest physiology, handling and utilization of tropical and sub tropical fruits and vegetables. The AVI publishing Co., West port, Connecticut, USA, pp 86-90.

[24] POOVAIAH, B.W., 1986, Role of calcium in prolonging storage life of fruits and vegetables. Food Technol. 40: 86-87.

[25] RAJPUT, C.B.S., SRIVASTAVA, K.K. AND SRIVASTAVA, A. K., 2004, Malviya Carambola 1: a promising star fruit selection.

[26] *REID, M.S. AND KOFRANEK, A.M., 1980. Post harvest physiology of cut flowers. Chron. Hort., 20: 25-27.

[27] SANJAY, G., 1996, Effect of post harvest treatments on keeping quality of Sapota (Manilkara achras) Fosberg cv. Kalipatti. M.Sc (Agri.) Thesis. Univ. Agric. Sci., Dharwad.

[28] SRIVASTAVA, K.K. AND RAJPUT, C.B.S., 2003, Genetic diversity in Carambola (Averrhoa carambola L.), Indian Horticulture, Oct – Dec., 2003. pp: 2.

[29] SRIVASTAVA, R.K., RAM, H.B. AND SINGH, U.P., 1973, A note on the storage behaviour of hill oranges in ventilated polythene bags. Prog. Hort., 5(1): 67-72.