Short communication

# Packaging and storage techniques to enhance the shelf life of sweet lovi-lovi (*Flacourtia* spp.) fruits

Karishma Sebastian*, P. Meagle Joseph and K. B. Sheela

*College of Horticulture, KAU P.O., Kerala Agricultural University, Thrissur 680656, Kerala, India*

Received 29 may 2017; received in revised form 15 June 2017; accepted 30 June 2017

**Abstract**

Sweet lovi-lovi (*Flacourtia* spp.), which is a less utilized plant species in Kerala belonging to *Flacourtiaceae* family, bears sweet, red fruits but with a very short shelf life of few hours. In this study an attempt is made to enhance the storability of sweet lovi-lovi fruits by packaging in different containers and storage at ambient, refrigerated and cold storage conditions. Sweet lovi-lovi accessions maintained at College of Horticulture, KAU were utilized for the study. The packaging of fruits in low density polythene covers of 200 gauge without ventilation, and shrink wrapped areca plates placed in cold storage condition at 12 ± 2°C temperature was found to increase the shelf life by three days.

**Keywords:** *Flacourtia*, Packaging, Shelf life

Lovi-lovi (*Flacourtia* spp.), is an underexploited crop seen in Kerala homesteads, bearing red fruits with high nutritional potential. Lovi-lovi, which belongs to *Flacourtiaceae* family, has both sweet and sour types. Sour type, *Flacourtia inermis,* is of common occurrence, and sweet type belongs to species *Flacourtia cataphracta*, *Flacourtia montana* and *Flacourtia jangomas.* The trees of sweet lovi-lovi are of spreading nature with sharp spines all over the trunk and this limits the cultivation of the crop to a certain extent. Fruits of sweet lovi-lovi are non - climacteric in nature with very short post harvest life. Fruits deteriorate rapidly within hours of harvest due to loss of firmness and browning followed by microbial infestation. The shorter shelf life is also related to the pedicel length, which is less or practically nil. Hence an attempt is made to enhance the shelf life, consumer acceptance and marketability of sweet lovi-lovi fruits by using convenient packages and storing under suitable conditions.

The present investigation was conducted in the year 2016-2017 at the Department of Processing Technology, College of Horticulture, Kerala Agricultural University. The sweet lovi-lovi fruits are non climacteric in nature. Hence fruits were collected at harvest maturity indicated by the deep pink colour (Prasad, 1998) (Fig. 1) and collected fruits (Fig. 2) were sanitised with 100 ppm sodium hypochlorite solution and packed in low density polythene covers of 200 gauge with ventilation (T,), low density polythene covers of 200 gauge without ventilation (T*f* ), polypropylene punnets (T,, ), polyestyrene box covered with cling film (T… ), and shrink wrapping in areca plate (T† ), and unwrapped fruits (T• ) were kept as control. They were stored under ambient, refrigerated condition at 5± 2°C and in cold storage at 12 ± 2°C.

The shelf life was calculated as number of days from harvest till the fruits showed symptoms of spoilage due to microbial growth. Physiological loss in

*Author for correspondences: Phone: 9447531085, Email id: karishmasebastian11@gmail.com

*Figure 1.* Sweet lovi-lovi tree

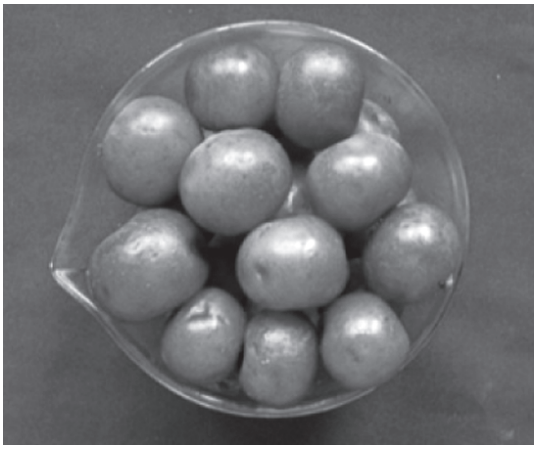

*Figure 2.* Sweet lovi-lovi fruits

weight (PLW), quality parameters like TSS, total sugar and browning are the factors contributing to the shelf life of fruits. Physiological loss in weight of sweet lovi-lovi fruits was estimated as per the method suggested by Srivastava and Tandon (1968). Total Soluble Solids and total sugars of stored fruits were also analyzed during storage as per AOAC

*Table 1*. Effect of packaging and storage condition on physiological loss (%) in weight of sweet lovi-lovi fruits

| Treatments | Physiological loss in weight (%) | | | | | |
|---|---|---|---|---|---|---|
| | Ambient | | Refrigerated storage | | Cold Storage | |
| | 1 DAS | 1 DAS | 2 DAS | 1 DAS | 2 DAS | 3 DAS |
| $T_1$ | 10.64 (3.26) | 4.54 (2.13) | - | 1.78 (1.33) | - | - |
| $T_2$ | 4.82 (2.19) | 0.41 (0.61) | 0.83 | 0.73 (0.85) | - | - |
| $T_3$ | 1.70 (1.30) | 0.45 (0.67) | 0.72 | 0.02 (0.15) | 0.16 | 0.29 |
| $T_4$ | 0.84 (0.92) | 0.54 (0.73) | - | 0.13 (0.36) | 0.17 | - |
| $T_5$ | 2.66 (1.63) | 0.85 (0.92) | - | 0.18 (0.42) | 0.48 | - |
| $T_6$ | 0.25 (0.50) | 0.04 (0.18) | 0.23 | 0.04 (0.19) | 0.07 | 0.26 |
| SE | 0.21 (0.04) | 0.09 (0.06) | - | 0.03 (0.02) | - | - |
| CD for treatment means | 0.64 (0.12) | 0.29 (0.18) | - | 0.09 (0.05) | - | - |
| CD for interaction | 0.13 | | | | | |

Values in parentheses are square root transformed values

$T_1$ – Control (Fruits kept unwrapped); $T_2$ – Low density polythene cover (200 gauge) with ventilation

$T_3$ - Low density polythene cover (200 gauge) without ventilation; $T_4$ - Polypropylene punnets

$T_5$ - Polystyrene tray overwrapped with cling film; $T_6$ - Shrink wrapping in areca tray

*Table 2*. Effect of packaging and storage condition on TSS (°B) content of sweet lovi-lovi fruits

| Treatments | TSS (°B) | | | | | |
|---|---|---|---|---|---|---|
| | Ambient | Refrigerated storage | | Cold Storage | | |
| | 1 DAS | 1 DAS | 2 DAS | 1 DAS | 2 DAS | 3 DAS |
| $T_1$ | 16.03 | 16.23 | - | 16.33 | - | - |
| $T_2$ | 16.27 | 16.53 | 13.43 | 16.60 | - | - |
| $T_3$ | 16.67 | 16.87 | 13.37 | 17.20 | 13.60 | 10.17 |
| $T_4$ | 16.73 | 16.77 | - | 16.63 | 13.13 | - |
| $T_5$ | 16.43 | 16.77 | - | 16.67 | 13.37 | - |
| $T_6$ | 16.63 | 16.93 | 13.87 | 17.27 | 13.57 | 10.87 |
| SE | 0.08 | 0.06 | - | 0.10 | - | - |
| CD for treatment means | 0.24 | 0.18 | - | 0.31 | - | - |
| CD for interaction | 0.23 | | | | | |

Initial TSS: 18.33°B

(1980) and Ranganna (1997) respectively. Browning of fruits was observed visually as brown and black spots or lesions, and when 70 per cent of the surface got discolored, fruits were considered unmarketable. The experiment was laid out in a factorial completely randomized block design with six treatments and three replications.

Maximum shelf life of 3 days was recorded in fruits packed in low density polythene cover (200 gauge) without ventilation and shrink wrapped areca plates stored under cold storage condition (12 ± 2°C) (Fig 1). All the packages stored under ambient condition and fruits stored in refrigerated condition without any packaging were found to have shortest shelf life (1 day). Polythene cover created a modified atmosphere with more carbon dioxide and less oxygen, which could extend the storage life of packed fruits (Dalal and Subramanyam, 1970). Rai et al. (2011) reported that the respiration of fruits decreased with the progress of storage under low temperature due to the accumulation of carbon dioxide in packages. The low rate of respiration reduced physiological, pathological and physical deterioration during storage. This helped to retain freshness of fruits in their marketing channel.

Physiological loss in weight (PLW %) increased in all the treatments during storage under ambient, refrigerated and cold storage condition. An increase in PLW of fruits in all the treatments with increasing period of storage was due to the loss of moisture by

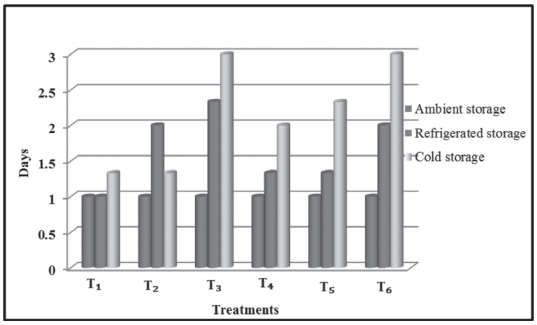


*Figure 1*. Effect of packaging and storage condition on shelf life (days) of sweet lovi-lovi fruits

evapo-transpiration and loss of reserve food material by respiration. On comparing the three storage conditions, fruits packed in low density polythene cover (200 gauge) without ventilation in cold storage at 10°C to 14°C had least PLW (0.02%), and maximum PLW was recorded for ambient stored fruits with no packaging (10.64%) (Table 1). Pahel (2013) reported that different types of wrapping materials had significant effect on PLW of sapota fruits during storage.

The TSS and total sugar content of sweet lovi-lovi fruits in different packages decreased during storage in three different storage conditions. On comparing the three storage conditions, fruits in areca plates wrapped with polyolefin film of 15ì thickness stored under cold storage (10°C to 14°C) were found to be best in retaining TSS and total sugars (17.27°Brix and 12.74%) after one day of storage (Table 2 and 3). Pelayo et al. (2003) reported a reduction in TSS of three per cent on storage at 5°C

*Table 3*. Effect of packaging and storage condition on total sugar (%) content of sweet lovi-lovi fruits

| Treatments | Total sugars (%) | | | | | |
|---|---|---|---|---|---|---|
| | Ambient | Refrigerated storage | | Cold Storage | | |
| | 1 DAS | 1 DAS | 2 DAS | 1 DAS | 2 DAS | 3 DAS |
| $T_1$ | 12.22 | 12.65 | - | 12.58 | - | - |
| $T_2$ | 12.39 | 12.54 | 10.98 | 12.61 | - | - |
| $T_3$ | 12.51 | 12.61 | 11.37 | 12.69 | 11.32 | 10.91 |
| $T_4$ | 12.25 | 12.42 | - | 12.63 | 11.12 | - |
| $T_5$ | 12.24 | 12.56 | - | 12.67 | 11.26 | - |
| $T_6$ | 12.49 | 12.47 | 10.84 | 12.74 | 11.66 | 10.65 |
| SE | 0.05 | 0.06 | - | 0.02 | - | - |
| CD for treatment means | 0.17 | NS | - | 0.06 | - | - |
| CD for interaction | 0.14 | | | | | |

Initial total sugar content: 12.81%

for strawberry cultivar Aromas, whereas the reduction was 10% in cultivar Selva after nine days. Mishra and Kar (2014) reported a significant decrease of 9% in total sugar in Chandler, and 10% in Camarosa cultivars of strawberry on storage at 5°C for 9 days.

Fruits are highly sensitive to minor bruises that cause enzymatic browning, adversely affecting the eating quality of the fruit, thus making it unfit for consumption and it aggravates the problem of marketing. Evaluation of three storage conditions showed that fruits packed in low density polythene cover (200 gauge) without ventilation and stored under refrigerated condition (3°C to 7°C) developed least browning (15.68%), followed by fruits stored in polypropylene punnets in cold storage condition (10°C to 14°C) (Table 4). Prasad (1998) observed that the reduction in quality of sweet and sour lovi-lovi fruits was gradual in refrigerated storage as compared to room conditions.

Storage at low temperature was found good for maintenance of acceptable appearance, texture and nutritive value of strawberries (Nunes et al., 1995). Hence packaging the sweet lovi-lovi fruits in low density polythene cover (200 gauge) without ventilation and in shrink wrapped areca plates placed in cold storage condition (12 ± 2°C) could increase the shelf life to 3 days. The method can be suitably adopted in cold chains so as to increase the availability of the nutritionally rich fruits to consumers at places other than their area of production.

*Table 4*. Effect of packaging and storage condition on browning (%) of sweet lovi-lovi fruits

| Treatments | Browning (%) | | | | | |
|---|---|---|---|---|---|---|
| | Ambient | Refrigerated storage | | Cold Storage | | |
| | 1 DAS | 1 DAS | 2 DAS | 1 DAS | 2 DAS | 3 DAS |
| $T_1$ | 45.83 (42.61) | 75.00 (60.12) | - | 33.33 (35.13) | - | - |
| $T_2$ | 46.29 (42.86) | 24.08 (29.24) | 53.7 | 83.33 (66.82) | - | - |
| $T_3$ | 39.21 (38.73) | 15.68 (23.04) | 45.1 | 35.29(36.40) | 39.21 | 49.02 |
| $T_4$ | 66.67 (54.79) | 46.67 (43.09) | - | 22.67 (28.29) | 29.33 | - |
| $T_5$ | 73.81 (59.27) | 68.89(56.13) | - | 26.19 (30.73) | 38.09 | - |
| $T_6$ | 68.62 (55.95) | 53.33 (46.92) | 71.11 | 39.22 (38.7) | 49.02 | 68.63 |
| SE | 3.31 (1.96) | 3.26 (2.19) | - | 4.18 (2.97) | - | - |
| CD for treatment means | 10.19 (6.05) | 10.04 (6.74) | - | 0.31 (9.16) | - | - |
| CD for interaction | 5.97 | | | | | |

Values in parentheses are angular transformed values

## Acknowledgement

The study formed a part of M.Sc. (Hort) programme of first author and financial support from Kerala Agricultural University is gratefully acknowledged.

## References

AOAC [Association of Official Analytical Chemists]. 1980. AOAC home page [online]. Available: http://www.aoac.org/iMIS15 pROD/AOAC., 18 Jan 2017.

Dalal, V.B. and Subramanyam, H. 1970. Refrigerated storage of fresh fruits and vegetables. Climate Control. 3: 37-50.

Mishra, R. and Kar, A. 2014. Effect of storage on the physicochemical and flavour attributes of two cultivars of strawberry cultivated in northern India. Sci. World J. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3920653/., 23 Jan. 2014.

Nunes, M.C.N., Brecht, J.K., Morais, A.M.M. B. and Sargent, S.A. 1995. Physical and chemical quality characteristics of strawberries after storage are reduced by a short delay to cooling. Postharvest Biol. Technol., 6: 17-28

Pahel, P. 2013. Studies on shelf life of sapota (*Manilkara zapota* (L.) Van Royen) cv. Cricket Ball. MSc.(Hort) thesis. CCS Haryana Agricultural University, Haryana, 84p.

Pelayo, C., Ebeler, S.E. and Kader, A.A. 2003. Postharvest life and flavor quality of three strawberry cultivars kept at 5°C in air or air + 20 kPa $CO_2$. Postharvest Biol. Technol., 27: 171-183.

Prasad, A.S. 1998. Growth, flowering, fruitset and fruit development in lovi-lovi (*Flacourtia inermis* R. and *F. cataphracta* R.). M.Sc. (Hort) thesis, Kerala Agricultural University, Thrissur, 140p.

Rai, D.R., Chadha, S., Kaur, M.P., Jaiswal, P. and Patil, R.T. 2011. Biochemical, microbiological and physiological changes in Jamun (*Syzyium cumini* L.) kept for long term storage under modified atmosphere packaging. J. Food Sci. Technol., 48(3): 357-365.

Ranganna, S. 1997. Handbook of Analysis and Quality Control for Fruits and Vegetable Products (3rd Ed.). Tata McGraw and Hill Publication Co. Ltd., New Delhi, 634p.

Srivastava, M.P. and Tandon, R.N. 1968. Influence of temperature on *Botrydiplodia* rots of citrus and sapodilla. Indian Phytopath., 21: 195-197.