Current Journal of Applied Science and Technology

Volume 42, Issue 48, Page 129-136, 2023; Article no.CJAST.111436
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Effect of Chemical Treatment and Wrapping Materials on Physico-Chemical Properties and Storage Life of Litchi Fruits (*Litchi chinensis Sonn*.) Cv. Shahi

A. K. Singh [a++], Ranju Kumari [b#*], Divya Tiwari [b#], N. Y. Azmi [c#] and J. N. Singh [d]

[a] KVK, Saraiya, (Dr. RPCAU, Pusa, Bihar), India.
[b] Nalanda College of Horticulture, Noorsarai, Nalanda (BAU, Sabour, Bhagalpur), Bihar, India.
[c] ARI, Patna (BAU, Sabour, Bhagalpur), Bihar, India.
[d] Department of Horticulture, Institute of Agricultural Sciences, B.H.U., 221 005, Varanasi, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2023/v42i484343

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/111436

Original Research Article

Received: 25/10/2023
Accepted: 29/12/2023
Published: 30/12/2023

ABSTRACT

Litchi fruits have poor shelf life and losses its commercial value within two days after harvest. Several physiological and chemical changes take place which reduces the quality of fruits at room temperature. To overcome these problems, the experiment was conducted at Department of Horticulture, Institute of Agriculture Sciences, BHU, Varanasi to find out the effect of post-harvest

[++]Senior Scientist and Head;
[#]Assistant Professor;
**Corresponding author: E-mail: ranjupusa@gmail.com;*

application of hot water treatment and dipping in different concentrations of calcium nitrate (1 %, 1.5% and 2 %) for five minutes followed by fruit wrapping in newspaper and perforated polythene on physico-chemical changes and storage life of litchi (*Litchi chinensis Sonn*.) cv. Shahi. Fruits without treatment were considered as control. The experiment was conducted in a completely randomized design with three replications and observations were recorded on alternate days up to 13 days of storage. It was observed that fruits treated with 2.0% calcium nitrate in combination with perforated polythene bags recorded minimum losses due to spoilage percentage (12.15%), minimum decrease in fruit size (length- 4.97% and breadth- 5.49%) as compared to control on 11th day of storage. Significantly minimum pH (5.1) change and the best economic life up to 11th day of storage were recorded in perforated polythene wrapping with different concentration of calcium nitrate. Total Sugar Content (17.00%) was recorded significantly highest in polythene wrapping along with 1.5 and 2.0% calcium nitrate. Less loss in volume (17.58%) was recorded in fruits treated with hot water along with polythene wrapping. Based on the above observations, it can be suggested that fruit dipping in calcium nitrate at 2.0 percent concentration with polythene wrapping (20% vent) gives better results for extending the storage life of litchi fruit at room temperature.

Keywords: Litchi; post-harvest treatments; calcium nitrate; storage life; economic life.

1. INTRODUCTION

The litchi (*Litchi chinensis* Sonn.) is an important tropical to subtropical fruit crop belongs to the family *Sapindaceae.* It is known for its pleasant flavour and juicy pulp (aril) with attractive red coloured pericarp which enhances its commercial value in the national and international markets. After harvested fruits loses their bright red skin colour within 1-2 days at ambient temperatures [1] which drastically reduces the commercial value of the fruit [2]. Litchi is a non-climacteric fruit and commercial value stands in the market due to its bright red colour epicarp and juicy flesh [3], [4]. Several studies revealed that it has gained increasing commercial interest for its organoleptic and nutraceutical value [5], [6]. Various biochemicals, physiological changes and microbial invasion take place after harvest. These changes are influenced by the temperature, humidity, ethylene production, and presence of microbes in the place of storage of fruits that deteriorate the quality of fruit. Several approaches like pre-cooling, treating or coating of fruit with different chemicals and packaging materials have been tried to extend the shelf-life of litchi fruit [7], [8], [9]. Along with these approaches modified atmosphere packaging can be considered effective in managing pericarp browning, microbial spoilage and preserving the quality of product [10], [11], [12]. "Coatings on litchi create a partial barrier to the movement of moisture on the surface of fresh fruit, which minimizes moisture loss during postharvest storage. Some chemicals like salicylic acid and 1-methylcyclopropane decrease the activities of enzymes like ACC synthase, cellulase, polygalacturonase and xylanase that regulate the ripening process" [13]. "Litchi fruits dipped in chemical solution was the longest i.e. 4 days at ambient conditions and also increased shelf life to 27 days under cold conditions (4-50C and 85-90% RH) after packaging in paper boxes and polyethylene bags" [14]. Suitable packaging materials provide a congenial environment which minimizes biochemical changes, slows down the rate of respiration, reduces the ethylene production and decay of fruits by micro-organisms attack [15], [16], [17]. Keeping the above facts, the present investigation was carried out to extend shelf life of litchi fruits with the post-harvest application of hot water, $CaNO_3$ and various packaging materials.

2. MATERIALS AND METHODS

The experiment was conducted in the Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Firm and good-looking fruits cv. Shahi of uniform size and maturity and free from pests, diseases, and injuries were selected for the experiment. "Fruits were stored at room temperature in different lots consisting of 200 fruits per treatment, per replication. The experiment was carried out in a completely randomized design (CRD) with three replications. These post-harvest treatments are T_1 – Newspaper wrapping, T_2 – Newspaper wrapping + hot water treatments 50 ± 2^{o}C for 5 minutes, T_3 – Newspaper wrapping + calcium nitrate 1.0 %, T_4 – Newspaper wrapping + calcium nitrate 1.5 %, T_5 – Newspaper wrapping + calcium nitrate 2.0 % , T_6 – Polythene wrapping (20% vent), T_7 – Polythene wrapping + hot water treatments 50 ± 2^{o}C for 5 minutes, T_8 – Polythene wrapping +

calcium nitrate 1.0 %, T_9 – Polythene wrapping + calcium nitrate 1.5 %, T_{10} – Polythene wrapping + calcium nitrate 2.0 % and T_{11} – Control. Newspaper in size 60 × 30 cms and 50-gauge thickness of 45 cm x 30 cm in size perforated polythene bag were used as wrapping materials. Different concentrations of calcium nitrate (1.0, 1.5, and 2.0 percent) were used for dip treatments of fruits for 5 minutes. The hot water treatment of litchi fruits was given in an electrically operated bath of 40-gallon capacity and required temperature of 50 ± 2^0C for 5 minutes then fruits were taken out and dried under the electric fan. Such treated fruits, either wrapped with newspaper or polythene were kept in bamboo baskets at room temperature. Observations to be recorded were loss due to spoilage of fruits (%), loss in volume (%), change in size (%), economic life of fruits, total sugar (%), and pH value" [18].

Loss due to spoilage of fruits - The percentage of spoiled fruits on each day was calculated by using the following formula.

$$\text{Percentage of spoilage} = \frac{\text{No. of spoiled fruits}}{\text{Original number of fruits}} \text{ x } 100$$

Economic life of fruits - The economic life of fruits was adjudged by observing the day on which a cumulative number of fruits due to spoilage subjected to a particular treatment exceeded 15 percent.

Loss in volume - The volume of the fruits was recorded by the water displacement method [19]. The percentage of loss in volume was calculated by using the formula:

$$\text{Percentage loss in volume} = \frac{\text{Loss in volume}}{\text{Original volume}} \text{ x } 100$$

Change in size - Length and diameter were measured in centimetres on the first and the last day of the experiment and average size in terms of length and diameter was calculated with the help of slide callipers using following formula.

$$\text{Percentage Change in size} = \frac{\text{Change in size (Length or diameter)}}{\text{Original size (Length or diameter)}} \text{ x } 100$$

Total sugar - 10 ml of juice was hydrolysed by adding 3 ml of conc. HCl. It was left for 24 hours. After that, it was neutralized by adding sodium hydroxide 4N solution. For complete neutralization blue and red litmus papers were used. This solution was then titrated against Fehling A and B and the percentage of total sugar was worked out.

pH value - p_H in the juice was measured directly with the help of systronic pH meter.

3. RESULTS AND DISCUSSION

Spoilage and economic life of fruits: A perusal of the data (Figs.1 and 2) indicated that the minimum spoilage percentage of 12.15 percent was recorded in the treatment T_{10} (2.0 percent calcium nitrate with perforated polythene) which was closely followed by T_9 and T_8 (1.5 and 1.0 percent calcium nitrate with perforated polythene bags) showing spoilage percentage 12.88 and 13.15 percent respectively on 11th days of storage. The spoilage percentage was found significantly higher in control (T_{11}) fruits with 43.22 percent on the 13th day of storage. The economic shelf life of fruits was maximum (11 days) for fruits treated with 1.0, 1.5, and 2.0 percent of calcium nitrate with perforated polythene bags whereas the maximum economic life of untreated fruits (control) was 5 days. Thus, the economic shelf life of litchi fruits was extended by 6 days with these treatments. It was observed that the spoilage of the fruits in newspaper wrapping was as compared to control but more than other respective treatments. These results are in agreement with the findings of [1], [14] [20], [21], [22]. Less spoilage under newspaper wrapping might be due to the barrier from the room atmosphere for fungal growth. It was recorded that fruits treated with calcium nitrate and kept in perforated polythene bags were found to spoil less. A similar observation was reported by [9], [23], [24] in litchi. Devi [14] reported that "hot water treatment along with HNO_3 and $CaCl_2$ was ideal pretreat for extending the shelf life of litchi fruit up to 4.64 days in 2% perforated polythene at ambient temperature". Moor *et al.* [25] in apple and Xu Ling *et al.* [26] in "sweet cheery had reported similar results of reducing fruits loss due to pre-harvest treatment of Ca and K". Calcium nitrate under different concentrations might have played the effective role in maintaining the vigour and resistance capacity to fight against the pathogens along with inhibit the activities of polygalactonase enzyme (PG) and peroxidase (POD) slow the accumulation of membranacious peroxide (NDA) in cells [26] resulting less spoilage of fruits under these treatments.

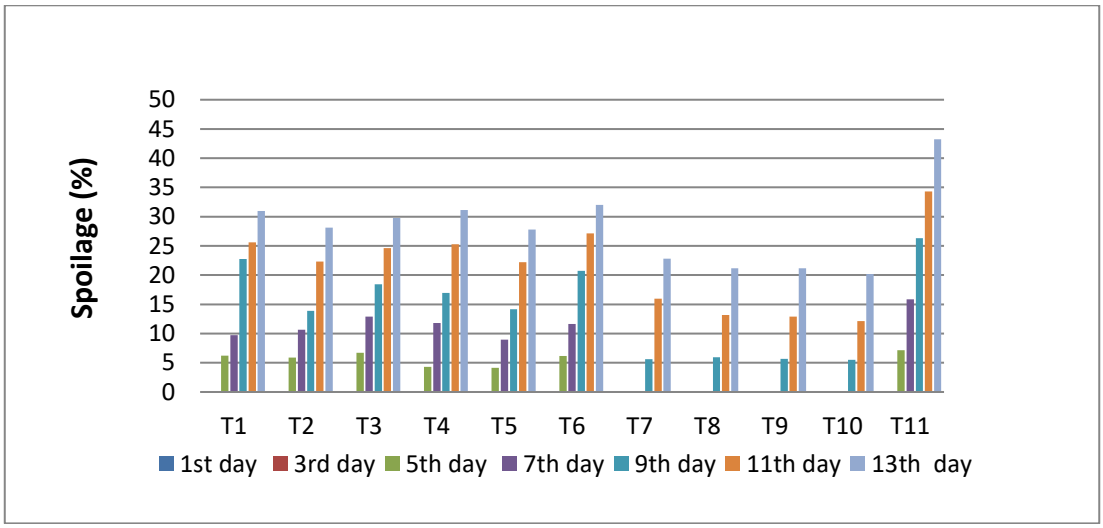

Fig. 1. Spoilage percentage of litchi fruits cv. Shahi during storage

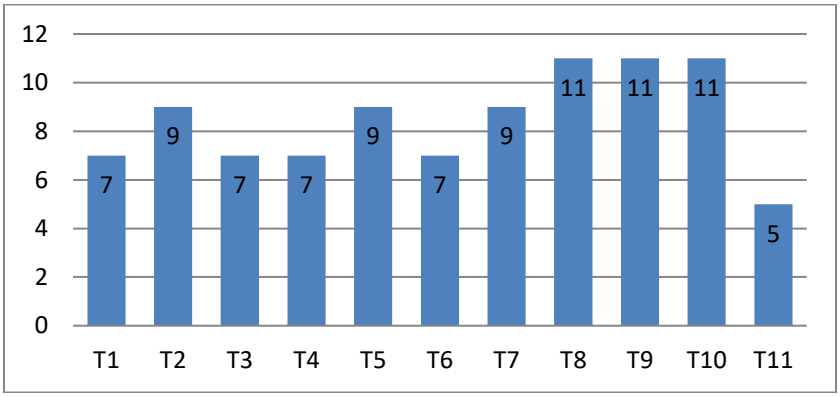

Fig. 2. Economic life (days) of litchi fruits cv. Shahi during storage

Size of fruits: Data (Fig. 3) indicated that the fruits under all the treatments showed variation in both length and width percentage on the 11th day of observation. Maximum percentage of reduction 14.71 and 13.98 in length and width respectively was observed in untreated fruits (T_{11}) which was followed by 11.42 and 11.88 percent respectively under newspaper wrapped (T_1). Minimum reduction in length and width 4.97 and 5.49 per cent respectively was found in the fruits treated with 2.0% calcium nitrate in combination with perforated polythene wrapping (T_{10}). However other treatment with calcium nitrate 1.0, 1.5 per cent with polythene wrapping was very close with 2.0% calcium nitrate with polythene wrapping.

Volume of fruits: The perusal of data (Fig. 4) revealed that polythene wrapping alone or in combination of hot water treatment and calcium nitrate dip have greatly influenced in checking the reduction of volume during storage. It was recorded that minimum reduction 17.58 to 20.35 per cent was observed in treatments T_6, T_7, T_8, T_9 and T_{10} and maximum reduction ranged from 27.14 to 28.43 per cent in rest of the treatments including control from first to eleventh day of storage. It was observed that the fruits packed in perforated polythene bags with combination of different concentration of calcium nitrate showed least change in their size and volume. Kanth *et al.* [24] and Moll *et al*. [9] found similar results in litchi and Rabiei *et al*. [27] in apple fruit using polythene bags. This might be attributed to loss of moisture resulting reduced turgidity and polythene wrapping maintained higher percentage of humidity around the outer layer of the fruits. Wrapping and coating with chemical slowed down metabolism and caused breakdown of insoluble protopectin into soluble pectin thus extending the shelf-life [17].

Total sugar: Total sugar content of fruits gradually increased up to 5th day in all the treatments revealed from data (Fig. 5). It was observed that the total sugar percentage was significantly maximum (17.00) in fruits of treatment T_9 (1.5 percent calcium nitrate + perforated polythene wrapping) and T_{10} (2.0 percent calcium nitrate + perforated polythene wrapping) on 11th day of storage which was significantly at par to T_7 and T_8 showing 16.70 and 16.85 percent total sugar respectively. Significantly minimum total sugar percentages (14.85 and 15.05 percent) were recorded in fruits of T_{11} (control) and T_1 (Newspaper wrapping) respectively. The result was in close agreement with the findings of [28], [24], [9]. This might be due to a slower rate of conversion of starch and polysaccharides into sugar in treated fruits in comparison to untreated ones. After the storage due to senescence the reduction in sugar conversion rate was due to utilization of sugar in the process of respiration [24].

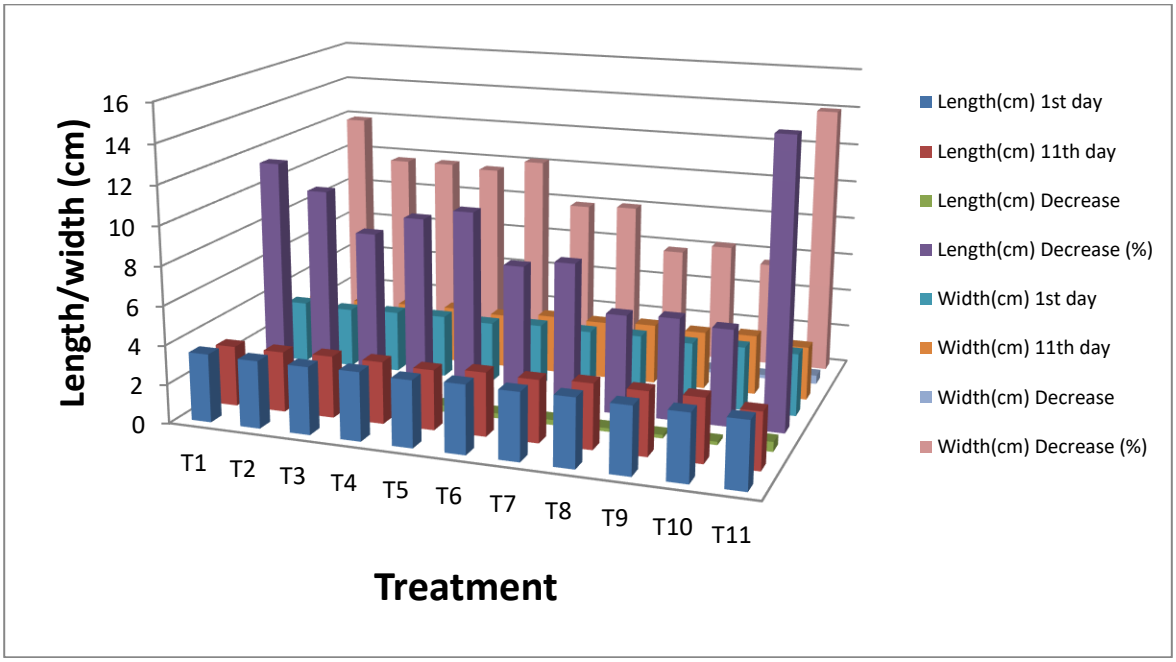

Fig. 3. Change in size of litchi fruits cv. Shahi during storage

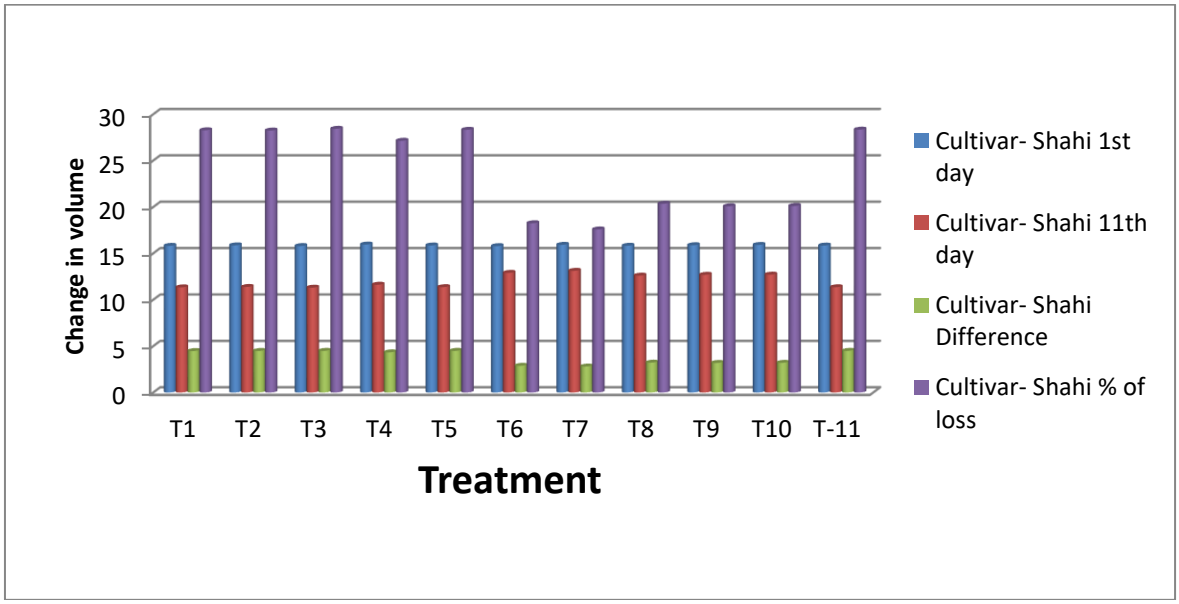

Fig. 4. Change in volume of litchi fruits cv. Shahi during storage

pH content: Data in Fig. 6 showed that pH gradually increased as the days advanced in storage. Significantly highest pH 5.60 was observed in untreated fruits (T_{11}) in comparison to treated fruits ranged from 5.10 to 5.20 on the same day of storage. Significantly minimum p^H (5.10) was estimated in treatment T_8 (Polythene wrapping + calcium nitrate 1.0 %) on 12th day of storage. Similar results were reported by [29] and [9]. The worker [30] had found the results on similar pattern on mandarin. pH was found to be correlated with the acidity of the fruits. The acidity of the fruits decreased continuously during storage and reverse was true for pH of fruits pulp [31]. The rapid utilization of acids of pulp in the respiratory process might have caused the rapid increase in pH leads to early ripening and senescence in the fruits. The treatment of calcium might have induced some buffer action on hydrogen ion during storage affecting slow rate of pH enhancement.

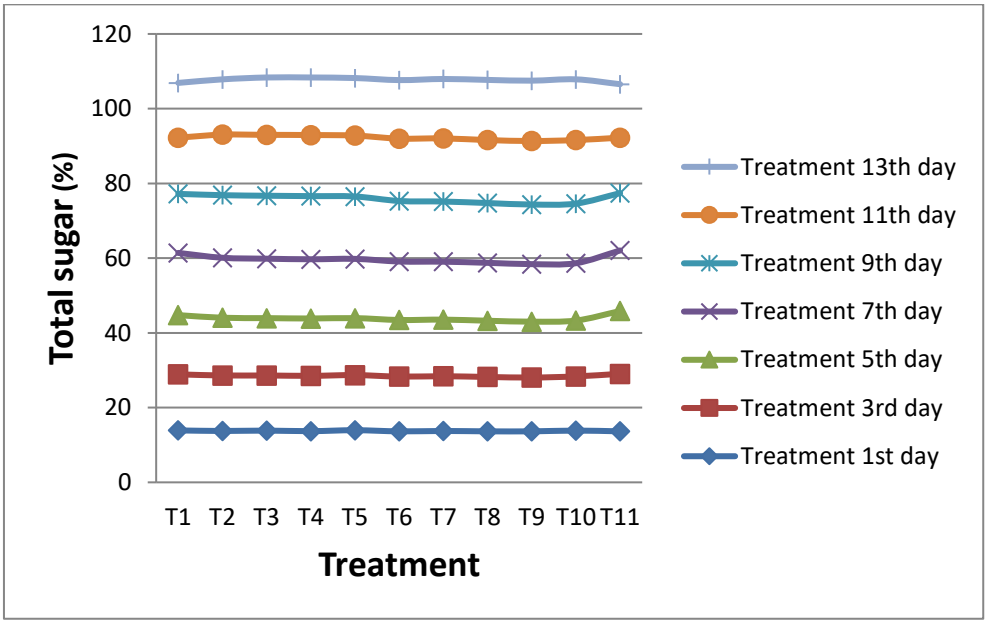

Fig. 5. Total sugar (percent) of litchi cv. Shahi fruits during storage

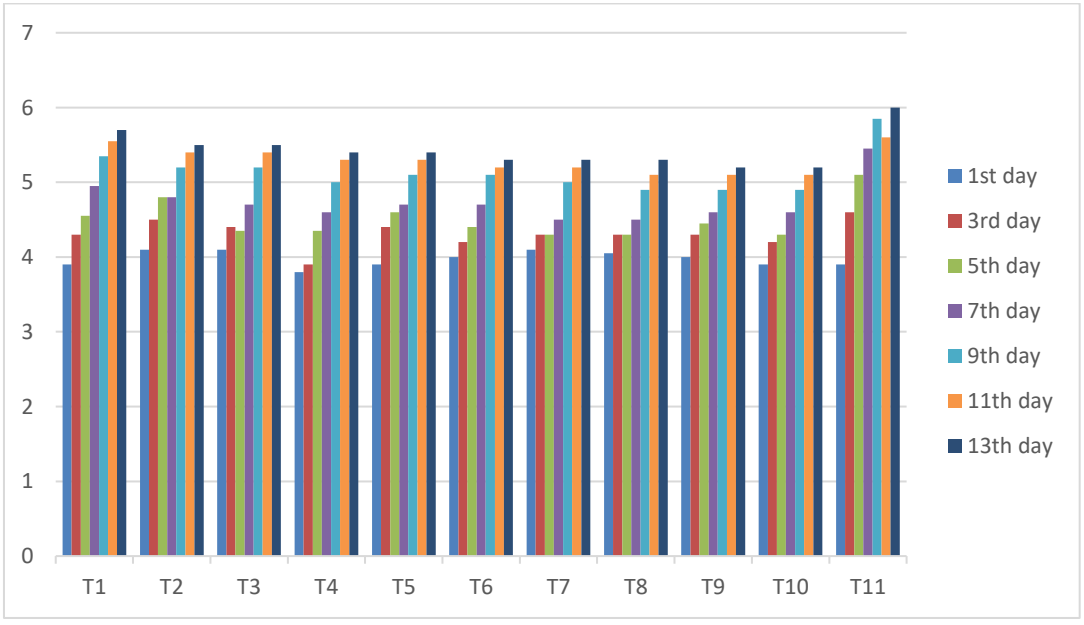

Fig. 6. pH of litchi cv. Shahi fruits during storage

4. CONCLUSIONS

Based on results obtained from the study it can safely be concluded that all concentrations of calcium nitrate (1.0, 1.5, and 2.0 percent) dip with perforated polythene (20% vent) treatments were equally most effective in enhancing the economic storage life of fruits up to 11th day whereas, under control for 5 days only and were noticed to maintain the desirable physico-chemical characteristics of litchi fruit cv. Shahi.

ACKNOWLEDGEMENT

The author was thankful to the Department of Horticulture, Institute of Agricultural Sciences, B.H.U., Varanasi for their cooperation and valuable guidance in completing Ph. D. degree programme.

COMPETING INTERESTS

The authors have declared that no competing interest exists.

REFERENCES

1. Zhang D, Chen F, Liu S, Li YB, Jiang YGJ, Quantick PC, Warren PJ. Effects of prolong coating on changes in colour and enzyme activity of post-harvest litchi fruit. Journal of Tropical and Sub tropical Botany. 1997;5(2):54-.60.
2. Snowdon AL. A colour atlas of post-harvest diseases and disorders of fruit and vegetables 1. General Introduction and Fruits. Wolfe Scientific, Barcelona.1990:126.
3. Baoyao W, Li H, Jianwen T, Min J. Chemical compositional characterization of ten litchi cultivars. in proceedings of the 2011. International Conference on New Technology of Agricultural, Zibo, China. 2011 May 27–29:1007–1011.
4. Pandey N, Joshi SK, Singh C, Kumar S, Rajput S, Khandal R. Enhancing shelf life of litchi (*Litchi chinensis*) fruit through integrated approach of surface coating and gamma irradiation. Radiat. Phys. Chem. 2013;85:197–203.
5. Chen Z, He M, Zhou Y, Chen X, Zhu H, Yang B, Jiang Y, Qu H. Degradation of water-soluble polysaccharides in pulp of litchi during storage. Food Chem. 2023;402;134289.
6. Veerappan K, Natarajan S, Chung H, Park J. Molecular insights of fruit quality traits in peaches, prunus persica. Plants. 2021;10:2191.
7. Neog M, Saikia L. Control of post-harvest pericarp browning of litchi (*Litchi chinensis* Sonn). J Food Sci Technol. 2010;47(1):100–104.
8. Jhalegar MJ, Sharma RR, Singh SK. Effect of surface coating on postharvest quality of Kinnow mandarin. Indian J. Hort. 2015;72(2):267-272.
9. Moll MM, Rahman E, Khatun A, Islam MF, Uddin MZ, Ullah MA, Saha MG, Miaruddin M. Color retention and extension of shelf-life of litchi fruit in response to storage and packaging technique. American J of Food Technology. 2017;12:322-331.
10. Luna MC, Tudela JA, Tomas-Barberan FA, Gil MI. Modified atmosphere (MA) prevents browning of fresh-cut romaine lettuce through multi-target effects related to phenolic metabolism. Postharvest Biol. Technol. 2016;119:84–93.
11. Tinebra I, Scuderi D, Sortino G, Inglese P, Farina V. Effects of argon-based and nitrogen-based modified atmosphere packaging technology on the quality of pomegranate (Punica granatum L. cv. Wonderful) Arils. Foods. 2021;10:370.
12. Passafiume R, Roppolo P, Tinebra I, Pirrone A, Gaglio R, Palazzolo E, Farina V. Reduction of pericarp browning and microbial spoilage on litchi fruits in modified atmosphere packaging. Horticulturae. 2023;9:651. Available:http://doi.org/10.3390/horticulturae9060651
13. Watkins CB. The use of 1-methylcyclopropene (1-MCP) on fruits and vegetables. Biotechnology Advances. 2006;24(4):389-409.
14. Devi S. Chemical dips and treatments to enhance shelf-life and retard browning of litchi (*Litchi chinensis* Sonn.). International Journal of Research and Analytical Reviews. 2019;6(1):454-459.
15. Jiang YM, Wang Y, Song L, Liu H, Lichter AK, Chuen O, Joyce DC, Shi J. Postharvest characteristics and handling of Litchi fruit an overview. Australian- Journal of Experimental Agriculture. 2006; 46(12):1541-1556.
16. Patel RK, Singh A, Yadav DS, Bhuyan M, Deka BC. Waxing, lining and polyethylene packaging on shelf life and juice quality of passion fruit during

storage. Journal of Food Science and Technology. 2009;46(1):70-75.
17. Mahajan BVC, Kumar D, Dhillon WS. Effect of different polymeric films on shelf-life and quality of fruits under supermarket conditions. Indian J. Hort. 2013;70(2):309-312.
18. Singh AK, Ranju Kumari, Rashmi Komal, Singh JP. Effect of post -harvest treatments of wrapping and chemical coating on storage life of litchi (*Litchi chineneis* Sonn.) fruits cv. Shahi, International Journal of Chemical Studies. 2019;SP6:587-591.
19. Gustafson PG. Growth studies of fruits. Plant Pathology. 1926;1:265-72.
20. Chaiprasart P. Effect of modified atmosphere packing by P.E. and P.V.C. on quality changes of lychee fruits. Acta Horticulturae. 2005;665:373-379.
21. Ramesh C, Pal RK. Influence of active cushioning materials in packaging on shelf-life of Litchi fruits. Indian J. of Horticultural Society of India. 2006; 63(1):31-35.
22. Jadhao SD, Borkar PA, Bakane PH, Shinde KJ, Murumkar RP. Effect of different chemicals and wax emulsion on physico-chemical attributes of nagpur mandarin fruits after harvest. J. Soils and Crops.2008;18(2):422-427.
23. Singh JP, Kumar V, Singh RR, Singh UK. Spoilage and economic life of litchi during storage. Journal of Applied Biology. 2004;14(2):19-21.
24. Kanth N, Hada TS, Lal RL. Effect of post harvest treatments on physic-chemical characteristics and shelf life of litchi fruit (*Litchi chinensis* sonn) cv. Rose scented. The Ecoscan. 2015; 9(1&2):159-163.
25. Moor U, Karp K, Poldma P, Asafova L, Starast M. Post harvest disorder and mineral composition of apple fruits as affected by pre harvest calcium treatments. Acta Horticulturae. 2006;56(3):179-185.
26. Xu Ling, Haoyi Hao Shuchi, Wang Yan, Lv Ren Qiang. Effects of pre-harvest calcium and potassium treatments on post-harvest physiology of sweet cherry cv. Hongdeng. Journal of Fruit Science. 2009;26(4):568-571.
27. Rabiei V, Shirzadeh E, Sharaf Y, Mortazavi N. Effects of postharvest applications of calcium nitrate and acetate on quality and shelf-life improvement of “jonagold” apple fruit. Journal of Medicinal Plants Research.2011;5(19):4912-4917.
28. Kumar S, Kumar A, Baig MJ, Chaubey BK. Effect of calcium on physico-chemical changes in aonla (*Emblica officinalis* Gaertn). Indian J. Hort. 2005;62(4):342-326.
29. Singh G. Effect of calcium nitrate and plant growth regulators on the storage of Allahabad Safeda guava. Indian. J. of Hort. 1988;45(1-2):45-50.
30. Gousia H, Bisati IA, Bhat HA, Hassan A. Shelf life of mandarin (*Citrus reticulata* Blanco) cv. Kinnow. Environment and Ecology. 2009;27(3A):1296-1299.
31. Wu-zhen Xian, Su- Meixia, Chen- weiXin, Ji-ZeoLiang, Li, chubin, Liang xiufang. Study on treatment and physiology of litchi fruit stored under room temperature. Journal -of-south china- Agricultural-university. 2001;22(1):35-38.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/111436