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Effect of post -harvest treatments of wrapping and chemical coating on storage life of litchi (*Litchi Chineneis* Sonn.) fruits cv. shahi

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Abstract
The present investigation was carried out to know the effect of post- harvest treatment for extending the shelf-life of litchi fruits cv. Shahi at the Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University Varanasi. The experiment was conducted in completely randomized design with three replications. Uniformed size fruits at the physiological maturity were treated with various treatments for 5 minute and fruits were stored at room temperature (34 ^{0}c ± 2 ^{0}C) with 51% ± 5% relative humidity. Untreated fruits were taken as control. It was observed that economic shelf life of fruits was maximum (11days) in fruits treated with 1.0, 1.5, and 2.0% of calcium nitrate with perforated polythene bags (T_8, T_9 and T_{10}). The fruits treated with 2.0 per cent calcium nitrate in combination with perforated polythene bags recorded minimum loss in specific gravity (2.66%) on 11th day of storage as compared to highest loss (11.44%) in untreated fruits T_{11}. Fruits/pulp ratio was recorded minimum (1.67) in perforated polythene wrapped (T_6) on 11th day of storage. Minimum pulp/juice ratio (1.27) was recorded in hot water treatment, perforated polythene wrapping alone and combination with hot water and 1.0% concentration of calcium nitrate with perforated polythene (T_6, T_7, T_8). The rest of the treatments including control showed higher pulp/juice ratio. The sugar/acid ratio of fruits increased gradually under all the treatments. However, on 11th day the ratio was found highest (63.59) in untreated fruits (control) whereas, 2.0 per cent calcium nitrate with perforated polythene (T_{10}) showed lower ratio (51.07). Thus, on the basis of results obtained from the present study it can be concluded that all concentrations of calcium nitrate (1.0, 1.5 and 2.0%) dip with perforated polythene (20% vent) treatments were equally most effective in enhancing the economic storage life of fruits up to 11th day.

Keywords: Litchi, Post-harvest, Economic life, Fruit/pulp ratio, specific gravity

Introduction
The litchi is one of the most important evergreen sub-tropical fruit of family Sapindaceae having excellent fruit quality, pleasant flavour, juicy flesh (aril) and attractive appearance which is closely related to fruits like longan and rambutan. It is originated in the area near southern China, possibly northern Vietanam (Hai and Dung, 2002) [7]. Its fruits are very delicate and lose their shape, beauty and commercial value within 24-36 hours. Such a delicate fruit having very short storage life, therefore much emphasis have been given to enhance post-harvest life of litchi fruits that's why fruits can be enjoyed for more days. Keeping quality of fruits can be improved by inhibiting polygalacturonase, enzyme for fruit ripening or by inhibiting the synthesis of fruit- ripening enzyme through antisense technique. Colour conservation is the chief problem in storage and transportation for a longer period. The post-harvest life of fruit at ambient temperature is less than 3 days (Lin, He Tong *et al.*, 2003) [12] which limits its long-distance transportation, marketing and consumption.

Various chemicals including calcium compounds are reported to extend the shelf-life of many fruits by maintaining their firmness and minimizing respiration rate, proteolysis, disease incidence, colour and tissue break down thus reducing the per cent loss in weight (Rabiei *et al*. 2011 [16] Gangwar *et al*. 2012 [3] and Singh *et al*. 2018) [18]. Other post-harvest technologies including efficient handling, packing techniques and adequate storage facilities have to be worked out to minimize post-harvest losses. Under refrigeration, litchi fruit has a storage life of approximately 30 days (Jiang *et al*., 2003) [12]. Different wrapping materials like newspaper or perforated polythene with cushioning materials, plant-growth regulators, fungicides and hot water dip treatments to minimize post-harvest changes in litchi and other fruits (Molla *et al*., 2017) [14]. Polythene and newspaper wrapping are supposed to become barriers for the direct effect of environment. Hot water treatment creates disturbance in the normal physiological functions of the fruits. Studies have indicated that calcium compounds are known to extend the storage life of many fruits by maintaining firmness and minimizing the rate of respiration, protein break down and disease incidence. Polythene bags alone could not help in checking the spoilage due to high humidity around the fruits which might have provided a very much conducive condition for pathogen growth, causing rot. When polythene wrapping was continued with pretreatment of calcium nitrate the stored fruits could maintain the freshness due to higher humidity as well as calcium nitrate induced more vigour and firmness in fruits. Chaiprasart (2005) [2] reported polyvinyl chloride (PVC) film wrapping might be more effective for extending the shelf life of litchi fruits. Jadhao *et al.* (2008) [8] concluded that the fruits stored in 200 gauged perforated polypropylene bags recorded best results. Keeping the above facts in view the present investigation will be carried out with an objective to find out suitable measures for extending the storage life of litchi cv. Shahi at ambient temperature

Materials and methods

The present investigation was conducted in department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The experimental material consisted of freshly harvested, firm, good looking, uniform size and mature fruit of litchi cv. Shahi. Fruits were handpicked in morning in bunches along with leaves avoiding any injury to the fruits carried to experimental site in Bamboo baskets. Prior to the application of post-harvest treatment, destalking of the fruits were done leaving 0.5 cm long pedicels in each fruit. Fruits were stored at room temperature in different lots consisting of 200 fruits per treatment per replication. The experiment was done in Completely Randomized Design (CRD) in three replication. These post – harvest treatments are T_1 – News paper wrapping, T_2 – News paper wrapping + hot water treatments 50 ± 2 ºC for 5 minutes, T_3 – News paper wrapping + calcium nitrate 1.0%, T_4 – News paper wrapping + calcium nitrate 1.5%, T_5 – News paper wrapping + calcium nitrate 2.0%, T_6– Polythene wrapping (20% vent), T_7 – Polythene wrapping + hot water treatments 50 ± 2 ºC 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. Observation to be recorded were economic shelf-life of fruits (days), change in specific gravity (%), fruit/pulp ratio, pulp/ juice ratio and sugar/acid ratio. Newspaper and 50 gauge thickness perforated polythene bag of size 60 × 30 cm and 45 cm x 30 cm respectively were used for wrapping of fruits and fruits were kept in bamboo basket at room temperature. Different concentrations of calcium nitrate (1.0, 1.5 and 2.0 per cent) 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 50 ± 2 ^{0}C for 5 minutes at the above temperature. Treated fruits were taken out and dried under electric fan. Such treated fruits, either wrapped with newspaper or polythene were kept in bamboo baskets at room temperature.

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

Specific gravity- The specific gravity of the fruits was determined by dividing the weight of the fruits in air by the volume of the fruits as obtained by water displacement method (Gustafson, 1926) [6].

Sugar /Acid ratio- The sugar/acid ratio was determined by dividing the percentage of total sugar with the percentage of titrable acidity. For determining total sugar 10 ml of juice was hydrolysed by adding 3 ml of conc. HCl and left for 24 hours. After that it was neutralised by adding sodium hydroxide 4N solution. This solution was then titrated against Fehling A and B and percentage of total sugar were worked out. Titratable acidity of the fruits was estimated by titrating a known volume of juice obtained from the fruits from each replication of all the treatments against standard sodium hydroxide solution (0.1N) using phenolphthalein as an indicator on each date of observation. The acidity of fruits so obtained was expressed as grams of anhydrous citric acid per 100g of pulp and calculated by using following formula –

$$\text{Acidity percent} = \frac{\text{0.1N NaOH consumed}}{\text{Volume of Juice taken}} \times \frac{64}{\text{Original weight}} \times \frac{100}{100}$$

Fruit/pulp ratio- All the ten randomly selected fruits per treatment replication wise were taken out and weigh out the whole fruits. After that peel out the skin from fruits and pulp were separated out from stone and pulp weight was measured. Using the following formula ratio of fruit/pulp was worked out.

$$\text{Fruit/Pulp ratio} = \frac{\text{Weight of fruit}}{\text{Weight of pulp}}$$

Pulp/Juice ratio- Peels from ten randomly selected fruits were taken out and weigh out the peels. After that juice were extracted from this peels and weight. Ratio of pulp and juice was calculated by using following formula-

$$\text{Pulp/juice ratio} = \frac{\text{Weight of pulp}}{\text{Weight of juice}}$$

Statistical analysis-The data were analyzed with the help of statistical department of the Institute.

Results and discussion

Economic life of fruits: Litchi fruit losses its commercial value within two days due to rapid skin discolouration and

shrinkage of fruits. The result showed that fruit coated with different concentrations of calciumnitrate along with perforated polythene bags extend the shelf life of litchi fruits. A perusal of the data (Fig.1) indicated that economic shelf life of fruits was maximum (11days) in fruits treated with 1.0, 1.5, and 2.0 per cent of calcium nitrate with perforated polythene bags whereas maximum economic life of untreated fruits (control) was 5days. After 11days of storage economic losses in fruits due to spoilage and shrinkage were continuously increased with increase in storage periods, irrespective to the treatments at ambient temperature. 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 news-paper wrapping was more than other respective treatments. Zhang, *et al. (*1997) [21] Jadhao *et al.* (2008) [8] Chaiprasart (2005) [2] Ramesh and Pal (2006) [17] observed the same finding. Economic losses of fruits may be due to more water loss and lower levels of relative humidity in newspaper. It was recorded that fruits treated with calcium nitrate and kept in perforated polythene bags were found to spoil less. Similar result was reported by Singh (2004) [19] in litchi. Moor *et al.* (2006) [15] in apple and Xu Ling *et al.* (2009) [20] in sweet cheery had reported similar results of reducing fruits loss due to pre harvest treatment of Ca and K. Post-harvest application of calcium nitrate for increasing economic life was also reported by Rabiei *et al.* (2011) [16] in apple and Gangwar *et al.* (2012) [3] in anola. Calcium applications known to effective in maintaining the membrane function and integrity may be the reason for less weight loss in calcium treated fruits. Less economic loss due to less spoilage or delay the quality deterioration during storage may also be due to spraying with different concentrations of calcium that could inhibit the activities of polygalactonase enzyme (PG) and peroxidase (POD), thus slow the accumulation of membranacious peroxide (NDA) in cells (Xu Ling *et al.*, 2009) [20]. Moll *et al*. (2017) [14] reported that marketable life of litchi fruits was extended more than 30 days with good colour under temperature of 5±1 °C in non-perforated polythene bag wrapping with newspaper.

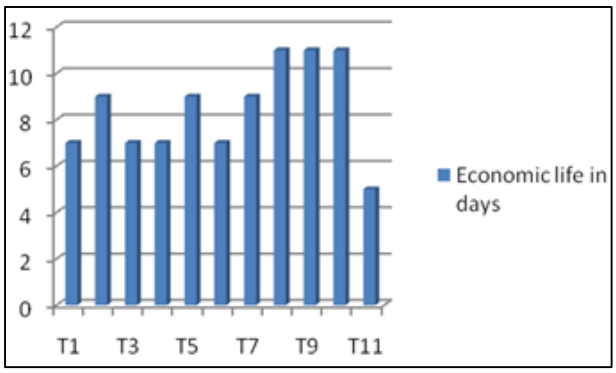

Fig 1: Economic life in days in litchi cv Shahi fruits during storage.

Specific gravity: The data of specific gravity of fruits (Fig. 2) indicated change in specific gravity percentage in all treatments on the 11th day of observation. Maximum change (11.44%) in specific gravity was observed in control (T_{11}) followed by (9.38%) in news-paper wrapped fruits (T_1). The minimum change in specific gravity (2.66%) was found in fruits treated with 2.0 per cent calcium nitrate with perforated polythene wrapping (T_{10}), which was closely (2.83%& 2.84%) followed by fruits treated with 1.0 and 1.5 per cent calcium nitrate with perforated polythene bags (T_8 and T_9) respectively. Similar results were obtained by Joshi and Roy (1985) [11] in mango and Bisen *et al*. (2014) [1] in guava. The reduction in specific gravity of fruits might be due to slow reduction in weight and volume of the fruits because of the retarding effect of calcium on ripening process during storage.

Fruit/Pulp ratio: The perusal of the data (Fig.3) revealed that fruit/pulp ratio generally increased form 1st day to 11th day in the fruits of all the treatments with some variation among the treatments. The data indicated that the minimum fruit/pulp ratio (1.67 to 1.73) was observed in all polythene wrapped treatments irrespective of hot water or all concentrations of calcium nitrate dip on 11th day of storage. Minimum fruit/pulp ratio in polythene wrapping indicated minimum moisture loss of fruits which might be due to reduced transpiration loss and respiration activity thus retained more turgidity of cells. Effect of polythene wrapping and chemical coating on preventing the moisture loss was also reported earlier by many workers (Mahajan *et al*. 2013; Jhalegar *et al*., 2015 and Moll *et al*; 2017 [13, 9, 14]

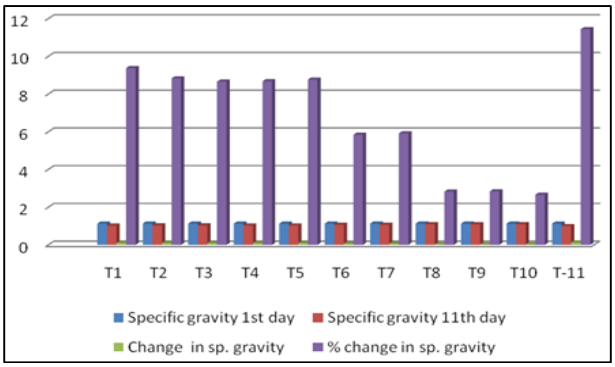

Fig 2: Change in specific gravity of litchi fruits during storage.

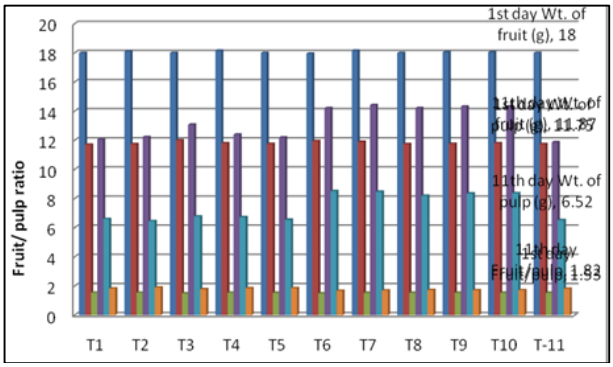

Fig 3: Fruit/Pulp ratio of litchi cv Shahi fruits during storage

Pulp/juice ratio: Data (Fig.4) revealed there was slight increasing trend in pulp/juice ratio from first to eleventh day in fruits of all the treatments of storage. The maximum pulp juice ratio (1.77) was recorded in fruits of control (T_{11}). Effect of polythene wrapping was showing the minimum increase in fruit /pulp ratio on 11th day of storage. The minimum increase of ratios (1.27) was recorded in polythene wrapped fruits alone or in combination of hot water or 1.0 per cent concentrations of calcium nitrate dipon 11th day of storage. The results are in agreement with the findings of Ganapathy and Singh (1976) [4] on passion fruit and Gaur and Bajpai (1978) [5] on litchi fruits. The transpiration and respiration seem to have interplayed for varying degrees of change in weight of pulp/juice ratio. The slow rate of transpiration and restricted respiration caused by pre-treatment of calcium

nitrate with polythene wrapping might be responsible for lower reduction in weight of the pulp and juice of fruits.

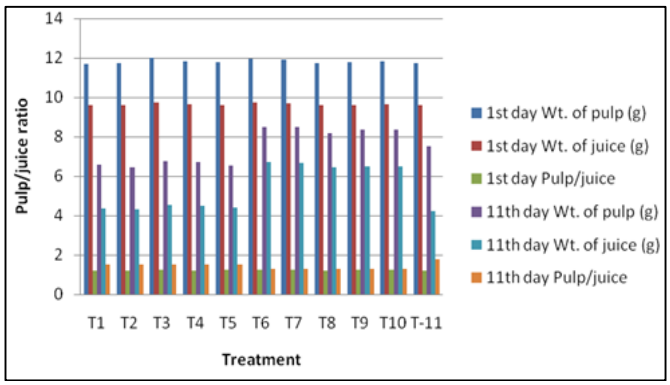

Fig 4: Pulp/Juice ratio of litchi cv. Shahi fruits during storage.

Sugar/acid ratio: The perusal of the data (Fig.5) revealed that there was a gradual increase in sugar /acid ratio during the storage. Faster rate of increase was observed in case of the fruits under control (T_{11}) whereas the treated fruits expressed the slower rate in different proportions according to the treatments. Minimum (51.07) sugar/acid ratio was observed in fruits of perforated polythene with 2.0 per cent calcium nitrate (T_{10}) and maximum (63.59) was recorded in fruits under control (T_{11}). Other concentrations of calcium nitrate in combination of perforated polythene wrapping and hot water treatment were also found to be effective for slower increase of sugar /acid ratio. The sugar/acid ratio is considered as the greatest factor for evaluating the intrinsic quality of fruits. During storage it was found to increase in all the treatments with different degrees. It was observed that calcium nitrate treated fruits with perforated polythene showed the lowest ratio for all days. This might be due to un-proportional increase or decrease of sugar and decrease of acidity of fruits under different treatments. The similar observations were found by Jadhao *et al.* (2008) [8] in guava.

On the basis of results obtained from the investigations it can be concluded that all concentrations of calcium nitrate (1.0, 1.5 and 2.0 per cent) 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 found to maintain the desirable physico-chemical characteristics of litchi fruit cv. Shahi.

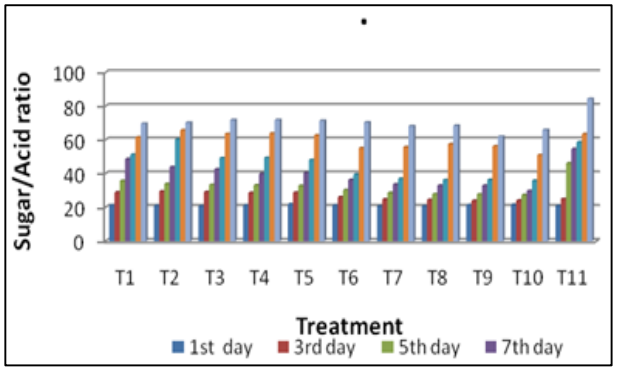

Fig 5: Sugar/Acid ratio of litchi cv. Shahi fruits during storage

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