



## Research Paper

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# Textural and biochemical changes in peach fruit during cold storage

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**ABSTRACT :** Peach is a highly perishable fruit and climacteric in nature. It can not be stored for longer period at ambient conditions. To maintain the post-harvest quality of fruits, peach trees of cv. Shan-i-Punjab were sprayed with putrescine and calcium nitrate at three concentrations each viz., 1.0, 2.0, 3.0 mmol L<sup>-1</sup> and 0.5, 1.0 and 2.0%, respectively 10 and 20 days before the anticipated commercial harvesting. Physiological mature treated fruits were packed in corrugated fibre-board (CFB) boxes and then stored at 0-1°C and 90-95% RH. The fruits were analyzed for various physico-chemical parameters on the day of storage and after 10, 20, 30 and 40 days of cold storage. Results revealed that pre-harvest application of putrescine and proved to be effective in maintaining the peach fruit health under cold storage conditions. Putrescine @ 2 and 3 mmol L<sup>-1</sup> (sprayed 10 days before harvesting) treatments were found effective in maintaining firmness, total soluble solids, acidity, reducing sugars and non reducing sugars up to 30 days of storage.

**KEY WORDS :** Peach, Putrescine, Calcium, Storage, Quality

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**P**each [*Prunus persica* (L.) Batsch] is one of the major stone fruit grown in temperate zones of the world. In sub-tropical climate, peach cultivation did not make much headway earlier, mainly because of non-availability of early ripening and superior quality varieties. But, with the introduction of low chilling cultivars from United States, the peach cultivation has greatly expanded in the North Indian plains especially in Punjab. Presently, varieties like Shan-i-Punjab, Partap and Earli-Grande are grown commercially in the state. Under Punjab conditions, the fruit of these cultivars matures from the last week of April to first week of May and because of high atmospheric temperature accompanied by a low relative humidity during this period, the fruit can not kept for long period and suffers from short post-harvest life.

During the growth and development of peach fruits after fruit setting till maturity and ripening, there are many physico-chemical changes takes place that governs their quality and post-harvest behaviour. Several growth regulators and other chemicals have been reported to delay the ripening and extend the post-harvest life of many fruits (Khader *et al.* 1988). Polyamines have been found to be anti-senescence

agents, exogenous application of polyamines, delay the fruit senescence and physiological processes leading to the fruit ripening. A higher endogenous level of putrescine (PUT) is associated with delayed fruit ripening (Dibble *et al.*, 1988). Calcium is known to strengthen the structure of cells by maintaining the fibrillar packaging in the cell walls thus reinforcing the cell to cell contact which is related to the formation of calcium pectate and counteracts the pectin methyl esterase activity as observed in calcium treated pear fruits (Alandes *et al.*, 2009). Treatment of fruits with calcium compounds to reduce post-harvest losses have proven to be effective by delaying fruit ripening and degradation caused by hydrolyzing enzymes (Dundar *et al.*, 1997). Keeping the above facts in view present investigations were undertaken to study the effect of pre-harvest applications of putrescine and calcium nitrate on the storage quality of peach fruits.

## RESEARCH METHODS

The experiment was conducted on peach plants of cv. 'Shan-i-Punjab' in the New Orchard of Department of Horticulture, Punjab Agricultural University, Ludhiana. Thirty

nine uniform experimental plants of peach cv. Shan-i-Punjab were sprayed with putrescine and calcium nitrate at three concentrations each viz., 1.0, 2.0, 3.0 mmol L<sup>-1</sup> and 0.5, 1.0 and 2.0 per cent, respectively 10 and 20 days before the anticipated commercial harvesting. A total of thirteen treatments were given comprising three replications in each treatment viz., T<sub>1</sub> [PUT 1 mmol/L (20 DBH)], T<sub>2</sub> [PUT 2 mmol/L (20 DBH)], T<sub>3</sub> [PUT 3 mmol/L (20 DBH)], T<sub>4</sub> [Ca(NO<sub>3</sub>)<sub>2</sub> (0.5%) (20 DBH)], T<sub>5</sub> [Ca(NO<sub>3</sub>)<sub>2</sub> (1.0%) (20 DBH)], T<sub>6</sub> [Ca(NO<sub>3</sub>)<sub>2</sub> (2.0%) (20 DBH)], T<sub>7</sub> [PUT 1 mmol/L (10 DBH)], T<sub>8</sub> [PUT 2 mmol/L (10 DBH)], T<sub>9</sub> [PUT 3 mmol/L (10 DBH)], T<sub>10</sub> [Ca(NO<sub>3</sub>)<sub>2</sub> (0.5%) (10 DBH)], T<sub>11</sub> [Ca(NO<sub>3</sub>)<sub>2</sub> (1.0%) (10 DBH)], T<sub>12</sub> [Ca(NO<sub>3</sub>)<sub>2</sub> (2.0%) (10 DBH)], T<sub>13</sub> Control (Water spray). Physiologically mature peach fruits of uniform size, disease and bruise free were picked randomly from all the four directions of the treated plants. The harvested fruits were immediately carried to the post-harvest laboratory for sorting and packaging. The bruised and diseased fruits were sorted out and healthy fruits were washed and air dried at room temperature. After drying, the fruits were packed in corrugated fibre board (CFB) boxes of one kg capacity in layers and subsequently placed in cold chamber (0 to 10 °C and 90-95 % RH). The physico-chemical characteristics of fruit samples were analyzed on the day of harvesting and after 10, 20, 30 and 40 days of storage. Firmness of randomly selected fruits (three from each replication) was measured with the help of fruit pressure tester (Model FT- 327, USA). About 1 square centimeter of the skin in each fruit from the shoulder end on both sides was removed with the help of peeler and firmness of pulp was recorded and expressed in terms of kgf. Total soluble solids (TSS) were determined from the juice at room temperature with the help of hand refractometer (Model Erma, Japan) and expressed in per cent. The readings were corrected with the help of temperature correction chart at 20°C temperature (AOAC, 1990). Acidity was estimated by titrating 2 ml of strained juice of fruits against 0.1 N NaOH solution using phenolphthalein as an indicator. The appearance of light pink colour marked the end point of titration. The percentage of titratable acidity was calculated and expressed in terms of anhydrous maleic acid. Sugars were analysed by AOAC(1990) methods. The data were analyzed by Factorial Randomized Block Design as described by Singh *et al.* (1998).

## RESEARCH FINDINGS AND DISCUSSION

Quality of peach fruits during storage was assessed from various physico-chemical characteristics. Putrescine and calcium nitrate treatments had significant effect in maintaining the fruit firmness (Fig. 1). The maximum average fruit firmness was observed in fruits treated with putrescine @ 3 mmol L<sup>-1</sup> (sprayed 10 days before harvesting), which was at par with putrescine @ 2 mmol L<sup>-1</sup> (sprayed 10 days

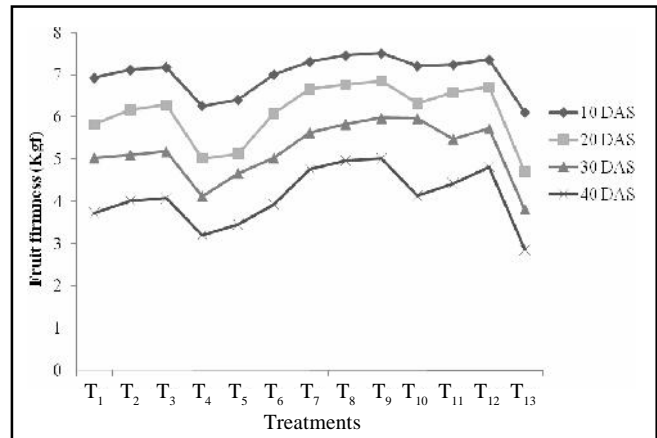


Fig. 1 : Effect of pre-harvest treatments on firmness of peach fruits under cold storage

before harvesting) treatment. A significant difference in fruit firmness was observed with advancement of storage period. The fruits treated with putrescine (1 mmol L<sup>-1</sup> and 2 mmol L<sup>-1</sup>) and calcium nitrate @ 0.5%, 1% and 2% (sprayed 10 days before harvesting) showed significantly higher fruit firmness compared to control, but lower than the fruits treated with putrescine @ 3 mmol L<sup>-1</sup> (sprayed 10 days before harvesting). Softening of fruits is caused either by the breakdown of insoluble protopectins into soluble pectins or by the cellular disintegration leading increased membrane permeability (Matoo *et al.*, 1975). Higher fruit firmness in putrescine treated fruits may be due to the role of polyamines in stabilizing cell walls, or by making cell walls less accessible to wall-softening enzymes (Kramer *et al.*, 1989). The bonds between polyamines and pectin inhibit the activity of wall-degrading enzymes, such as pectinesterase, pectinmethylesterase and polygalacturonase and reduce fruit softening during storage (Valero *et al.*, 2002). Khan *et al.* (2007) also reported the role of putrescine in retardation of plum fruit softening during low temperature storage. Similarly, Romero *et al.* (2001) observed an increase in fruit firmness with putrescine treatments in apricot fruits.

Total soluble solids (TSS) content in peach fruits showed an inconsistent content during the storage period (Fig. 2), these increased up to 30 days of storage, after which a decline was recorded by the end of 40 days of storage. The mean minimum total soluble solids (9.64%) were observed at the time of harvesting and the mean maximum total soluble solids (12.12%) were recorded after 30 days of storage interval. Freshly harvested control fruits recorded the highest total soluble solids, which was at par with fruits treated with calcium nitrate 0.5% and 1% (sprayed 20 days before harvesting). The minimum total soluble solids were noticed in fruits treated with putrescine @ 3 mmol L<sup>-1</sup> (sprayed 10 days before harvesting), followed by putrescine @ 2 mmol L<sup>-1</sup> and calcium nitrate @ 2% (sprayed 10 days before

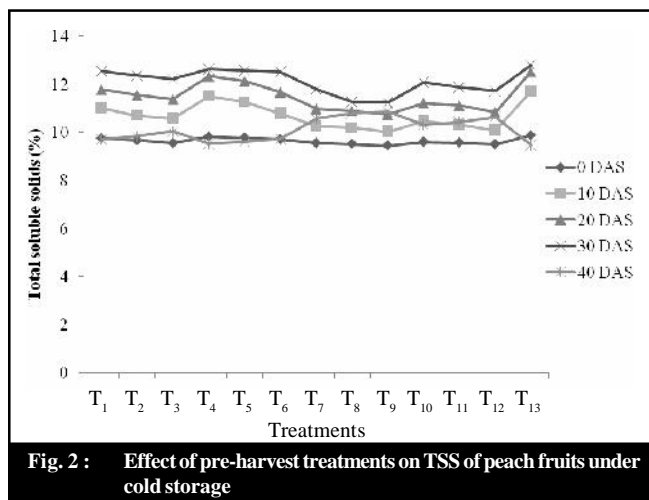


Fig. 2 : Effect of pre-harvest treatments on TSS of peach fruits under cold storage

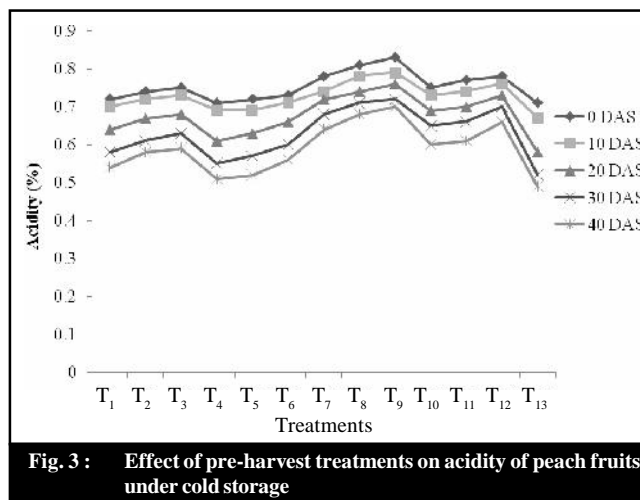


Fig. 3 : Effect of pre-harvest treatments on acidity of peach fruits under cold storage

harvesting) treatments. Similar trend of TSS was recorded after 10, 20 and 30 days of storage, while at the end of the storage period *i.e.* after 40 days of storage the total soluble solids declined and found highest in putrescine @ 3 mmol L<sup>-1</sup> (sprayed 10 days before harvesting) treated fruits, followed by putrescine @ 2 mmol L<sup>-1</sup> and calcium nitrate @ 2% (sprayed 10 days before harvesting) treatments. In general, the increase in TSS with the advancement of storage period may be due to the numerous catabolic processes taking place in the fruits during ripening and senescence processes. The reason for the increase in TSS could be attributed to the water loss and hydrolysis of starch and other polysaccharides to soluble form of sugar. Wills *et al.* (1980) also reported that starch gets hydrolyzed into mono and disaccharides, which in turn may lead to an increase in TSS. The results on TSS in the present studies are in agreement with the findings of Malik *et al.* (2003) who reported a slow increase in total soluble solids in 'Kensington Pride' mango treated with putrescine as compared to control. Ramezani *et al.* (2010) also reported that calcium chloride and spermidine treatments on pomegranate fruits showed lower soluble solid content as compared to control. Khosroshahi and Ashari (2007) found that exogenous application of putrescine on apricot fruit resulted in less TSS content as compared to control.

Putrescine treatments also showed a significant effect in retaining the acidity of peach fruit (Fig. 3). Acidity of peach fruit treated with putrescine and calcium nitrate showed a linear declining trend with advancement of storage period. The mean maximum acidity was observed at the time of harvesting and the mean minimum acidity was observed after 40 days of storage. During the entire storage period, the highest acidity was recorded in putrescine @ 3 mmol L<sup>-1</sup> treated fruits (sprayed 10 days before harvesting), which ranged between 0.83 to 0.70%. The lowest acidity was recorded in control fruits ranging from 0.71 to 0.49%. On

the day of harvesting, the maximum acidity was observed in putrescine @ 3 mmol L<sup>-1</sup> treated fruits (sprayed 10 days before harvesting), followed by putrescine @ 2 mmol L<sup>-1</sup> and calcium nitrate @ 2% (sprayed 10 days before harvesting) treatments and the lowest acidity (0.71%) was recorded in control fruits, followed by calcium nitrate @ 0.5%, 1% and putrescine @ 1 mmol L<sup>-1</sup> (sprayed 20 days before harvesting). A similar trend was followed after 10, 20, 30 and 40 days of storage interval. The maintenance of higher acidity in putrescine treated fruits may be due to the decreased hydrolysis of organic acids and subsequent accumulation of organic acids which were oxidized at a lower rate because of decreased respiration. The decrease in acidity during storage may be attributed to utilization of organic acid in pyruvate decarboxylation reaction occurring during the ripening process of fruits (Pool *et al.*, 1972). Similar findings with regard to slow decline in acidity with putrescine treatments were reported by Khan *et al.* (2008) in 'Angelino' plum and by Khosroshahi and Ashari (2007) in 'Tokhm-sefid' apricot fruit.

Reducing sugars of peach fruits showed an increase with advancement of storage period (Fig. 4) only up to 30 days of storage, thereafter, it followed a declining trend. On the day of storage, minimum reducing sugars were found in putrescine @ 3 mmol L<sup>-1</sup> (sprayed 10 days before harvesting) treated fruits, followed by putrescine @ 2 mmol L<sup>-1</sup> and calcium nitrate (sprayed 10 days before harvesting) treatments and the maximum reducing sugar were found in fruits kept under control. A similar trend was followed after 10, 20 and 30 days of storage. However, after 40 days of storage interval when the reducing sugars decreased, the maximum reducing sugars were found in putrescine @ 3 mmol L<sup>-1</sup> (sprayed 10 days before harvesting) treated fruits, followed by putrescine @ 2 mmol L<sup>-1</sup> and calcium nitrate @ 2% (sprayed 10 days before harvesting) treatments, respectively. In case of non-reducing sugars the mean

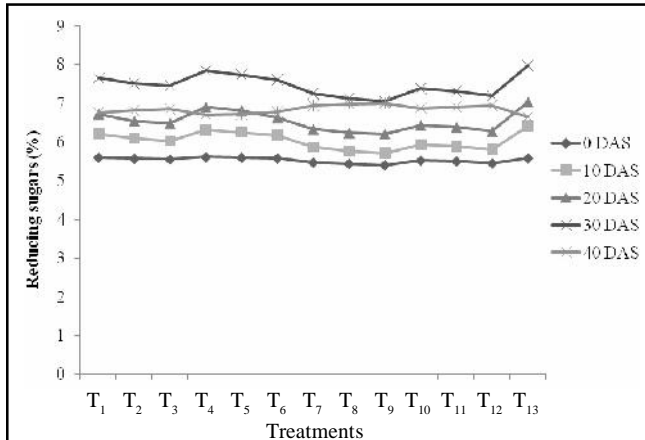


Fig. 4 : Effect of treatments on reducing sugars of peach fruits under cold storage

minimum were estimated at the time of harvesting and the maximum average non reducing sugars were observed after 30 days of storage (Fig. 5). On the day of harvesting, minimum non reducing sugars were estimated in putrescine @ 3 mmol L<sup>-1</sup>, followed by putrescine @ 2 mmol L<sup>-1</sup> and calcium nitrate @ 2% (sprayed 10 days before harvesting) treatments and the maximum non reducing sugars were found in control fruits. Similarly, after 10, 20, and 30 days of storage whereas, after 40 days of storage trend was reversed. The increase in sugars during storage may possibly be due to breakdown of complex organic metabolites into simple molecules or due to hydrolysis of starch into sugars. The decline in the sugar content at the later stages of storage may be attributed to the fact that after the completion of hydrolysis of starch, no further increase in sugars occurs and subsequently a decline in sugars is predictable as they along with other organic acids are primary substrate for respiration (Wills *et al.*, 1980). The data of present study shows that total sugars increased in all the treatments with

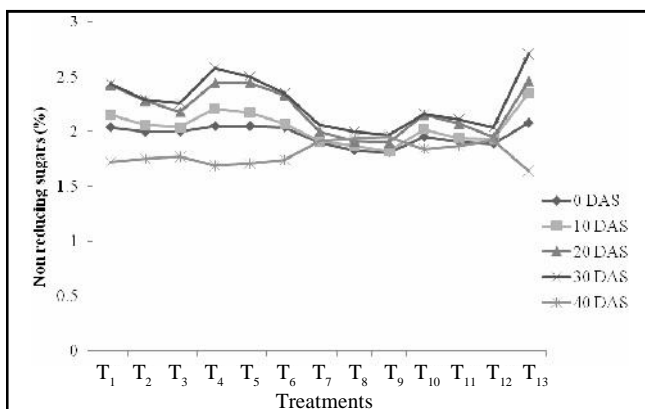


Fig. 5 : Effect of treatments on non-reducing sugars of peach fruits under cold storage

the advancement of storage period, but the rate of total sugars increase was slower in putrescine treated fruits than the untreated ones. Malik *et al.* (2003) also reported a reduced rate of increase of total and non reducing sugars in ‘Kensington Pride’ mango treated with pre- and post-harvest application of putrescine as compared with control. El-Motty *et al.* (2007) also observed apricots treated with calcium chloride (2%) and chelated calcium (1.0%) showed a slow increase in total sugars as compared to control ones. Bhullar *et al.* (1981) also recorded minimum total sugars in 2% calcium nitrate treated fruits after storage of 5 days in ‘Flordasun’ peach.

### Conclusion :

Putrescine @ 2 and 3 mmol L<sup>-1</sup> (sprayed 10 days before harvesting) were found effective in maintaining peach fruit quality in terms of fruit firmness, total soluble solids, acidity, reducing sugars and non reducing sugars up to 30 days of cold storage.

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