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EFFECT OF CALCIUM NITRATE AND PUTRESCINE TREATMENTS ON QUALITY OF PEAR FRUITS UNDER LOW TEMPERATURE CONDITIONS

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ABSTRACT
Pear undergoes various ripening changes after harvest and the magnitude of post-harvest losses in fresh fruits is quite high which result into high economic losses. An attempt was made to reduce these losses in which physiologically mature, uniform and healthy fruits of pear *cv*. Punjab Beauty were harvested and treated for 5-minutes in aqueous solutions of calcium nitrate (2, 4, 6%) and putrescine (1.0, 2.0, 3.0 mmol liter^{-1}) at three different concentrations. Treated fruits were packed in CFB boxes before storage at 0-1°C and 90-95% RH for 75 days. Results revealed that post-harvest treatments of calcium nitrate and putrescine were effective in delaying ripening and extending the post-harvest life of pear fruits under cold storage conditions.

KEYWORDS: PLW, juice acidity, TSS, PME, Cold storage.

INTRODUCTION

In Punjab, pear cultivation is mainly concentrated in Amritsar, Jalandhar, Hoshiarpur and Ludhiana districts and is becoming more popular now because of higher returns from per unit area. But, heavy post-harvest losses and a short post-harvest life are the major constrains in its cultivation. To boost its cultivation it is necessary to develop a profitable technology to extend its post-harvest life with minimum post-harvest losses. Different chemicals *viz*; fungicides, disinfectants, nutrients and growth regulators are used in various fruits to extend their post-harvest life. Among various treatments, pre and post-harvest calcium applications have been used to delay senescence, to reduce post-harvest decay. Calcium compounds significantly increased the firmness of fruits by thickening of middle lamella of fruit cells owing to increased formation and deposition of calcium pectate (Gupta *et al.,* 1984). Studies have shown that the rate of senescence often depends on the calcium status of the tissue and by increasing calcium levels, various parameters of senescence such as respiration, protein, chlorophyll content and membrane fluidity are altered (Poovaiah, 1986). Three principle roles of calcium in the plants were assigned *viz:* .cation interaction, cell wall structure and membrane function and stability (Ferguson and Drobak, 1988). Polyamine comes under the new class of growth regulators and they regulate the various physiological processes in plants. Polyamines are designated as anti-senescence agents and their level usually decreases during the ripening in most of the fruits (Kumar *et al.,* 1997). Exogenous application of polyamines influences the post-harvest life of fruits. It blocks ethylene receptors and prevent ethylene effects in plant tissues for extended period (Sisler and Serek, 1997). Ethylene and polyamines share a common precursor, S adenosylmethionine (SAM) and they compete with each other during fruit development and ripening (Panday *et al.,* 2000). The inverse relationship between ethylene and polyamine is primarily illustrated by their opposite synthesis pattern during fruit development and delay or inhibition of ethylene production by free polyamines. Therefore, keeping the above facts in view an investigation was planned to study the effect of post-harvest applications of putrescine, calcium nitrate on the storage life of pear fruit *cv*. Punjab Beauty.

MATERIALS & METHODS

The present study was conducted in the post-harvest laboratory, Department of Fruit Science, Punjab Agricultural University, Ludhiana during the year 2013. The fruits of pear cv. Punjab Beauty were harvested at colour break stage. The bruised and diseased fruits were sorted out and only healthy, uniform sized fruits were selected for the present studies. The fruits were subjected to three different concentrations of calcium nitrate *viz*., 2, 4, 6% and putrescine *viz*., 1, 2,3 mmol liter^{-1}.The experiment was laid out in completely randomized block design. Experiment was comprised of seven treatments with three replications in each treatment and the treatments were T_1 [Calcium nitrate (2%)], T_2 [Calcium nitrate (4%)], T_3 [Calcium nitrate (6%)], T_4 [(Putrescine (1.0 mmol liter $^{-1}$)], T_5 [Putrescine (2.0 mmol liter^{-1})], T_6 [Putrescine (3.0mmol liter $^{-1}$)], T_7 [Control (Water dip)]. Treated fruits were air dried under shade before packaging in CFB boxes. Packed fruit were kept at low temperature conditions (0 -1°C and 90-95% RH). The observations on various physico-chemical attributes were recorded after 45, 60 and 75 days of storage. The percent loss in weight after each storage interval was calculated by subtracting final weight from the initial weight of the fruits and then converted into percentage value. The total soluble solids (TSS) of the juice was determined with the help of ATAGO digital refractometer, and expressed as percent. Titratable acidity was recorded as per standard methods

(A.O.A.C., 1990). The PME activity was estimated by standard methods (Mahadevan and Sridhar, 1982).

RESULTS & DISCUSSION

A significant increase in physiological loss in weight was observed with the advancement of the storage period (Table 1). The mean PLW of fruits was lowest (2.31%) after 45 days of storage which increased progressively and recorded maximum (4.91%) at the end of storage period. Simnani (1995) reported that physiological loss in weight of 'Shan-i-Punjab' peach fruits increased significantly with increase in storage period. Various post-harvest dip treatments showed a significant influence on PLW of pear fruits. Calcium nitrate @ 2 % maintained mean minimum loss in weight (1.52%), followed by calcium nitrate @ 4% (1.53%). Interaction between storage and treatment was found to be significant. After 45 days, the minimum physiological loss in weight (1.52%) was noticed in fruits treated with calcium nitrate @ 2%, which was followed by calcium nitrate@ 4% treatments but the maximum physiological loss in weight (3.03%) was noticed in control fruits. Similar trend in physiological loss in weight was noticed after 2nd and 3rd interval of storage. In Le Conte pear, calcium nitrate treatments (0.5%) reduced the PLW of fruits (Banday, 1996). A study was conducted on the effect of zinc, boron, calcium chloride and calcium nitrate on 'Flordasun' peach and reported a systematic decrease of fruit weight in all treatments from one day to fourth day of storage (Singh and Arora, 1997). The minimum physiological loss in weight of ber fruits cv. Gola was observed when treated with calcium nitrate (0.5%) and stored at 7°C for 15 days (Nath and Bhargava, 1998). The lower weight loss in polyamines treated fruits could be attributed to stabilization or consolidation of both cell integrity and the permeability of the tissues, ameliorating chilling injury, the latter induces tissue disruption and connection between the skin and the external atmosphere allowing the transference of water vapour (Woods, 1990).

TABLE 1: Effect of calcium nitrate and putrescine on the physiological loss in weight of pear cv. Punjab Beauty

Treatment	Physiological loss in weight (%)			
	Storage interval (Days)			
	45	60	75	Mean
T_1 Calcium nitrate @ 2%	1.52	3.15	3.76	2.81
T_2 Calcium nitrate @ 4%	1.53	3.24	4.05	2.94
T_3 Calcium nitrate @ 6%	1.50	3.36	4.23	3.03
T_4 Putrescine @ 1 mmol liter-^{1}	1.54	3.47	4.16	3.11
T_5 Putrescine @ 2 mmol liter -^{1}	1.83	3.48	5.90	3.74
T_6 Putrescine @3mmol liter -^{1}	2.71	3.61	5.71	4.01
T_7 Control	3.03	4.97	6.61	4.87
Mean	2.31	3.60	4.91	

CD at 5 % level		
Treatment(A)	:	0.02
Storage Interval (B)	:	0.01
(A x B)	;	0.05

The acidity of pear fruits experienced a linear decline as the storage period advanced (Table 2). The mean titratable acidity contents after 45, 60 and 75 days is 0.31, 0.26 and 0.22%. Various treatments showed a significant effect on titratable acidity of pear fruits. Calcium nitrate @ 2 % showed mean maximum acidity (0.27%), followed by calcium nitrate @ 4% treatment. Whereas, lowest acidity (0.21%) was recorded in the control fruits, followed by putrescine @ 2 mmol liter $^{-1}$. Interaction between treatments and storage period was found to be significant. After 45 days, calcium nitrate @ 2% showed maximum total acidity (0.32%) and minimum acidity was observed in control fruits. Similar trend was followed after 2nd and 3rd interval of storage. The fruits treated with calcium nitrate @ 2% maintained higher acidity during storage probably due to delay in ripening process. Rhodes *et al.,* (1968) suggested that calcium treatment causes utilization of organic acids in pyruvate decarboxylation reaction occurring during ripening process as a reason for decline in titratable acidity. Ramana *et al.,* (1979) related that the change in total titratable acids during storage was mainly due to the metabolic activities of living tissues during which depletion of organic acids takes place. It has been suggested that titratable acidity decreases in fruits as a result of breakup of acids to sugars during respiration (Ball, 1997). It was stated that during storage, the fruit itself might utilize the acids so that the acid in the fruits during storage decreases (Bhattarai and Gautam, 2006).

TABLE 2: Effect of calcium nitrate and putrescine on the fruit acidity of pear cv. Punjab Beauty

Treatment	Titratable Acidity (%)			
	Storage interval (Days)			
	45	60	75	Mean
T_1 Calcium nitrate @ 2%	0.32	0.27	0.24	0.27
T_2 Calcium nitrate @ 4%	0.30	0.26	0.23	0.26
T_3 Calcium nitrate @ 6%	0.29	0.25	0.21	0.25
T_4 Putrescine @ 1 mmol liter-^{1}	0.30	0.26	0.23	0.26
T_5 Putrescine @ 2 mmol liter-^{1}	0.31	0.25	0.21	0.24
T_6 Putrescine @ 3mmol liter-^{1}	0.32	0.25	0.22	0.23
T_7 Control	0.31	0.26	0.20	0.21
Mean	0.31	0.26	0.22	

CD at 5% level		
Treatment (A)	:	0.03
Storage Interval (B)	:	0.01
(A x B)	:	0.04

The total soluble solids (TSS) content increased slowly and steadily upto 60 days of storage and thereafter a decline was noticed during the storage period (Table 3). All the treatments showed significant effect on the TSS content of pear fruits. Calcium nitrate @ 2% registered mean minimum TSS, followed by calcium nitrate @ 4%. Interaction between the treatments and storage period was found to be significant. Calcium nitrate @ 2% registered fruits recorded the highest TSS content after 60 days of storage and thereafter TSS content declined but fruits treated with calcium retained the highest TSS (11.2%) after 75 days of storage. The control fruits registered the highest TSS content upto 60 days of storage as compared to treated fruits and thereafter declined at a faster pace and recorded the lowest TSS as compared to calcium nitrate treated fruits at the end of storage. The increase in TSS may possibly be due to the numerous catabolic processes taking place in the fruit, ending to senescence. It was also reported that starch gets hydrolysed into mono and disaccharides, which in turn may lead to increase in TSS (Wills *et al.*, 1982). The conversion of starch and polysaccharides to simple sugars and organic acids enhanced the TSS level. Gautam *et al.* (1981) also observed less TSS with calcium treatments as compared to control in peach *cv*. Kanto-5.

TABLE 3: Effect of calcium nitrate and putrescine on the fruit TSS of pear cv. Punjab Beauty

Treatment	Total soluble solids (%)			
	Storage interval (Days)			
	45	60	75	Mean
T_1 Calcium nitrate @ 2%	12.26	12.43	12.40	12.36
T_2 Calcium nitrate @ 4%	12.30	12.46	12.36	12.37
T_3 Calcium nitrate @ 6%	12.36	12.56	12.31	12.46
T_4 Putrescine @ 1 mmol liter -^{1}	12.33	12.53	12.33	12.40
T_5 Putrescine @ 2 mmol liter -^{1}	12.43	12.60	12.26	12.54
T_6 Putrescine @ 3mmol liter -^{1}	12.46	12.66	12.30	12.48
T_7 Control	13.33	13.46	12.23	13.01
Mean	12.6	12.8	12.4	

CD at 5% level		
Treatment(A)	:	0.04
Storage Interval (B)	:	0.03
(A x B)	:	0.12

The activity of pectin methyl esterase (PME) increased with the advancement in storage period (Table 4). The PME activity (1.49 ml 0.02N NaOH used) increased slowly upto 60 days of storage and thereafter sharp decline was noticed. This decrease in PME activity at later stage could be attributed to the reduced substrate level due to decomposition. The decrease in PME activity at later stage of storage was also reported in ber fruits (Jawandha *et al.*, 2012).Various treatments showed a significant effect on the PME activity. Calcium nitrate @ 2% showed mean minimum (1.30 ml 0.02N NaOH used) PME activity followed by calcium nitrate @ 4%. Interaction between treatments and storage was found to be significant. Calcium nitrate @ 2 % treated fruits recorded the highest PME activity (1.67 ml 0.02N NaOH used) after 60 days of storage and thereafter PME content declined but calcium nitrate @ 2% treated fruits maintained the highest PME activity (1.57 ml 0.02N NaOH used) after 75 days of storage. The control fruits registered the highest PME activity upto 60 days of storage as compared to treated fruits and thereafter declined at a faster pace and recorded the lowest PME at the end of storage period. Pre-harvest application of calcium to guava fruits minimized the activity of PME during storage (Singh and Chauhan, 1981).

TABLE 4: Effect of calcium nitrate and putrescine on the PME activity of pear cv. Punjab Beauty

Treatment	Pectin Methyl Esterase (PME) (ml 0.02N NaOH used)			
	Storage interval (Days)			
	45	60	75	Mean
T_1 Calcium nitrate @ 2%	1.12	1.67	1.57	1.30
T_2 Calcium nitrate @ 4%	1.18	1.63	1.49	1.32
T_3 Calcium nitrate @ 6%	1.20	1.58	1.24	1.41
T_4 Putrescine @ 1 mmol liter $^{-1}$	1.19	1.60	1.48	1.35
T_5 Putrescine @ 2 mmol liter $^{-1}$	1.35	1.41	1.28	1.46
T_6 Putrescine @ 3mmol liter $^{-1}$	1.37	1.48	1.24	1.39
T_7 Control	1.59	1.30	1.10	1.50
Mean	1.28	1.49	1.31	

CD at 5% level
Treatment (A) : 0 .01
Storage Interval (B) : 0.06
(A x B) : 0.02

CONCLUSION

From the present studies it may be concluded that 'Punjab Beauty' fruits treated with calcium nitrate (2%) can be stored for 75 days at 0-1°C and 90-95% RH.

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