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Full Length Research Paper

Effect of harvest dates, pre harvest calcium sprays and storage period on physico-chemical characteristics of pear cv. Bartlett.

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A study undertaken to assess the effects of harvest dates, calcium chloride and storage of pear fruit cv. Bartlett revealed that fruits harvested 110 and 115 days after full bloom (DAFB) showed rapid colour development, decrease in firmness, less physiological loss in weight, higher organoleptic rating and more spoilage. However, late harvested fruits recorded less acid content, higher TSS, total and reducing sugars, decreased in starch content and more calcium content. The fruits treated with calcium chloride showed delayed colouration, improved, fruit firmness, organoleptic rating, TSS, sugars , both peel and flesh calcium content and reduced physiological loss in weight, spoilage and acidity. After 15 days of storage period, fruit colour, physiological loss, spoilage, organoleptic rating increased and fruit firmness decreased. Comparatively, TSS, sugars, starch content, calcium content (both peel and flesh) increased and the acid content decreased. Fruits harvested 110 and 115 DAFB and treated with calcium chloride at 0.5 and 0.75% retained all the Physico-chemical characteristics and enhanced the storage and keeping quality.

Key words: Calcium chloride, harvest date, pear, Physico-chemical characteristics and pre-harvest treatment.

INTRODUCTION

Pear (*Pyrus communis)* is next only to apple in importance, acreage, production and varietal diversity among temperate fruits. Pear is grown under temperate and subtropical conditions because of its wide climatic and soil adaptability. Pear can be grown in a wide range of climatic conditions as it can tolerate as low as -26°C temperature when dormant and as high as 45°C during growing period. A large number of pear cultivars require about 1200 hours below 7°C during winter to meet their chilling requirements to flower and fruit satisfactorily.

In the Indian administered Jammu &Kashmir state the cultivation of pear is spread over an area of 12547 ha with the annual production of 47982M tones (Anonymous, 2009).Maximum area has been brought under Bartlett. Bartlett is a mid season cultivar and matures in the 1st week of August.

Since Bartlett is a climacteric fruit and has very less storage life when it fully matures, Calcium plays an important role in maintaining the quality and storability of fruits. By applying calcium nutrition, the respiration rate is reduced, delaying ripening and there is increase in fruit firmness and the storage life is extended. Most of the disorders are related to calcium deficiency. Experiments designed to increase calcium content of fruit have shown that this is the most complex nutritional problem which orchardists/scientists have ever faced (Faust, 1979). Calcium being an essential macronutrient is not only involved as a constituent of cell wall, but also controls the functions of cell membrane by maintaining the ionic balance.

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Since the modern facilities of fruit storage for prolonging their storage life are not available in the Indian administered Jammu and Kashmir state and the orchardists store their fruit under ambient conditions, the experiment was designed to study the effect of harvest dates, calcium chloride and storage life of pear cv. Bartlett on its physico-chemical characteristics.

MATERIALS AND METHODS

The investigation was conducted at experimentation station, Division of Pomology, Sher-e-Kashmir University of Agriculture Science and Technology- Kashmir. 24 years old bearing trees on seedling stock, uniform in vigor and health were selected for experimentation. The orchard has proper soil and air drainage and has the southern aspct.The trees are spaced 6 x 6 meters and received uniform cultural treatments. Pre harvest sprays of calcium chloride salt at three concentrations each with control were tested. The concentration used was 0.25, 0.5 and 0.75% calcium chloride. Two sprays were given 45 days and 60 days before harvest. The treatments were replicated thrice in a randomized block design. The foliage and the fruits were completely drenched to a slightly run-off by spraying in clockwise and then in anti-clockwise direction. The fruits were harvested at three different dates viz. 105,110 and 115 days after bloom (DAFB). After removing the diseased/ damaged fruits, they were analyzed for different physico-chemical characteristics viz:- fruit; size, weight , volume, color, organoleptic rating, firmness, acidity, total soluble solids, starch rating, sugar and calcium contents.

Fruit size of each harvested fruit in each treatment was measured in millimeters with the help of digital vernier caliper. Fruit weight in grams was recorded in a sensitive mono pan balance. Fruit volume was recorded by water displacement method. The colour change was determined by visual score (green=1, greenish yellow =2, straw yellow =3 and yellow=4). Organoleptic rating was done on a 4 pt scale by employing the characteristic of taste, flavor, texture, crispness and juiciness. Flesh firmness was measured with the help of effigy Pressure tester plunger (diameter 8mm) in kg/cm².Acidity was measured in terms of malic acid and total soluble solids by AOAC method (1990) using hand refractometer. Starch rating was determined in iodine solution by visual scores 1-4 (starch present throughout entire surface colored=1, starch absent from core area=2, starch absent from core area and vascular bundles=3, starch present in outer half of cortex=4). Sugars were determined by standard methods (AOAC, 1990). Calcium content in the fruit was determined using atomic absorption spectrophotometer. For statistical analysis randomized block design (RBD) was followed

Storage Studies

The fruit of each harvest date, after calculating the physical and chemical characteristics, were stored under ambient conditions, the temperature varying between ±25.7°c with relative humidity of 56.33% and ±28.3°C with the relative humidity of 64.8% during the two consecutive years. The fruit of each harvest date was stored for 15 days and analyzed at the interval of 5, 10 and 15 days with respect to spoilage (%), physiological loss in weight and other physico-chemical characteristics.

Spoilage (%): The percentage of fruits that had been spoiled during storage was calculated on the basis of number of fruits used in each treatment.

Physiological loss in weight: The labelled fruits in each treatment were weighed prior to storage and subsequently, at each stage of analysis during storage, reduction in weight was determined and the loss in weight expressed on percentage basis.

Statistical analysis: For statistical analysis randomized block design was followed. In Physico-chemical characteristics, harvest dates, calcium chloride treatments and storage periods were considered as variants. The last sample considered for statistical analysis was drawn on 15th day of storage for all the characteristics.

RESULTS AND DISCUSSION

Physical characteristics

Colour: Colour development in pear fruit was significantly affected by harvest dates, calcium chloride and storage period. Fruits of third harvest showed significantly more colour than the fruits of 1st and second harvest. Fruits treated with higher concentration (0.75%) of calcium chloride showed significantly less colour development than those treated with lower concentration and control; however no significant colour difference was observed in fruits treated with 0.75% and 0.5% calcium chloride.

Prolonged storage enhanced the extent of coloration in pear fruit: Significant increase in fruit colour was observed in each sampling date during the storage period and highest coloration (2.632 pts) was observed after 15 days of storage, Table -1. The colour development in fruits showed significant change in colour. Fruits harvested late were significantly faster than those harvested early. The delay in coloration seems probably due to delayed ripening (Looney, 1972). Color development in fruits treated with higher concentration of calcium chloride was delayed. Similar results have been reported in mango and pear by Tirimazi and Wells (1981). Color development in pear fruits increased with advancing period of storage at room temperature.

Fruit firmness (Kg/cm^2): Fruit firmness decreased significantly with the delayed harvesting. Fruits of first harvest were firmer (9.23Kg/cm^2) where as those of third harvest were soft (7.49Kg/cm^2).fruits treated with higher concentration of calcium chloride (0.75%) remained significantly firmer than untreated (7.25Kg/cm^2). During storage period the fruit firmness decreased significantly and lowest was recorded after 15 days of storage. Fruits picked early were more firm than those harvested late due to the reduced extent of softening and possibly less hydrolysis of starch reserves. Similar findings have been reported by earlier workers on d, Anjou pear, and

Table 1. Effect of harvest dates, calcium chloride treatments and storage period on physical characteristics of pear fruit cv. Bartlett

Treatment	Colour (score)	Firmness (Kg/cm^2)	Weight loss (%)	Organoleptic rating (score)	Spoilage (%)
Harvest date(DAFB)					
D1	1.60	9.23	10.05	2.51	4.56
D2	1.84	8.43	8.40	2.59	8.66
D3	2.20	7.49	6.76	2.66	12.00
CD(P=0.05)	0.06	0.16	0.19	---	0.08
Calcium chloride (%)					
C0	1.98	7.52	9.51	2.39	11.12
C1	1.89	8.28	8.81	2.48	9.09
C2	1.84	8.60	8.06	2.65	7.52
C3	1.80	9.12	7.22	2.82	5.90
CD(P=0.05)	NS	NS	0.14	----	0.06
Storage period					
S0	1.19	1.37	0.00	2.42	0.00
S1	1.63	9.62	5.38	2.51	4.91
S2	2.07	7.90	11.99	2.62	10.91
S3	2.62	5.64	16.09	2.76	17.94
CD(P=0.05)	0.05	0.14	0.17	----	0.07

Pathernakh pear (Chen and Melenthin, 1981 and Randhawa *et al,* 1984). Fruits treated with higher concentration of calcium chloride recorded more firmness as compared to untreated fruits which may be due to reduced extent of fruit softening as observed by Wills and Tirimazi (1981) in case of Avocado and Bhat, etal, 2009 in Bartlett pear. Fruit firmness significantly decreased with advancing storage period.

Weight loss (%): As evident from the table the physiological loss in weight of pear fruit decreased with delayed harvesting. Fruits of third harvest showed significantly less loss in weight than those of second and first harvest. However the fruits treated with higher concentration of calcium chloride (0.75%) recorded less loss in weight (7.2 %) as against (9.5 %) in untreated fruits. A significant increase in the extent of weight loss of fruits was recorded with the advancement of storage period. Fruit harvested earlier exhibited more loss in weight than those harvested late, which may be due to more transpiration and metabolic processes. These findings are in conformity with those of Blank (1980) and Bhat, etal, 2009 in Bartlett pear. Treated fruits exhibited less loss in weight than untreated fruits. Fruits treated with higher concentrations of calcium chloride recorded less loss of weight which may be due to reduced transpiration during pre-climacteric and climacteric phases, Tingwa and Young (1974).

Organoleptic rating: The fruits of third harvest showed higher organoleptic rating than those of other harvest dates. Lowest organoleptic rating was recorded in the fruits of first harvest. Fruits treated with (0.75%) calcium chloride recorded significantly higher organoleptic rating than the untreated ones. As the storage period increased the organoleptic rating increased significantly, and highest organoleptic rating was recorded after 15 days of storage. During storage, the weight of pear fruit decreased, fruits harvested late had higher organoleptic rating and during storage the organoleptic rating increased. Fruits treated with higher concentrations of calcium chloride showed higher organoleptic rating, which may be due to retarted rate of fruit ripening and softening, Will *et al* (1982), in case Bartlett pears.

Spoilage: Extent of fruit spoilage significantly increased with delay in harvesting. Fruits of first harvest recorded significantly less spoilage as compared to fruits of other harvests. Fruits treated with higher concentration of calcium chloride significantly recorded less spoilage than untreated ones. Spoilage of fruits increased significantly with the increase in storage period. Significantly increased extent of spoilage was observed after 15 days of storage. . Late harvested fruits exhibited more spoilage, reported by Blank (1980) in Ignol apple. Calcium treated fruits exhibited lesser extent of rotting, which may be due to higher flesh and skin calcium content that resulted in stronger intracellular organization and rigidified cell wall, Dhillon *et al* (1981).

Chemical characteristics

Starch rating: Table 2 reveals that delayed harvesting significantly decreased the starch rating of pear fruits.

Table 2. Effect of harvest dates of calcium chloride treatments & storage on chemical characteristics of pear fruit cv Bartlett.

Treatments	Acidity (%)	TSS (%)	Starch rating	Non- reducing Sugar (%)	Reducing Sugar	Total sugar	Calcium content (%)	
							Peel	Flesh
Harvest date(DAFB)								
D1	0.406	12.38	30.49	4.28	3.35	3.74	0.094	0.108
D2	0.409	13.24	33.08	3.97	4.25	4.69	0.093	0.108
D3	0.395	13.61	34.50	3.73	6.31	6.74	0.095	0.109
CD(P=0.05)	0.0007	0.22	0.55	0.07	0.01	0.04	0.0009	0.001
Calcium chloride (%)								
C0	0.401	13.63	34.00	3.63	4.80	5.19	0.090	0.104
C1	0.401	13.24	33.06	3.87	4.66	5.08	0.091	0.108
C2	0.400	12.85	32.11	4.11	4.57	4.99	0.095	0.111
C3	0.399	12.59	31.60	4.36	4.50	4.94	0.099	0.113
CD(P=0.05)	0.0005	0.15	0.39	0.05	0.009	NS	0.0007	0.001
Storage period								
S0	0.414	12.58	30.39	4.42	4.00	4.30	0.090	0.101
S1	0.404	13.00	31.90	4.10	4.29	4.68	0.092	0.108
S2	0.394	13.26	33.56	3.85	4.68	5.15	0.096	0.110
S3	0.385	13.48	34.92	6.60	5.57	6.08	0.096	0.114
CD(P=0.05)	0.0006	0.19	0.48	0.06	0.01	0.03	0.0008	0.001

Lowest starch rating was observed in the fruits of third harvest as compared to fruits of first harvest. Fruits treated with higher (0.75%) concentration of calcium chloride recorded higher starch iodine rating; the lowest reading was recorded in the untreated fruits. Delayed harvesting reduced the starch content of the fruit and during storage as well. Fruits treated with calcium chloride increased the starch content. The decrease in starch content may be attributed to the conversion of starch to soluble sugars with progress of time, Gangawar and Tripathi (1972) in peach, during storage. The retention of higher starch level in calcium chloride treated fruits could possibly be indicative of delay in starch transformation, Randhawa (1982) with Pathernakh

Acidity (% malic acid): Acidity of fruits decreased significantly with delayed harvesting. Fruits of third harvest recorded significantly lower acid content as compared to fruits of first harvest. Fruits treated with higher concentration of calcium chloride (0.75%) recorded significantly lower acid content as compared to untreated fruits; however there was significant difference in fruits treated with 0.75 and 0.5% calcium chloride.

With the advancement of storage period, the acid content of fruits significantly decreased and after 15 days of storage period the mean acid content of 0.385 % was recorded as against 0.414 % prior to storage. The higher acidity of fruits harvested early may be attributed to the fact that these fruit had reached to pre-climacteric stage (Magness, 1920) .With advancement in storage period, the acidity decreased. Claypool (1954), Li and Hansen (1964) in Bartlett pears and Bhat, etal, 2010 in Bartlett pear. Fruits treated with higher concentration of calcium chloride recorded significantly less acid content, which may be due to slow rate of respiration and fruit ripening, thus reducing the possibility of utilization of some of the acids in the process of respiration and conversion of some of these acids to sugars (Raese and Drake, 1993) with Anjou pears, (Farooq and Khajwal, 1999) with Bartlett.

Total soluble solids (%): TSS content of the fruits increased with the delayed harvesting. Significantly higher total soluble solid content was recorded in the fruits of third harvest as compared to fruits of first harvest. Significantly lower total soluble solid content was recorded in the fruits treated with higher concentration (0.75%) of calcium chloride as against untreated fruits, however no significant difference was observed in fruits treated with 0.75 and 0.50% calcium chloride.

TSS content of fruits was significantly affected by advance in storage period and after 15 days of storage; fruits recorded a TSS of 13.48 % as against 12.58 % recorded prior to storage.

TSS/Acid ratio: Delayed harvesting significantly increased the total soluble solids/acid ratio. Highest TSS/acid ratio was recorded in the fruits of third harvest.

However there was no significant difference between the fruits of first and second harvest. Higher concentration of calcium chloride (0.75%) treatment significantly decreased the TSS/acid ratio as compared to untreated fruits. TSS/acid ratio of fruits significantly increased with enhanced storage period and higher TSS/acid ratio was observed after 15 days of storage as compared to fruits stored earlier.

Reduced sugar (%): Table 2 revealed that reduced sugar significantly increased with the advanced storage period and in each delayed harvesting significantly increased the reduced sugar content of pear fruits. Significantly higher reducing sugar content was observed in fruits of third harvest as compared to those of first harvest.

Calcium chloride significantly reduced the reducing sugar content of pear fruits and significantly lower reducing sugar content was recorded in the fruits treated 0.75% calcium chloride as against in control. Reducing sugar content significantly increased with enhanced storage period and highest reducing sugar content was observed after 15 days of storage as compared to prior to storage.

Total sugars (%): Total sugar content of pear fruit increased significantly with delayed harvesting. Significantly higher sugar content was recorded in fruits of third harvest and lowest in fruits of first harvest.

Fruits treated with higher concentration of calcium chloride (0.75%) recorded lowest sugar content as against highest in the untreated fruits, however there was no significant difference between the fruits treated with 0.5 and 0.75% calcium chloride and between 0.25% and that of control.

Total sugar content of fruits increased significantly with the enhanced storage period and the highest content was observed after 15 days of storage. TSS, total and reducing sugars with increasing harvest dates may be attributed to the hydrolysis of polysaccharides to monosaccharides and concentration of juice as a result of moisture loss through transpiration. The results are in agreement with earlier reports on Satgudhi orange (Dalal *et al*, 1962). The lesser amounts of TSS, reducing sugars and total sugar content in calcium treated fruits may be due to less transpiration and respiration losses, resulting in slower hydrolysis of polysaccharides to monosaccharides, Tingwa and Young (1974), Wills (1979), Farooq and Khajwall (1999).

Peel calcium content: Peel calcium content of pear fruits increased significantly with delayed harvesting. Significantly higher peel calcium content was recorded in the fruits of third harvest and lowest peel calcium content was recorded in the fruits of first harvests. Fruits treated with higher concentration of calcium chloride (0.75%) significantly increased the peel calcium content as against lowest recorded in the untreated fruits. There was however no significant difference between the fruits treated with 0.25% calcium chloride and those of control.

Peel calcium content of pear fruits increased significantly with the enhanced storage period. Significant increase in peel calcium content was observed on each day of sampling and highest peel calcium content was observed after 15 days of storage.

Flesh calcium content: Flesh calcium content in pear fruits increased significantly with delayed harvesting. Significantly higher flesh calcium content was recorded in the fruits of third harvest as compared to first harvest. Fruits treated with higher concentration of calcium chloride (0.75%) significantly increased the flesh calcium content as compared to untreated fruits; there was however no significant difference in flesh calcium content of fruits treated with 0.5 and 0.75% calcium chloride. Flesh calcium content of pear fruits increased significantly with the enhanced storage period. Significant increase in flesh calcium content was observed in each sampling date and highest flesh calcium content was observed after 15 days storage period and lowest was recorded prior to storage. The higher calcium content in late harvested fruits as compared to those picked earlier may perhaps be due to the incessant accumulation of metabolites including Ca in the late harvested fruits on the trees up to optimum level, the flow of which seems to have disrupted in case of fruits picked earlier. Higher calcium content in peel and flesh in treated fruits seems to have resulted in stronger intracellular organisation and rigid cell walls (Legge *et al*, 1982). Treated fruits are less susceptible to rotting, thereby have less spoilage. Peel and flesh calcium content increased throughout the storage period. The flesh calcium content of the fruit was more than that of peel calcium content, which may be due to migration of calcium from peel to inner regions during storage period, Betts and Bramlage (1977) in McIntosh apples. It may be concluded that at 110 and 115 DAFB and treated with 0.5 and 0.75% calcium chloride retained all the physico-chemical characteristics and enhanced the storage life.

Conclusion

Thus the fruits treated with calcium chloride showed delayed colouration, improved, fruit firmness, organoleptic rating, TSS, sugars , both peel and flesh calcium content and reduced physiological loss in weight, spoilage and acidity. After 15 days of storage period, fruit colour, physiological loss, spoilage, organoleptic rating increased and fruit firmness decreased. Comparatively, TSS, sugars, starch content, calcium content (both peel and flesh) increased and the acid content decreased. Fruits harvested 110 and 115 DAFB and treated with calcium chloride at 0.5 and 0.75% retained all the Physico-chemical characteristics and enhanced the storage and keeping quality.

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