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Effect of pre-storage application of diphenylamine (DPA) on storage life and quality of pear fruits

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ABSTRACT

Pear fruits of cultivar 'Patharnakh' were harvested at physiological mature stage and treated with different concentration of DPA (500, 1000, 1500 ppm) each for five minutes After treatment the fruits were air dried and packed in corrugated fibre board cartons and stored at 0-1^{0}C and 90-95% RH. A control lot, without any treatment, was also kept under same conditions for comparison. The data revealed that fruits treated with DPA (1500 ppm) recorded minimum weight loss, maintained acceptable firmness and quality attributes till 75 days of storage, as compared to control which could be stored for 60 days. An increase in storage life of pear fruits with DPA (1500 ppm) treatment can be a useful tool for regulating the marketing of pear fruits, which in turn will help in boosting the economy of pear growers.

Key Words: Pear, DPA, post-harvest treatments, cold storage, quality

INTRODUCTION

In India pear is grown from warm humid sub-tropical plains to cold dry temperate regions occupying an area of 38,600 ha with an annual production of 1.76 lakh MT (Anonymous, 2). 'Patharnakh' is the leading cultivar of pear, which is predominantly grown in Punjab state. The fruits of this cultivar are liked very much by the consumers due to its juicy pulp and crisp texture. The harvesting of Patharnakh pear starts in the third weak of July and continues up to the end of August. Generally, this period coincides with heavy rainfall and high temperature, which interferes with post-harvest quality and marketability of the fruits. Hence, the farmers are forced to sell their produce during this period at throw-away prices, which, creates glut in the market, resulting in huge post-harvest losses.

In recent years, interest has developed to arrest ripening changes and senescence by using inhibitors of ethylene biosynthesis/ action. Ideally, its effects should be reversed by treatment with ethylene (McGlasson, 10). These inhibitors are said to play an important role in modulating the process of maturation and ripening by affecting the change in fruits firmness brought about by change in cellular events, thereby increasing the storage life of the fruits. DPA is commercially used in U.S. and Europe on many cultivars of apple and pear as postharvest treatment against scald. Therefore, the bio-efficacy of this compound need to be tested on Asian pears particularly on 'Patharnakh' grown under Punjab conditions in order to improve its market quality and storeability.

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MATERIALS AND METHODS

The fruits of pear cv. Patharnakh were harvested at physiological maturity, when fruits attained light green colour. The bruised and diseased fruits were sorted out and only healthy, uniform sized fruits were selected for the present studies. The fruits were treated with different concentrations of DPA viz. 500 ppm, 1000 ppm and 1500 ppm solution each for five minutes. After treatment, the fruits were packed in corrugated fibre board boxes and stored in walk-in cold-room maintained at 0- 1°C and 90-95% RH. There were four treatments and three storage intervals. The experiment was laid out in completely randomized design with three replications for each treatment and each interval. The observations on various physico-chemical attributes were monitored initially after 45 days of storage and thereafter, at fortnightly interval till 90 days. The physiological loss in weight (PLW) of the fruits was calculated on initial weight basis and expressed in per cent. The fruit firmness was measured with the help of 'Penetrometer' (Model FT-327) using a probe of 8 mm in diameter and results expressed in terms of lb force. The sensory quality of the fruit was determined by a panel of ten judges using 'Hedonic scale' (1-9 points) as described by Amerine et al (1). The total soluble solid (TSS) of the juice was determined with the help of a Erma Hand Refractometer,

and expressed in percent after making the temperature correction at 20°C.The total sugars and titratable acidity was estimated as per standard AOAC procedure (3).

RESULTS AND DISCUSSION

The per cent PLW, in general, increased with the advancement in storage period rather slowly in the beginning but at a faster pace as the storage period advanced (Table 1). During different storage intervals, DPA (1500 ppm) registered the lowest weight loss ranged between 1.3 to 7.6 per cent from 45 to 90 days of cold storage, respectively as compared to control where PLW ranged from 3.9 to 10.4 per cent during same intervals. A slight shriveling was observed on pear fruits above 6% weight loss and it was considered as cut off limit for deciding the quality of pear fruits on the basis of weight loss. Keeping this limit in view, DPA (1500 ppm) treated fruits recorded 5.6% weight loss after 75 days of storage and the corresponding value for untreated fruits was 5.3% after 60 days of storage. The reduction in weight loss in DPA treated fruits may be attributed to delay in respiration rate and maintenance of tissue rigidity of the fruits. Farooqi and Hall (5) observed that wax coatings containing diphenylamine (DPA) reduced weight loss from apples and pears in storage, kept the fruit firmer and greener, improved its external appearance and significantly reduced rates of respiration and ethylene production

Fruit firmness, in general, followed a declining trend commensurate with advance in storage period (Table 1). The fruits treated with different concentrations of DPA maintained higher firmness as compared to control at all storage intervals. The fruit treated with DPA (1500 ppm) maintained higher fruit firmness throughout the stipulated storage period of 90 days which ranged between 14.1 to 11.3 lb force as compared to other treatments. On the other hand, the control fruits experienced the faster loss of firmness during storage and ranged between 13 to 8.7 lb force, thereby leading

Table 1. Effect of pre-storage treatment of DPA on PLW and firmness of pear fruits during storage.

Treatments	Days after storage										
	PLW (%)					Firmness (lb force)					
	45	60	75	90	Mean	0	45	60	75	90	Mean
DPA 500 ppm	2.2	4.1	6.9	8.4	5.4	16.75	13.6	12.4	10.9	9.6	11.6
DPA 1000 ppm	2.0	3.8	6.3	8.3	5.1	-	13.6	12.6	11.3	10.0	11.9
DPA 1500 ppm	1.3	2.5	5.6	7.6	4.3	-	14.1	13.4	12.2	11.3	12.8
Control	3.9	5.3	7.9	10.4	6.9	-	13.0	12.2	10.2	8.7	11.0
Mean	2.4	3.9	6.7	8.7		-	13.6	12.7	11.2	9.9	
CD (0.05)	Treatment(T) = 1.26						Treatment(T) = 0.66				
	Storage(S) = 0.84						Storage(S) = 0.45				
	TxS = 2.50						TxS = 1.30				

Table 2. Effect of pre-storage treatment of DPA on sensory quality and spoilage of pear fruits during storage.

Treatments	Days after storage										
	Sensory Quality						Spoilage (%)				
	0	45	60	75	90	Mean	45	60	75	90	Mean
DPA 500 ppm	4.5	6.3	7.6	7.6	5.6	6.8	0.0	5.1	9.0	13.0	6.8
DPA 1000 ppm	-	6.3	7.5	7.8	6.2	7.0	0.0	0.0	6.1	11.2	4.3
DPA 1500 ppm	-	6.2	7.5	8.0	6.4	7.0	0.0	0.0	6.4	9.10	3.9
Control	-	7.8	8.0	5.7	4.4	6.5	0.0	7.0	15.3	24.0	11.6
Mean	-	6.7	7.7	7.3	5.7		0.0	3.0	9.2	14.3	
CD (0.05)	Treatment(T) = 0.40						Treatment(T) = 2.16				
	Storage(S) = 0.24						Storage(S) = 1.57				
	TxS = 0.90						TxS = 4.50				

to excessive softening and shriveling of fruits. The pear fruits attained best eating quality at 12-14 lbs force pressure (Mahajan and Dhatt, 7). DPA (1500 ppm) treated pear fruits were able to retain this much firmness up to 75 days of storage, as compared to 60 days in untreated fruits. Softening of fruits is caused either by breakdown of insoluble protopectins into soluble pectin or by hydrolysis of starch (Mattoo *et al.,* 9). The loss of pectic substances in the middle lamella of the cell wall is perhaps the key steps in the ripening process that leads to the loss of cell wall integrity thus cause loss of firmness and softening (Solomos and Laties, 12). The maintenance of higher firmness as a result of DPA may be due to their ability to prevent the physiological weight loss during storage and to inhibit/delay ethylene production and/or action in different fruits (Farooqi and Hall, 5).

Initially, the control fruits recorded the highest sensory score (8.0) after 60 days of storage and fruits were rated as very much acceptable but thereafter sudden decline in sensory quality was noticed and fruits registered a score of 5.7 and 4.4 after 75 and 90 days of storage, respectively and rated as slightly desirable to neither desirable nor undesirable (Table 2). The fruits treated with DPA (1500 ppm) showed the highest sensory quality (8.0) after 75 days of cold storage and the fruits were rated as very much desirable. Bauchot and John (4) observed that DPA was the most effective treatment in maintaining the acceptable quality of apple during storage.

The spoilage of fruits progressed gradually during storage and ranged between 5% to 24% as a result of different treatments and storage intervals (Table 2). However DPA (1500 ppm) application proved effective in lowering the spoilage of fruits as compared to control and other treatments. Sandhu et al (11) reported Kinnow fruits treated with DPA did not show any rotting and maintained desired quality during storage.

The TSS content increased slowly and steadily up to 75 days of storage and thereafter declined gradually in DPA treated fruits (Table 3). On the other hand, in control, the TSS content increased up to 60 days and thereafter sharp decline was noticed indicating rapid metabolic breakdown in these fruits. DPA (1500 ppm) treated fruits recorded the highest TSS content (13.9%) after 75 days of storage and thereafter TSS content declines but fruits maintained the highest TSS (12.8%) even after 90 days of storage. The control fruits registered the highest TSS content after 60 days of storage (13.4%) as compared to treated fruits and thereafter declined at a faster pace and recorded the lowest TSS as compared to treated fruits. The similar trend was noticed in case of total sugars content (Table 1). The highest total sugars

Table 3. Effect of pre-storage treatment of DPA on TSS, total sugars and acidity of pear fruits during storage.

Treatments	Days after storage																	
	TSS (%)						Total Sugars (%)						Acidity (%)					
	0	45	60	75	90	Mean	0	45	60	75	90	Mean	0	45	60	75	90	Mean
DPA 500 ppm	12.0	12.4	13.0	13.4	12.3	12.8	7.62	8.2	8.4	8.5	6.9	8.0	0.38	0.32	0.30	0.26	0.23	0.3
DPA 1000 ppm	-	12.2	12.8	13.5	12.5	12.8	-	8.0	8.4	8.6	7.1	8.0	-	0.33	0.29	0.27	0.23	0.3
DPA 1500 ppm	-	12.3	13.0	13.9	12.8	13.0	-	7.9	8.3	8.9	7.7	8.2	-	0.36	0.33	0.31	0.28	0.3
Control	-	12.7	13.4	12.3	11.2	12.4	-	8.4	8.7	7.9	6.4	7.9	-	0.30	0.28	0.25	0.23	0.3
Mean		12.4	13.1	13.3	12.2			8.1	8.5	8.5	7.0			0.33	0.30	0.27	0.24	
CD (0.05)	Treatment(T) =0.25 Storage(S) = 0.11 TxS = 0.56						Treatment(T) = 0.18 Storage(S) = 0.09 TxS = 0.30						Treatment(T) = NS Storage(S) = 0.09 TxS = NS					

(8.9%) was noticed in DPA (1500 ppm) treated fruits after 75 days of storage and declined thereafter, while the untreated fruits recorded the maximum total sugars (8.7%) after 60 days of storage and decreased afterwards. The increase in TSS and sugars during storage may possibly be due breakdown of complex organic metabolites into simple molecules or due to hydrolysis of starch into sugars, on complete hydrolysis of starch no further increase in sugars occurs and subsequently a decline in these parameters is predictable as they along with other organic acids are primary substrate for respiration (Wills *et al.,* 13). In DPA treated fruits, the increase in TSS and total sugars up to 75 days and gradual declined thereafter as compared control fruits where increase in TSS and sugars was noticed up to 60 days and sharp decline thereafter, indicating the possible role of DPA in delaying metabolic activity of fruits during ripening and storage (Mahajan and Chopra, 8).

The acidity of pear fruits experienced a linear decline as the storage period advanced (Table 3). However, the loss of acidity during storage was gradual in DPA treated fruits whereas, it declined at faster pace in case of control fruits. The highest mean acidity content ranged between 0.36-0.28% in DPA (1500 ppm) treated fruits, whereas, it was lowest in the control fruits it ranged between 0.30-0.23percent. The decrease in titratable acids during storage may be attributed to marked increase in malic

Table 4. Effect of different pre-storage treatments on physiological loss in weight (PLW), firmness and sensory quality of pear cv. Patharnakh during post-cold storage at ambient shelf life.

Treatment	Storage interval (days)								
	45			60			75		
	3*	6*	Mean	3*	6*	Mean	3*	6*	Mean
				PLW (%)					
DPA 500 ppm	4.70	6.51	5.61	6.03	8.72	7.38	8.46	9.98	9.22
DPA 1000 ppm	4.51	6.19	5.35	5.99	8.43	7.21	7.95	10.06	9.01
DPA 1500 ppm	3.70	5.69	4.70	4.91	7.70	6.31	6.19	9.88	8.04
Control	5.71	7.49	6.60	6.20	9.52	7.86	10.44	11.96	11.20
Mean	4.66	6.47		5.78	8.59		8.26	10.47	
CD (0.05)	Treatment (T) = 0.24			Treatment (T) = 0.29			Treatment (T) = 0.50		
	Storage (S) = 0.11			Storage (S) = 0.13			Storage (S) = 0.22		
	T x S = 0.34			T x S = 0.42			T x S = 0.70		
				Firmness (lb force)					
DPA 500 ppm	12.82	12.29	12.56	11.45	10.59	11.02	10.10	9.53	9.82
DPA 1000 ppm	12.74	11.44	12.09	11.52	10.60	11.06	10.71	9.36	10.04
DPA 1500 ppm	13.63	12.36	13.00	12.24	11.00	11.62	11.55	10.43	10.99
Control	12.32	11.36	11.84	11.01	10.08	10.55	8.72	6.50	7.61
Mean	12.88	11.86		11.56	10.57		10.27	8.96	
CD (0.05)	Treatment (T) = 0.62			Treatment (T) = 0.52			Treatment (T) = 0.69		
	Storage (S) = 0.28			Storage (S) = 0.23			Storage (S) = 0.31		
	T x S = 0.88			T x S = NS			T x S = NS		
				Sensory Quality					
DPA 500 ppm	6.98	7.56	7.27	7.23	6.45	6.84	6.45	6.09	6.27
DPA 1000 ppm	6.75	7.68	7.22	7.56	6.56	7.06	6.48	6.13	6.31
DPA 1500 ppm	6.65	7.78	7.22	8.08	7.89	7.99	7.80	6.45	7.13
Control	8.02	6.45	7.24	7.68	5.56	6.62	5.12	4.26	4.69
Mean	7.10	7.37		7.64	6.62		6.46	5.73	
CD (0.05)	Treatment (T) = 0.10			Treatment (T) = 0.24			Treatment (T) = 0.10		
	Storage (S) = NS			Storage (S) = 0.11			Storage (S) = 0.05		
	T x S = 0.14			T x S = 0.35			T x S = 0.14		

*Post cold storage shelf life

acid utilization during ripening (Hulme, 6). Visai *et al.* (13) noticed that apple fruits treated with DPA followed by storage under ultra low oxygen conditions maintained high acidity as compared to untreated fruits.

The pear fruits under all the treatments were taken out regularly at a storage interval of 45,60 and 75 days and kept at ambient temperature(28-30°C) and relative humidity of 65-70% in order to simulate changes during retail market (Table 4 and 5). During ambient retail marketing conditions, a considerable loss in weight, firmness and quality was noticed irrespective of all treatments but the overall behaviour of pear fruits treated with DPA (1500 ppm) was significantly better as compared to other treatments. Keeping all marketable parameters in view, it was observed that pear fruits treated with DPA (1500 ppm) can be kept at ambient condition up to 3 days after 75 days of cold storage, whereas, the control fruits registered 3 days of shelf life at ambient conditions after 60 days of cold storage.

From the present studies it can be concluded that 'Patharnakh' pear fruits treated with DPA (1500 ppm) can be stored for 75 days in cold storage with 3 days shelf life at ambient temperature. The fruits maintained highly acceptable sensory quality, crispness and biochemical traits during storage and shelf life. The postharvest application of DPA on Pathanakh pear fruits seems to hold promise in extending the marketable period.

Table 5. Effect of different pre-storage treatments on TSS, total sugars and acidity of pear cv. Patharnakh during post-cold storage at ambient shelf life.

Treatment	Storage interval (days)								
	45			60			75		
	3*	6*	Mean	3*	6*	Mean	3*	6*	Mean
				TSS (%)					
DPA 500 ppm	12.66	13.27	12.97	13.78	13.11	13.45	12.54	12.24	12.39
DPA 1000 ppm	12.83	13.18	13.01	13.45	13.16	13.31	13.01	12.67	12.84
DPA 1500 ppm	12.66	13.25	12.96	13.58	13.97	13.78	14.08	13.38	13.73
Control	13.17	13.42	13.30	12.95	12.15	12.55	11.98	11.55	11.77
Mean	12.83	13.28		13.44	13.10		12.90	12.46	
CD (0.05)	Treatment (T) = 0.27			Treatment (T) = 0.30			Treatment (T) = 0.39		
	Storage (S) = 0.12			Storage (S) = 0.13			Storage (S) = 0.17		
	T x S = 0.38			T x S = 0.42			T x S = NS		
				Total Sugars (%)					
DPA 500 ppm	8.21	8.66	8.44	8.53	8.70	8.62	8.21	7.89	8.05
DPA 1000 ppm	8.31	8.69	8.50	8.66	8.79	8.73	8.39	7.97	8.18
DPA 1500 ppm	8.21	8.72	8.47	8.79	9.08	8.94	9.16	8.57	8.87
Control	8.66	9.04	8.85	8.55	8.06	8.31	7.68	7.46	7.57
Mean	8.35	8.78		8.63	8.66		8.36	7.97	
CD (0.05)	Treatment (T) = 0.24			Treatment (T) = 0.27			Treatment (T) = 0.33		
	Storage (S) = 0.11			Storage (S) = 0.12			Storage (S) = 0.15		
	T x S = NS			T x S = 0.38			T x S = NS		
				Acidity (%)					
DPA 500 ppm	0.28	0.27	0.28	0.27	0.25	0.26	0.23	0.21	0.22
DPA 1000 ppm	0.30	0.26	0.28	0.27	0.25	0.26	0.25	0.22	0.24
DPA 1500 ppm	0.33	0.27	0.30	0.31	0.24	0.28	0.27	0.26	0.26
control	0.28	0.26	0.27	0.26	0.24	0.25	0.23	0.21	0.22
Mean	0.30	0.27		0.28	0.25		0.25	0.23	
CD (0.05)	Treatment (T) = 0.02			Treatment (T) = 0.02			Treatment (T) = 0.02		
	Storage (S) = 0.01			Storage (S) = 0.01			Storage (S) = 0.01		
	T x S = 0.03			T x S = 0.03			T x S = NS		

* Post cold storage shelf life

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