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ORIGINAL ARTICLE

Effect of 1-methylcyclopropene (1-MCP) on storage life and quality of pear fruits

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Abstract Pear (*Pyrus pyrifolia* (Burm) Nakai) fruits of cultivar 'Patharnakh' were harvested at optimum maturity and treated with 500, 750 and 1000 ppb concentration of 1-MCP gaseous vapours for 4 h in a closed chamber maintained at 20°C. After treatments the fruits were packed in corrugated fibre board cartons and stored at 0–1°C and 90–95% RH. Fruits treated with 1000 ppb 1-MCP recorded minimum weight loss, maintained acceptable firmness and quality attributes till 75 days of storage. The stored fruits also retained post-storage shelf life for 3 days at ambient conditions (30–35°C and 60–65% RH) and 6 days at supermarket conditions (20°C and 85–90% RH).

Keywords Pear . 1-Methylcyclopropene . Cold storage . Shelf-life . Quality

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Introduction

In India pear is grown in warm humid sub-tropical plains and cold dry temperate regions occupying an area of 38,600 ha with an annual production of 1.76 lakh MT (Anon 2006). '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 (Dhatt et al. 2003). Hence, the farmers are forced to sell their produce during this period at very low prices. Storage of fruits at optimum temperature and relative humidity (RH) coupled with safe post-harvest treatments not only regulate the market supply but also protect fruits from various losses (Fan et al. 2002).

1-Methylcyclopropene (1-MCP) is a new inhibitor of ethylene action in fruits for extending shelf life by blocking ethylene receptors (Sisler and Serek 1997). It is being commercially used in U.S. and Europe on many cultivars of apple, pear and other horticultural crops (Mitchem 2001).Therefore, an attempt was made to test the efficacy of this compound on 'Patharnakh' pear grown under Punjab conditions on its storage life as well as quality.

Materials and methods

The fruits of pear (*Pyrus pyrifolia* (Burm) Nakai) cv. 'Patharnakh' were harvested at physiological maturity, when fruit attained light green colour. The bruised and diseased fruits were sorted out and only healthy, uniform sized fruits were selected. The fruits were exposed to 0 (control) 500, 750 and 1000 ppb 1-MCP gaseous vapours in an air tight chamber maintained at 20°C for 4 h. 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. The experiment was laid out in completely randomized design with 3 replications. The observations on various physico-chemical attributes were monitored initially after 45 days of storage and thereafter, at fortnightly interval till 90 days of storage. 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, Italy) 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 10 judges using 'Hedonic scale' (1–9 points) as described by Amerine et al. (1965). The total soluble solids (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 were estimated as per standard AOAC (1990) methods.

Results and discussion

The PLW, in general, increased during storage rather slowly in the beginning but at a faster pace later (Table 1). The lowest PLW (3.9 %) was observed in fruits treated with 1000 ppb 1-MCP which was found to be statistically significant as compared to other treatments. On the other hand, the highest PLW (6.8%) was in control fruits. During different

Table 1 Effect of 1-methylcyclopropene (1-MCP) on physiological and biochemical changes in pear during cold storage (0–1°C, 90–95% RH)

Storage period, days	1-MCP, ppb				CD (p>0.05) n =3
	0	500	750	1000	
Physiological loss in weight, %					
45	3.9	2.0	1.5	1.1	
60	5.2	3.0	2.4	2.0	T = 0.3
75	7.9	6.0	5.6	5.1	S = 0.2
90	10.3	7.9	7.6	7.4	TxS= 0.6
Firmness, lb force					
45	13.0	13.9	14.1	14.7	
60	12.2	13.1	13.3	13.8	T = 0.3
75	10.2	11.8	11.9	12.6	S = 0.2
90	8.7	10.6	10.8	11.5	TxS = 0.6
Sensory quality					
45	7.8	6.7	6.3	6.2	
60	8.0	7.7	7.6	7.5	T = 0.06
75	5.6	7.7	8.0	8.3	S = 0.04
90	4.4	6.1	6.4	6.5	TxS = 0.12
Acidity, %					
45	0.30	0.33	0.34	0.36	
60	0.28	0.31	0.32	0.35	T = 0.02
75	0.25	0.29	0.29	0.32	S = 0.02
90	0.23	0.25	0.27	0.28	TxS = NS
Total soluble solids, %					
45	12.7	12.5	12.5	12.2	
60	13.4	13.3	13.2	13.1	T = 0.3
75	12.3	13.6	13.8	14.0	S = 0.2
90	11.1	13.0	13.2	13.7	TxS = 0.6
Total sugars, %					
45	8.3	8.3	8.2	8.1	
60	8.6	8.5	8.5	8.4	T = 0.3
75	7.9	8.6	8.7	9.1	S = 0.2
90	6.4	7.2	7.3	7.8	TxS = NS

T = Treatment, S = Storage period

storage intervals, 1-MCP treatment (1000 ppb) registered the lowest weight loss, which ranged from 1.1 to 7.4% during 45 to 90 days of cold storage, respectively as compared to control where PLW ranged from 3.9 to 10.3% during the same intervals. Slight shriveling was observed on those pear fruits which had > 6% weight loss and it was considered as cut off limit for deciding the quality of pear fruits. Keeping this in view, 1000 ppb 1-MCP treated fruits recorded 5.1% weight loss after 75 days of storage and the corresponding value for untreated fruits was 5.2% after 60 days of storage. The reduction in weight loss in 1-MCP treated fruits may be attributed to slow respiration rate (Dong et al. 2002) and maintenance of tissue rigidity of the fruits.

Fruit firmness, in general, followed a declining trend during storage (Table 1). The treated fruits maintained higher firmness as compared to control at all storage intervals. The maximum mean fruit firmness (13.1 lb force) was in fruits treated with 1000 ppb 1-MCP. The pear fruits attained best eating quality at 12-14 lb force pressure (Mahajan and Dhatt 2004). 1-MCP (1000 ppb) treated pear fruits retained this firmness up to 75 days of storage, as against 60 days in untreated fruits. Softening of fruits is caused either by breakdown of insoluble protopectin into soluble pectin or by hydrolysis of starch (Mattoo et al. 1975). The loss of pectic substances in the middle lamella of the cell wall is perhaps the key step in the ripening process that leads to the loss of cell wall integrity thus causing loss of firmness and softening (Solomos and Laties 1973). The maintenance of higher firmness as a result of 1-MCP treatment may be due to its ability to prevent PLW during storage and to inhibit/delay ethylene production (Jiang et al. 2001, Dong et al. 2002). 1-MCP has been reported to delay softening in avocado, custard apple, mango and papaya (Hofman et al. 2001).

The sensory quality score was highest (7.1) in fruits treated with 1000 ppb 1-MCP. The control fruits recorded the lowest score (6.4). 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 5.6 and 4.4 after 75 and 90 days of storage, respectively (Table 1). The fruits treated with 1000 ppb 1-MCP showed the highest sensory quality (8.3) after 75 days of cold storage. The improvement in palatability rating of guava with 1-MCP treatment has been reported by Bassetto et al. (2005) and Mahajan and Singh (2008).

The acidity of pear fruits declined during storage slower in 1-MCP treated fruits and faster in control fruits (Table 1). The highest acidity content (0.33%) was in 1000 ppb 1-MCP treated fruits, whereas, it was lowest (0.27%) in control fruits. The decrease in titratable acids during storage may be attributed to marked increase in malic acid utilization during ripening (Hulme 1971). The fruits treated with 1-MCP maintained higher acidity during storage probably due to delay in ripening process. Fan et al. (2002) observed lower acidity loss during storage in peach treated with 1-MCP.

The TSS content increased slowly up to 75 days and thereafter declined gradually in 1-MCP treated fruits (Table 1). In control, the TSS content increased up to 60 days and thereafter sharp decline was noticed indicating rapid metabolic breakdown in these fruits. 1-MCP treated (1000 ppb) fruits recorded highest TSS content (14.1%) after 75 days of storage and thereafter TSS content declines but fruits maintained higher TSS (13.7%) even after 90 days of storage. Similar trend was also noticed in total sugar contents (Table 1). 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 occurred and subsequently a decline in these parameters is evident as they along with other organic acids are primary substrate for respiration (Wills et al. 1980).

The data on post cold storage shelf life of pear fruits at 30–35°C and 60–65% RH (ambient condition) and at 20°C and 85–90% RH (supermarket conditions) revealed that 1000 ppb 1-MCP treated fruits recorded minimum weight loss, highest firmness, highly acceptable sensory quality, highest TSS, total sugars and acidity as compared to control fruits (Table 2). The fruits treated with 1000 ppb 1-MCP can be stored for 75 days in cold storage with 3 days under ambient conditions or 6 days under super market conditions.

Table 2 Effect of 1-methylcyclopropene (1-MCP) on quality of pear fruits during post storage shelf life at ambient and super market conditions after 75 days of cold storage

1-MCP, ppb	PLW,%		Firmness, lb force		Sensory quality		TSS,%		Total sugars ,%		Acidity,%	
	3*	6**	3*	6**	3*	6**	3*	6**	3*	6**	3*	6**
500	6.9	6.6	10.8	11.2	7.0	7.0	13.5	13.5	8.8	8.5	0.25	0.22
750	6.5	6.0	10.9	11.2	7.5	7.6	13.9	13.8	9.0	8.6	0.27	0.22
1000	6.0	5.5	11.5	12.0	8.0	8.0	14.2	14.5	9.2	9.8	0.29	0.26
0	10.4	9.0	8.7	9.1	5.1	5.2	11.9	12.0	7.6	7.6	0.23	0.20
CD (p>0.05) n=3	0.4	0.3	0.2	0.2	0.3	0.2	0.1	0.4	0.5	0.7	NS	NS

PLW = Physiological loss in weight, TSS = Total soluble solids

Post cold storage shelf life of 3* days at 30–35°C, 60–65% RH (ambient) and 6** days at 20°C and 85–90% RH (supermarket)

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