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Effect of 1-MCP on shelf-life and quality of kiwifruit stored under ambient conditions

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ABSTRACT

The study was conducted to observe the effect of different concentrations of 1-MCP on post-harvest life and quality of kiwifruit. Kiwifruits cv. Allison were treated for 24 h at 20°C with different concentrations of 1-methylcyclopropene (0.5, 1, 2 µl/l) and un-treated fruits served as control. The fruits were transferred to ambient storage (22 ± 4°C; 65-70% RH) after treatments, and observations on different quality parameters were recorded at 3-day interval. The results indicated that all concentrations of 1-MCP influenced PLW, fruit firmness and decay loss in kiwifruit but 2 µl/l concentration was the most effective. PLW in untreated fruits was very high (18.6%) in comparison to 1-MCP treated fruits at the end of 18th day of storage, and 1-MCP (2.0 µl/l) treated fruit were much firmer (31.7 N) than untreated fruit (8.4 N). Fruits treated with 1-MCP (2.0 µl/l) showed the least (8.2%), and untreated fruits the highest fruit decay (22.2%) at the end of storage. TSS in the untreated fruits showed sudden increase on 6th day (12.5%), which increased up to 12th day (16.8%) and declined thereafter (15.7%), whereas in 1-MCP (2 µl/l) treated fruits, it increased sharply from 15th day. 1-MCP (2 µl/l) treated fruit retained ascorbic acid better than other treatments and control. Total acidity and titratable acidity decreased during storage without any significant difference among the treatments. Thus, it could be concluded that 1-MCP (2 µl/l) treated kiwifruits could be stored for 18 days at ambient conditions without much loss in fruit quality.

Key words: 1-MCP, firmness, decay, quality parameters.

INTRODUCTION

Kiwifruit (*Actinidia deliciosa*) is commercially cultivated in many countries of the world and was introduced in India during early sixties. However, its importance was realized only recent years, primarily because of its sweet-sour taste, nutritional value and unique appearance. The fruit is an excellent source of potassium and vitamin C and has low sugar content. Hence, it is an ideal fruit for diabetic, hypertension and asthma patients (Chattopadhay, 4). There has been sizeable increase in the area and production of kiwifruit in India during recent years. Several varieties are grown in India but Hayward and Allison dominate, though Hayward is shy bearer under Indian conditions. Thus, preference is given for growing Allison in several parts of hilly states of the country.

It usually matures by last week of October or first week of November in the mid hill conditions of India, depending upon the elevation, temperature and other climatic conditions. After harvesting the fruit at full maturity, it does not show rapid changes for about a week at room temperature (Chattopadhay, 4). However, after a week, it starts ripening at a faster rate and deteriorates, thereby limiting its shelf-life for about 3-4 days only after ripening. Thus, there is an urgent need to develop a protocol for extending its shelf-life so as to make it available in the market for a longer period. 1-MCP is an ethylene action inhibitor, can prevent several ethylene-dependent responses in perishable horticultural commodities (Blankenship and Dole, 2; Schotsmans *et al.*, 12). By inhibiting ethylene production, 1-MCP delays softening in many fruits (Schotsmans *et al.*, 12). Very little efforts in the country have been made on regulation of kiwifruit ripening under ambient conditions. Therefore, a study has been undertaken to prolong the shelf-life of 1-MCP treated kiwifruit under ambient conditions.

MATERIALS AND METHODS

Kiwifruit cv. Allison were procured from the orchard of Dr Y.S. Parmar University of Horticulture and Forestry, Solan, H.P. after harvesting the fruits at appropriate maturity (TSS - 6.2°B), they were sorted, graded, packed in corrugated fibre board boxes (CFB) cushioned with paper shavings, and transported to the Division of Postharvest Technology, IARI, New Delhi. In the laboratory, fruits were sorted again to remove bruised and defective ones. Fruits were then treated with different concentrations of 1-MCP (0.5, 1.0 and 2.0 µl/l). The untreated fruits served as control.

For the treatment with 1-MCP, fruits were divided into four lots of 60 fruits each and were replicated three times. The required amount of 1-MCP was weighed

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and dissolved in small quantity of distilled water in a test tube (10 ml) sealed with a rubber septum. The gas so released was drawn and injected into 7 l capacity air tight plastic containers in which known number of fruits (60) were kept. These plastic containers were then kept in air-cooled chamber maintained at 20°C for 24 h. The control fruits were also kept in air sealed containers for 24 h. Next day, the plastic containers were opened and fruits were stored at room temperature (22 ± 4°C and 65-70% RH) in open plastic crates.

The observations on physical parameters (physiological loss in weight, fruit decay and fruit firmness) and quality parameters (total soluble sugars, total sugars, titratable acidity, and ascorbic acid) were recorded at 3 day interval up to 18 days of storage. The PLW was measured by subtracting the initial weight from final weight and expressed as percentage. Similarly, decay loss was determined by counting the rotten fruits, divided by total fruits and expressed as percentage. Fruit firmness was determined using a texture analyzer (model TA + Di, Stable Micro Systems, UK) using compression test. The sample was compressed using a cutting and puncture probes by pre test (5 mm/sec), test speed (0.5 mm/sec) and post test speed (10 mm/sec), and the data was expressed in Newtons (N).

The total soluble solids in samples were estimated using Fisher Scientific hand refractometer and expressed as °Brix at 20°C. Total sugars were determined in lead-free aliquot by titrating it against boiling Fehling's solution (Ranganna, 11). Titratable acidity was determined as described per Ranganna (11). By titrating known amount of fruit sample was titrated with 0.1 N NaOH using a few drops of phenolphthalein solution (1%) as indicator. Ascorbic acid content was determined as per method described by Ranganna (11). The experiment was laid out in factorial CRD design with each treatment consisting of 60 fruits with three replications. The data obtained was statistically analysed (Panse and Sukhatme, 10).

RESULTS AND DISCUSSION

There was a steady increase in physiological loss in weight (PLW) of fruits with the increase in the storage period. In general, PLW increased steadily in 1-MCP treated fruits with the increase in the storage period, whereas in untreated fruits the PLW showed sharp increase. Further, untreated fruits showed quite high PLW (12.5%) on 12th day of storage, whereas fruits treated with 1-MCP (2 µl/l) had lower PLW (9.3%) even on 18th day of storage (Fig. 1). The significant effect of 1-MCP on PLW reduction may be attributed to its effect on reduction in respiration and transpiration rate. These findings are in conformity with the findings of Bassetto *et al.* (1), and Singh and Pathak (14) who reported delay in weight loss in 1-MCP treated avocado, and mango, respectively.

1-MCP treated fruits had better firmness than untreated fruits. Among different treatments, fruits treated with 1-MCP (2 µl/l) showed highest firmness (49.8 N) followed by treatment of 1 µl/l (41.6 N) and 0.5 µl/l (35.9 N) (Fig. 2). Fruit firmness decreased sharply with the increase in storage period from 3rd day (61.8 N) to 18th day (19 N) of storage. Untreated fruits showed very less firmness (14.5 N) on 12th day which decreased further to (8.2 N) on 18th day, whereas 1-MCP (2 µl/l) treated fruits were quite firmer (31.7 N) on 18th day of storage (Fig. 2). Since 1-MCP is known to delay senescence by blocking the evolution of ethylene, it thereby inhibited fruit softening (Blakenship and Dole, 2; Jeong *et al.*, 7). Thus, due to lesser softening, 1-MCP treated fruits retained firmness for a longer period than untreated

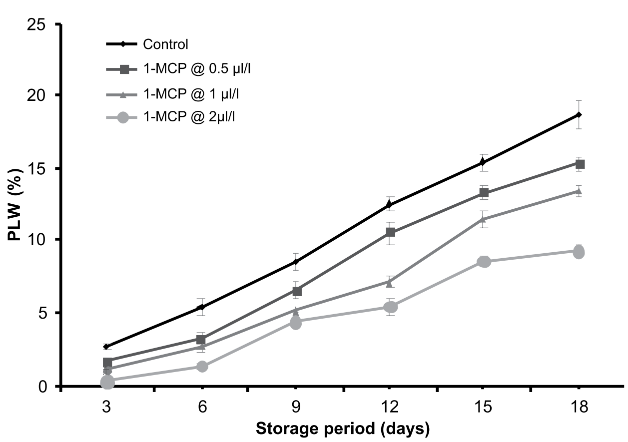

Fig. 1. Effect of 1-MCP on physiological loss in weight (%) of kiwifruit cv. Allison during storage.

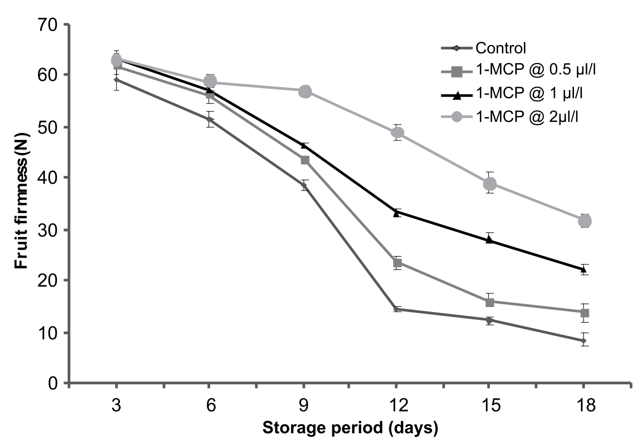

Fig. 2. Influence of 1-MCP on fruit firmness (N) of kiwifruit cv. Allison during storage.

fruits. Moreover, decrease in fruit firmness with advancement in storage period may also be attributed to breakdown of insoluble proto-pectin into soluble pectin or by hydrolysis of starch.

Neither 1-MCP treated nor untreated fruits showed any decay up to 6th day of storage (Table 1). However, with prolongation of storage period, fruit decay increased significantly in the untreated fruits, than the treated ones. Among different treatments of 1-MCP, fruits that received 2 µl/l showed significantly least fruit decay followed by 1 and 0.5 µl/l after 18 days of storage. The decay loss in untreated fruits was 8.1%, which was significantly higher than 2 µl/l (2.0%) treated fruits. It is difficult to explain the reason for lower decay in 1-MCP treated fruits but it may be due to stimulation of some natural defence mechanism included by 1-MCP, in addition to maintaining tissue integrity during storage and ripening. Further, it may also be ascribed to its inhibitory effects on disease and disorder incidence as reported by Dong *et al.* (5) in apricots.

Untreated fruits showed high TSS from 6th day itself and they increased till 15th day but thereafter it declined, whereas in 1-MCP treated fruits it kept on increasing until 18th day of storage (Table 2) but at slower rate. Among different 1-MCP treatments, fruits receiving 2 µl/l showed least TSS (8.3°Brix), significantly followed by 1 (8.7°Brix) and 0.5 µl/l (10.5 °Brix). Irrespective of treatments, TSS increased with increase in storage period. Early senescence in the untreated fruits compared to 1-MCP treated fruits, which showed delayed loss of TSS due to delayed senescence. Similar results of 1-MCP treatments were noticed in kiwifruit by Boquete *et al.* (3), although Dong *et al.* (5) reported that TSS in 1-MCP treated apricots and plums remained unaffected.

The untreated fruits showed high total sugars from 6th day, which increased till 12th day of storage and thereafter declined, whereas in 1-MCP treated fruits total sugars showed increasing trend till 18th day of storage (Table 2) but at slower rate. However, irrespective of storage period, total sugars were significantly higher in the untreated fruits, than the treated ones. Among different treatments of 1-MCP, fruits that received 2.0 µl/l showed least total sugars. Reduction in total sugars in 1-MCP treated fruits may be due to slower rate of ripening and conversion of complex carbohydrates in simple sugars. Our results are in contradiction to several other researchers because soluble solids have been reported to be higher in 1-MCP-treated apples by Fan *et al.* (6), but in agreement with Tian *et al.* (15) who reported low soluble solids in 1-MCP treated strawberry.

Irrespective of storage period, 1-MCP treated fruits retained higher acidity than untreated fruits (Table 2). Although acidity decreased with the increase in storage period in 1-MCP treated fruits but, this decline was less fast than untreated fruits. Among different treatments, fruits treated with 2 µl/l retained higher titratable acidity followed by 1 and 0.5 µl/l treated fruits (Table 2). These differences in effectiveness of 1-MCP on TA may be due to different cultivars, maturity stage or other experimental conditions (Blankenship and Dole, 2). Similarly, decrease in TA with the increase in storage period could be ascribed to utilization of organic acids in pyruvate decarboxylation reaction occurring during ripening process of kiwifruits. The reduction in acidity with increase in storage period might be due to increase in TSS or soluble sugars (Sharma *et al.*, 13). 1-MCP treated fruits retained higher ascorbic acid than untreated fruits and among 1-MCP (2 µl/l) being the best treatment (Table 2). The higher retention of ascorbic acid in 1-MCP treated fruits could be attributed to the ripening retarding effect and slow rate of biological activities during storage. Whether treated or not, kiwifruits showed almost similar trend with respect to ascorbic acid. The role of 1-MCP in delaying the loss of ascorbic acid has

Table 1. Fruit decay (%) in kiwifruit cv. Allison as affected by pre-storage 1-MCP treatment.

1-MCP conc.	Storage period (days)					
	3	6	9	12	15	18
0 (control)	0.0	0.0	3.5	7.8	15.1	22.2
0.5 µl/l	0.0	0.0	1.6	5.5	12.4	18.4
1 µl/l	0.0	0.0	0.0	2.4	7.4	14.5
2 µl/l	0.0	0.0	0.0	0.7	3.1	8.2
CD (p = 0.05)						
Treatment (T)				0.19		
Storage period (D)				0.25		
D × T				0.51		

Table 2. Effect of 1-MCP on quality attributes of kiwifruit cv. Allison during storage at ambient conditions.

Treatment 1-MCP (µl/l)	Storage period (days)						CD (p = 0.05)		
	3	6	9	12	15	18			
	TSS (°Brix)						Treatment (T)	Storage period (D)	D × T
0 (control)	7.8	12.5	14.0	16.8	15.7	15.1	0.05	0.07	0.14
0.5	6.5	8.1	8.5	9.6	13.3	16.8			
1.0	6.2	6.3	6.6	6.9	10.5	15.7			
2.0	6.0	6.2	6.3	6.4	9.4	15.3			
	Total sugars (%)								
0 (control)	6.5	10.0	12.0	14.4	13.4	12.9	0.06	0.07	0.14
0.5	4.5	6.0	6.4	7.5	11.2	14.7			
1.0	4.1	4.2	4.5	4.7	8.4	13.6			
2.0	3.9	4.1	4.2	4.3	8.0	13.5			
	Titratable acidity (%)								
0 (control)	1.36	1.29	1.15	0.76	0.73	0.71	0.04	0.06	0.12
0.5	1.40	1.34	1.18	1.07	0.94	0.79			
1.0	1.47	1.35	1.31	1.23	1.09	0.97			
2.0	1.56	1.45	1.4	1.31	1.13	1.11			
	Ascorbic acid (mg/100 g pulp)								
0 (control)	119.3	116.4	114.8	102.8	95.1	83.3	1.03	0.78	2.1
0.5	122.2	119.9	118.2	106.1	96.9	90.4			
1.0	124.2	121.3	118.9	109.9	100.8	97.8			
2.0	124.9	123.1	121.7	112.9	106.6	105.9			

been well documented by Khan and Singh (8) who reported that application of 1-MCP decreased the loss in ascorbic acid.

Our studies indicated that all concentrations of 1-MCP had significant effect on PLW, decay loss, fruit softening with no adverse effect on quality parameters of kiwifruit cv. Allison. Of different concentrations, 1-MCP (2.0 µl/l) was the most effective, increasing the shelf-life of 'Allison' kiwifruit by 6 days, with significant and effective increase in some quality parameters thereby, being acceptable up to 18 days under ambient conditions in comparison to 12 days in control.

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