



Effect of 1-Methylcyclopropene (1-MCP) on Shelf Life and Quality of Mango (*Mangifera indica* L.) Cv. Alphonso under Cold Storage

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Received: 30.06.2013

Accepted: 29.08.2013

An experiment was conducted in completely randomized design with four treatments viz., T₁: Cel-fresh 0.18% tablet (1-MCP) = 1 tablet/m³, T₂: Cel-fresh 0.18% tablet (1-MCP) = 1 Tablet / 2 m³, T₃: Cel-fresh 0.18% tablet (1-MCP) = 1 tablet/3 m³ and T₄: Control (without Cel-fresh tablet). The treatment T₁ recorded significantly delayed ripening, lowest per cent of spoilage and lowest physiological loss in weight as compared to other treatments. The treatment T₁ also recorded highest T.S.S. (19.70 °Brix), acidity (0.35%), reducing sugar (3.92%), total sugar (14.32%), non-reducing sugar (9.88%), β-carotene (10192.2 µg /100 g of pulp) as compared to T₄, T₃ and T₂ in ripened stage. Treatment T₃ recorded highest ascorbic acid content (33.16 mg/100 g of pulp) as compared to T₄, T₂ and T₁ in cold storage at ripened stage. It is evident that 1-methylcyclopropene improves the quality and shelf life of Alphonso mango fruits. The treatment T₁ (Cel-fresh 0.18% 1 tablet/m³) increased the storage life, chemical composition and sensory qualities of Alphonso mango fruits.

(Key words: 1-Methylcyclopropene, Shelf life, Quality, Alphonso mango)

Mango (*Mangifera indica* L.) belonging to the family Anacardiaceae is the national fruit of India and rightly known as the 'King' of fruits owing to its attractive colour, excellent taste, exotic flavour, exemplary nutritive value, Alphonso is a premium export variety of mango and the export by air is very costly. If the shelf life of fruits increased by upto 30 days, it could be exported through sea route. This will reduce the freight cost and will boost the export of fresh fruits. 1-Methylcyclopropene (1-MCP) is an extensively studied ethylene-action inhibitor that has recently been shown to delay ripening and improve post harvest quality of a wide variety of fruits and vegetables, including tropical fruits (Porat *et al.*, 1999, Feng *et al.*, 2000) and stone fruits (Fan *et al.*, 2002) including apricots (Fan *et al.*, 2000; Dong *et al.*, 2002). In India not much work has been carried out on this aspect. Hence, the present study on the effect of 1-MCP on shelf life and quality of mango Cv. Alphonso under cold storage has been taken up.

MATERIALS AND METHODS

The experiment was conducted in completely randomized design with four treatments viz., T₁: Cel-fresh 0.18% tablet (1-MCP) = 1 tablet/m³, T₂: Cel-fresh 0.18% tablet (1-MCP) = 1 Tablet/2 m³, T₃: Cel-fresh 0.18% tablet (1-MCP) = 1 tablet/3 m³ and T₄: Control (without Cel-fresh tablet). The Alphonso mango fruits were harvested at 85 per cent maturity

('B' stage). The unit was 40 fruits per treatment per replication. A calculated amount of 0.18% 1-MCP (Cel-fresh) tablet was taken in petridish and placed into plastic chamber with fruits. Water (15 ml.) was poured into Petridish and transferred immediately to the center of the fumigation chamber, and then sealed hermetically for 6 hours. The untreated control fruits were not given this treatment. After 6 hours, the treated lots of fruit were removed from fumigation chamber and were transferred for ripening under cold storage condition (13°C + 1°C; 85-90% RH). The spoilage and physiological loss in weight were recorded at 7 days interval. Each fruit was thoroughly examined for any visible symptoms of stem end rot, anthracnose during storage and spoilage percentage was recorded and calculated. Ten fruits from each replication were selected for recording weight of PLW. The loss in weight (g) was calculated by noting down the progressive loss in weight (g) of the fruit recorded from initial day to every seventh day under cold storage. The chemical composition viz., TSS (°Brix), acidity (%), reducing sugar (%), total sugar (%), ascorbic acid (mg/100 g of pulp), β-Carotene (µg/100 g of pulp) were estimated on 0, 7, 14, 21 and 28th day after treatment. The chemical analysis was done as per the methods suggested by Ranganna (1997). The results were analysed statistically as per the method suggested by Panse and Sukhatme (1995).

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RESULTS AND DISCUSSION

The treatment T_1 (0.18% Cel-fresh tablet) recorded 6 days more shelf life than the treatment T_4 (Control). The treatments T_3 (30.46 days) and T_2 (29.99 days) were on par with T_1 (30.53 days). The treatment T_1 recorded lower spoilage (22.45%) and physiological loss in weight (6.57%), while the treatment T_4 recorded higher spoilage and physiological loss in weight (Table 1). There was no significant difference between control as well as 1-MCP treated fruits with respect to T.S.S. of Alphonso mango fruit at initial stage. However, significant differences were observed among the treatments from 7 days onwards. The control fruits showed higher T.S.S. over 1-MCP treated fruits at initial stage. At 28 days, the treatment T_1 recorded the highest T.S.S. (19.70 °Brix), while treatment T_4 recorded the lowest T.S.S. of 17.06 °Brix (Table 2). The higher T.S.S. in 1-MCP treated fruits than in control fruits during ripening could be attributed to increased activity of enzymes responsible for hydrolysis of starch to soluble sugars such as sucrose, fructose and glucose. Similar findings were observed by Singh and Pathak (2008) in mango. The treatment T_1 (0.18% Cel-fresh tablet) recorded highest titratable acidity (0.35%), while treatment T_4 (control) recorded lowest titratable acidity (0.20%) (Table 2). These results are in conformity with the

findings reported by Singh and Mathur (1952), and Naik (1985) in Alphonso mango fruits. The treatment T_1 recorded the highest reducing sugars as well as total sugars at 28 days, while treatment T_4 recorded the lowest reducing sugars and total sugars (Table 3). The increase in total sugars during storage during ripening could be attributed to hydrolysis of starch into sugars.

There were no significant differences in ascorbic acid content among the treatments up to 14th days of storage. The ascorbic acid (mg/100 g of pulp) content in Alphonso mango in control was significantly higher as compared to 1-MCP treated fruits up to 21st days. At 28th day, the treatment T_3 recorded the highest ascorbic acid content (33.16 mg/100 g), while the control fruits (T_4) recorded lowest ascorbic acid content (28.57 mg/100 g of pulp). The ascorbic acid showed a continuous decline during storage from harvest towards ripe stage (Table 4). The decline in ascorbic acid during storage, ripening and post ripening storage could be possibly due to its degradation during this period. Similar observations were reported by Selvarajah *et al.*, (2001) in stored pineapple and Quiping *et al.*, (2006) in sapota. The data on β -carotene content in Alphonso mango fruits did not show any significant difference among the treatments at initial stage. The

Table 1. Effect of 1-methylcyclopropene on shelf life of Alphonso mango fruits under cold storage

Treatment	ripening behaviour	Spoilage (%)	Physiological loss in weight (%)
T_1	30.53	22.45	6.57
T_2	29.99	23.60	7.97
T_3	30.46	25.40	7.24
T_4	24.73	29.97	8.62
Mean	28.93	25.35	7.60
SEm +	0.34	1.42	0.83
CD at 1 %	1.39	5.88	NS

Table 2. Effect of 1-methylcyclopropene on T.S.S. (°Brix) and Acidity (%) of Alphonso mango fruits under cold storage

Treatment	TSS (°Brix)						Acidity (%)					
	0	7	14	21	28	Mean	0	7	14	21	28	Mean
T_1	9.24	11.16	13.82	17.50	19.70	14.28	3.20	1.31	0.93	0.66	0.35	1.29
T_2	9.18	11.66	13.48	16.46	18.24	13.84	3.20	1.25	0.80	0.57	0.30	1.22
T_3	9.24	11.32	13.26	15.48	17.84	13.43	3.20	1.39	0.88	0.56	0.33	1.27
T_4	9.36	12.32	14.54	15.72	17.06	13.76	3.20	1.41	0.80	0.33	0.20	1.19
Mean	9.25	11.61	13.77	16.29	18.21	13.83	3.20	1.34	0.85	0.53	0.30	1.24
SEm +	0.10	0.21	0.24	0.39	0.48		0.00	0.06	0.03	0.06	0.015	
CD at 1%	NS	0.88	1.00	1.60	1.98		NS	NS	0.11	0.26	0.06	

Table 3. Effect of 1-methylcyclopropene on reducing sugars (%) and total sugars (%) of Alphonso mango fruits under cold storage

Treatment	Reducing sugars (%)						Total sugars (%)					
	0	7	14	21	28	Mean	0	7	14	21	28	Mean
T ₁	1.31	2.24	2.76	2.95	3.92	2.64	3.41	6.90	9.26	11.89	14.32	9.17
T ₂	1.34	2.11	2.74	3.08	3.81	2.62	3.43	6.69	8.77	11.79	13.60	8.85
T ₃	1.28	2.31	2.81	3.04	3.87	2.66	3.34	6.88	9.34	11.87	13.45	8.98
T ₄	1.36	2.37	2.90	3.31	3.73	2.72	3.49	6.98	10.02	12.20	13.32	9.19
Mean	1.32	2.26	2.80	3.09	3.83	2.66	3.42	6.86	9.35	11.94	13.67	9.04
SEm +	0.11	0.19	0.03	0.05	0.03		0.13	0.32	0.22	0.08	0.18	
CD at 1 %	NS	NS	0.12	0.23	0.13		NS	NS	0.89	0.31	0.77	

Table 4. Effect of 1-methylcyclopropene on ascorbic acid (mg/100g of pulp) and β -carotene (μ g/100 g of pulp) of Alphonso mango fruits under cold storage

Treat	Ascorbic acid (mg/100g of pulp)						β -carotene (μ g/100 g of pulp)					
	0	7	14	21	28	Mean	0	7	14	21	28	Mean
T ₁	78.65	65.69	57.50	46.43	33.04	56.45	701.2	1896.6	4179.4	8173.6	10192.2	5028.6
T ₂	77.11	66.99	57.32	49.86	30.13	56.29	695.4	1912.6	4244	7998.6	10017.4	4973.6
T ₃	78.88	65.71	56.74	49.48	33.16	56.77	701.0	2079	4220.2	7944	9997.2	4988.3
T ₄	79.52	68.21	59.64	51.83	28.57	57.38	701.8	2285	4428	7737	9868.4	5004
Mean	78.54	66.65	57.80	49.4	31.22	56.72	699.85	2043.3	4267.9	7963.3	10018.8	4998.6
SEm +	0.695	0.95	0.97	0.85	0.96		2.35	67.01	45.78	76.12	55.32	
CD at 1%	NS	NS	NS	3.52	3.96		NS	276.8	189.1	314.4	228.5	

Table 5. Sensory qualities of Alphonso mango fruits at 7, 21 and 28th day during cold storage ($13^{\circ}\text{C} \pm 1^{\circ}\text{C}$, 90% RH)

Treat	7th day				21th day				28th day			
	Pulp colour	Flavour	Texture	Mean	Pulp colour	Flavour	Texture	Mean	Pulp colour	Flavour	Texture	Mean
T ₁	8.07	7.77	7.63	7.82	7.50	7.04	7.22	7.25	7.38	6.96	7.02	7.12
T ₂	7.76	7.30	7.28	7.45	7.86	7.50	7.54	7.63	6.80	6.55	6.51	6.62
T ₃	7.93	7.22	7.10	7.42	7.02	6.80	6.46	6.76	6.98	6.66	6.47	6.70
T ₄	7.76	7.18	7.30	7.41	7.50	7.08	6.90	7.16	6.90	6.27	6.08	6.42
Mean	7.88	7.37	7.33	7.52	7.47	7.10	7.03	7.20	7.01	6.61	6.52	6.71
SEm +	0.05	0.08	0.062		0.15	0.11	0.20		0.09	0.11	0.17	
CD at 1%	0.235	0.35	0.26		0.61	0.46	0.83		0.36	0.46	0.69	

β -carotene content in control was significantly higher as compared to 1-MCP treated mango fruits up to 14th day of treatment. However, treatment T₁ recorded comparatively higher β -carotene content (10192.2 μ g/100 g of pulp) at 28th day (Table 4).

All the ripening stages of Alphonso were highly influenced by 1-MCP and it significantly arrested the ripening process as well as delayed all ripening stages as compared to control (Burondkar *et al.*, 2009). 1-MCP was effective in delaying fruit ripening

in mango Cv. Amrapali for 8 days (Mathur and Srivastava, 2005). 1-MCP reduced the development of internal breakdown and senescence decay in pear (Calvo, 2002). Loss in physiological weight of fruit during ripening was significantly lower in 1-MCP treatments as compare to control (Burondkar *et al.*, 2009). 'Nam Dokmai' mangoes treated with 1-MCP treatment had prolonged shelf life upto 15 days at 20°C (Penchaiya *et al.*, 2006). 1-MCP treated 'Tommy Atkins' mango fruits had higher vitamin C content (Cocozza *et al.*, 2004).

REFERENCES

- Burondkar, M. M., Mane, A. V., Jadhav, B. B. and Bendale, V. W. (2009). Efficacy of 1-methylcyclopropene (1-MCP) on ripening behaviour and fruit quality of Alphonso mango fruits under cold storage conditions. *Recommendation Proposal on Joint Agresco* 1 - 17.
- Calvo, G. (2002). Effect of 1-methylcyclopropene (1-MCP) on pear maturity and quality. *ISHS - Toronto* 230 - 247.
- Cocozza, F. M., Alves, R. E., Filgueiras, H. A. C., Pereira, M. E. C. and Jorge, J. T. (2004). Respiration rate and chemical characteristics of cold stored 'Tommy Atkins' mangoes influenced by 1-MCP and modified atmosphere packaging. *Acta Horticulturae* 645. VII International Mango Symposium.
- Dong, L., Lurie, S. and Zhou, H. W. (2002). Effect of 1-methylenecyclopropene on ripening of 'Canino' apricots and 'Royal Zee' plums. *Postharvest Biology and Technology* **24**:135 - 145.
- Feng, X., Apelbaum, A., Sisler, E. C. and Goren, R. (2000). Control of ethylene responses in avocado fruit with 1-methylcyclopropene. *Postharvest Biology and Technology* **20**: 143 - 150.
- Fan, X., Argenta, L. and Mattheis, J. P. (2002). Interactive effects of 1-MCP and temperature on 'Eloberta' peach quality. *Hort Science* **37**: 134-138.
- Fan, X., Argenta, L. and Mattheis, J. P. (2000). Inhibition of ethylene action by 1-methylcyclopropene prolongs storage life of apricots. *Postharvest Biology and Technology* **20**: 135-142.
- Mathur, K. and Srivastava, G. C. (2005). Effect of 1-MCP on malic enzyme activity and ethylene production in mango during ripening. *Indian Journal of Plant Physiology* **10**(3): 273 - 275.
- Naik, S. R. (1985). Studies on physico-chemical changes in Alphonso and Ratna mango (*Mangifera indica* L.) fruits during growth, development and storage. *M.Sc. (Agri.) Thesis*, Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri. Maharashtra.
- Panase, V. G. and Sukhatme, P. V. (1985). Statistical Methods for Agricultural Workers. 4th Edition. I.C.A.R., New Delhi. pp. 58 - 152.
- Penchaiya P., Jansasithom, R. and Kanlayanarat, S. (2006). Effect of 1-MCP on physiological changes in mango 'Nam Dokmai'. *Acta Horticulturae* 712.
- Porat, R., Weiss, B., Cohen L., Daus, A., Goren, R. and Droby, S. (1999). Effects of ethylene and 1-methylcyclopropene on the postharvest quality of 'Shamouti' oranges. *Postharvest Biology and Technology* **15**: 155 - 163.
- Quiping, Zhong, Xia Wenshui and Yueming Jiang (2006). Effects of 1-methylcyclopropene treatments on ripening and quality of harvested sapodilla fruit. *Food Technology and Biotechnology* **44**(4): 535 - 539.
- Selvarajah, S., Bauchot, A. D. and John, P. J. (2001). Internal browning in cold-stored pineapples as suppressed by a post harvest application of 1-methylcyclopropene. *Postharvest Biology and Technology* **23**: 167 - 170.
- Singh, K. K. and Mathur, P. B. (1952). Ripening of mangoes. *Current Science* **21**: 295.
- Singh, V. K. and Pathak, N. (2008). Response of 1-methylcyclopropene on activities of pectin hydrolases and associated post-harvest physiological changes in different mango cultivars. *Indian Journal of Horticulture* **65**(1): 20-24.
- Ranganna, S. (1997). *Handbook of Analysis and Quality Control for Fruits and Vegetable Products*. 2nd Edition. Tata McGraw Hill Publishing Company Ltd. New Delhi.