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Effects of postharvest application of 1-methylcyclopropene on tomato fruits of cv. *Vaishali*

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Abstract

An investigative research study was undertaken to study the effects of post-harvest application of 1-methylcyclopropene (1-MCP) on physico-chemical parameters of the tomato fruits cv. *Vaishali*. The tomato fruits harvested at the breaker stage of maturity were selected, washed followed by grading based on their surface colour and then given a fungicidal treatment of 500 ppm. These fruits were then subjected to the application of 1-MCP at various concentrations *viz*. 1.0 µL/L, 1.5 µL/L, 2.0 µL/L and 2.5 µL/L respectively for 24 hrs along with absolute control sample respectively. These fruits were then stored at 20°C for further investigation with respect to percent physiological loss in weight (% PLW), surface colour, firmness, total soluble solids, titrable acidity, ascorbic acid content, total phenolic content and lycopene content during the storage. From the present investigation, the treatment T_4 of 1-MCP in which tomatoes were treated at the concentration of 2.5 µL/L showed significant retention of all parameters as compared to other treatments. The % PLW showed a gradual decrease from 0 to 10.1, surface colour improved significantly from 3.19 to 4.82 hue angle, TSS increased from 1.6 to 3.8°Bx, titrable acidity decreased from 0.35 to 0.16%, ascorbic acid content decreased from 76.98 to 30.08 mg/100 g, total phenolic content decreased from 3.87 to 3.28 mg GAE/g and lycopene showed a significant increase from 6.89 to 12.64 mg/100 g. These changes in the values of all the above parameters were found significantly superior to those of the rest of the treatments. The tomatoes treated at 2.5 µL/L of 1-Methylcyclopropene (1-MCP) concentration showed the highest shelf life of 34 days with maximum retention of overall acceptability parameters as compared to control fruits with the least shelf life of only 12 days. The experiments showed that 1-MCP at 2.5 µL/L concentration and 20°C storage temperatures maintain the shelf life of tomatoes with better retention of overall physico-chemical parameters as compared to other treatments.

1. Introduction

The tomatoes are rich in carotenoid and lycopene compounds, which reduce the risk of cancer and heart diseases. Tomatoes are rich sources of fibre, vitamins A, C, and lycopene. Over the past few years, a few novel chemicals such as hexanal, 1-methylcyclopropene (1-MCP), Salicylic acid and silver nanoparticles are under the interest of many researchers in order to investigate the potential shelf life extension ability of these chemicals. Tomato is one of the most widely consumed vegetable food crops worldwide (Fanasca *et al.*, 2020).

Since tomato is highly perishable it encounters several problems in their transportation, storage and marketing (Guillén *et al.*, 2006). In the past, some efforts have been made in this direction by employing certain chemicals to hasten or delay ripening, reduce losses and improve and maintain the colour and quality by slowing down the metabolic activities of the fruits. These chemicals are reported to arrest the growth and spread of microorganisms by reducing the shrivelling which ultimately leads to increased shelf life and maintains the marketability of the fruit for a longer period (Mir *et al.,* 2004). Tomato being a climacteric fruit, the start of ripening is accompanied by a rapid rise in respiration rate called 'respiratory climacteric' during which oxidative breakdown of complex substrates occurs,

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ageing follows, leading to product deterioration. Also, tomatoes being fleshy fruits, continue to lose water after harvest. This results in a wilted, dull appearance that reduces the visual appeal and freshness and eventually becomes unmarketable (Su and Gubler 2012).

Recently, a novel nontoxic gaseous compound, 1-methylcyclopropene (1-MCP) as one of the ethylene antagonists has been commercially used to extend the storage life of fruits, vegetables and flowers. It is reported to have inhibitory effects on ethylene action in various cut flowers and potted plants plums, apples, bananas, citrus, strawberries, mangoes, broccoli, and lettuce (Tian 2000), tomatoes (Chavan and Sakhale 2020). Keeping these points in view, the present study evaluated the potential of post-harvest treatments of 1-MCP on the shelf life and physicochemical characteristics of tomato fruit during its storage.

2. Materials and methods

The tomatoes (Lycopersicon esculentum Mill.) of cv. *Vaishali* was harvested at the breaker stage of maturity. Good quality analytical grade chemicals were obtained from reputed manufacturers. The sophisticated analytical instruments like Colorimeter, Texture Analyzer and UV-Spectrophotometer. required for carrying out this research work were available in the Food technology laboratories and were effectively and efficiently used as specified by (Jeong *et al.,* 2002).

2.1 Treatment of tomato fruits with different chemicals

The tomato fruits of cv. *Vaishali* harvested at the breaker stage of maturity were selected, washed and graded on the basis of their specific gravity and given the fungicidal treatment of 500 ppm. These fruits were then subjected to post-harvest application of 1-MCP at different concentrations. The tomato fruits were treated for 24 hrs along with absolute control samples respectively and then stored at 20°C for further investigation with respect to overall quality parameters during storage (Lohani *et al.,* 2004).

2.2 Physicochemical analysis of tomato fruits

Various physicochemical analyses of the control and treated fruits were carried out using standard methods of analysis in order to determine the effect of treatments of 1-MCP at different concentrations on the quality and shelf life of tomato fruits. The observations were recorded at frequent intervals of 4 days during the storage period for various parameters (Opiyo *et al.,* 2005).

2.3 Statistical analysis

The analyses of physical-chemical, textural and sensory characteristics were done using triplicate samples. The data obtained from various experiments were statistically analyzed using one way ANOVA and Duncan's test at 95% ($P \leq 0.05$) level of significance (Das and Giri, 1988).

3. Results and discussion

3.1 Effect of 1-MCP on tomato fruits

The effect of post-harvest application of 1-MCP at the different concentrations on cv. *Vaishali* of tomato fruit was studied for different parameters.

3.1.1 Effect on percent physiological loss in weight of tomato fruits

There was no significant difference observed with respect to % PLW among the tomatoes treated with 1-MCP. However, there was still a comparable difference observed with respect to overall acceptability in the T_4 sample of tomatoes treated with 2.5 µL/L concentration of 1-Methylcyclopropene (1-MCP) which showed very fewer changes in % PLW from 3.4 to 10.1% and higher shelf life of 34 days as compared to all the other treatments of 1-MCP as well as with comparison of all the treatments and absolute control as shown in Table 1. 1-MCP binds some specific sites on the tomato surface and prevents moisture loss. Similar findings were reported by (Chavan and Sakhale, 2020).

3.1.2 Effect on the surface colour of cv. Vaishali of tomato fruits

Among the rest of the treatments of all three chemicals, the T_4 sample which was treated with 2.5 µL/L of 1-MCP showed a very gradual change in the value of hue angle (-3.19 to 4.97) till the 34th day of its shelf life as shown in Table 2. The sudden change in the surface colour of the tomatoes in terms of hue angle was delayed by the action of 1-MCP (Figure 1). The mechanism of its action resulted in gradual desirable changes in the surface colour of the tomato fruits during their storage life, this phenomenon corresponds to the investigation carried out by (Guillén *et al.,* 2006).

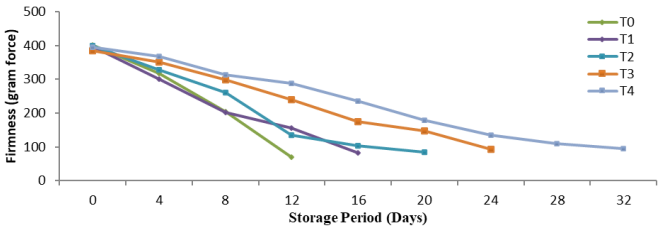

Figure 1. Effect of 1-MCP on firmness (gf) of tomato fruits

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3.1.3 Effect on the firmness of tomato fruits

Firmness or texture which was measured as gram force possessed major variations among all the treatments of control and treated samples. Moreover, 2.5 µL/L 1-MCP treated T_4 sample remained fit for consumption till the 34th day and also retained maximum firmness of the tomatoes as compared to the rest of the treatments as well as the control sample as shown in Figure 2. The firmness of the tomatoes treated with 1-MCP was significantly acceptable even on the last day of their shelf life.

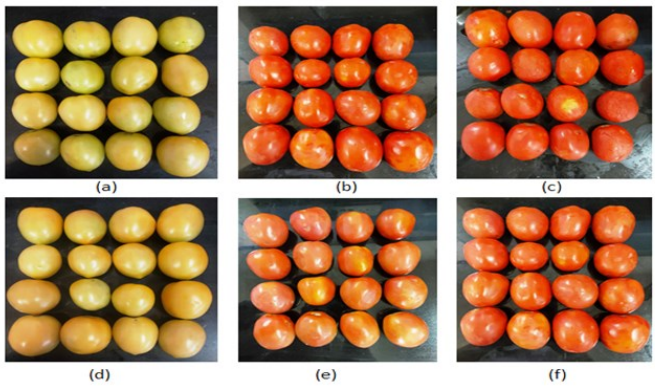

Figure 2. Effect of 1-MCP treatment on tomato fruits during storage. (a), (b) and (c) are the control samples at intervals of 1, 4 and 12 days respectively while (d), (e) and (f) are 1-MCP treated samples at intervals of 1, 24 and 34 days respectively.

Initially the tomato fruits of cv. *Vaishali* from all the lots of treatments were having a firm texture but later on as the storage days increased, the untreated tomato fruits started getting soft exponentially as compared to the 1-MCP treated fruits. A similar trend of changes in the firmness of the fruits was reported by (Mir *et al.,* 2004).

3.1.4 Effect on total soluble solids (TSS) of tomato fruits

All the tomatoes which were given treatments of 1-MCP showed a very gradual change in TSS except the T_o sample of control fruits which showed rapid change in TSS from 1.7 to 3.1 on the 12th day of its maximum shelf life as compared to T_4 treatment in which TSS showed a very gradual change from 1.6 to 3.8 within its highest shelf life of 12 days as compared with all other samples.

However, the T_4 sample of 1-MCP was found best among all as shown in Table 3. As the tomatoes started ripening, the sugar content of the tomato fruits also started increasing. The increase in TSS was gradual in the fruits treated with 1-MCP, but there was a sudden increase in the TSS content of untreated fruits. Similar results were published by (Opiyo and Ying, 2005) with respect to the total soluble solids content of the untreated and treated fruits.

Table 1. Effect on percent physiological loss in weight of tomato fruits cv. *Vaishali*

Treatments	Storage Period (Days)									
	0	4	8	12	16	20	24	28	32	34
T_0	0	3.8	6.7	11.3	*	*	*	*	*	*
T_1	0	3.4	5.9	6.7	8.2	10.7	*	*	*	*
T_2	0	3.6	5.1	6.2	7.9	8.8	*	*	*	*
T_3	0	3.4	4.8	5.9	7.2	8.1	9.0	*	*	*
T_4	0	3.5	4.3	5.4	6.9	7.8	8.6	9.2	9.7	10.1

Each value is the average of three determinations. (*) indicates fruit discarded due to spoilage

Table 2. Effect on Surface color (hue angle) of tomato fruits cv. *Vaishali*

Treatments	Storage Period (Days)									
	0	4	8	12	16	20	24	28	32	34
T_0	-3.28	1.74	2.46	4.97	*	*	*	*	*	*
T_1	-3.32	1.34	1.69	2.16	4.68	*	*	*	*	*
T_2	-3.21	1.49	2.07	2.93	3.87	4.42	*	*	*	*
T_3	-3.28	2.53	2.73	3.09	3.44	3.47	4.11	*	*	*
T_4	-3.19	1.23	1.53	1.85	2.39	2.97	3.26	3.48	4.01	4.97

Each value is the average of three determinations. (*) indicates fruit discarded due to spoilage

Table 3. Effect on TSS of tomato fruits cv. *Vaishali*

Treatments	Storage Period (Days)									
	0	4	8	12	16	20	24	28	32	34
T_0	1.7	1.8	2.3	3.1	*	*	*	*	*	*
T_1	1.4	1.7	2.2	2.3	2.7	*	*	*	*	*
T_2	1.8	2.0	2.1	2.4	2.7	3.2	*	*	*	*
T_3	1.3	1.6	1.7	1.9	2.3	2.6	3.5	*	*	*
T_4	1.6	1.8	2.1	2.3	2.6	2.9	3.1	3.3	3.5	3.8

Each value is the average of three determinations. (*) indicates fruit discarded due to spoilage

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3.1.5 Effect on titrable acidity of tomato fruits

Table 4 shows the effect of different treatments on the percent titrable acidity of the tomatoes. T_4 sample treated at 2.5 µL/L concentration of 1-MCP showed a very gradual decrease in titrable acidity from 0.38 to 0.11 and also remained best among all other samples. The rapid decline in the TSS of untreated tomatoes was due to an exponential rise in the ripening behaviour of these fruits.

The research investigation of (Mir *et al.,* 2004) showed an identical trend of changes in the values of titrable acidity in tomatoes which were kept as absolute control whereas the tomatoes treated with the 1-MCP showed gradual changes in the titrable acidity.

3.1.6 Effect on ascorbic acid content of tomato fruits cv. Vaishali

The ascorbic acid content in fruits treated with the highest 1-MCP was found to be reduced gradually from 76.98 to 30.08 mg/100 g up to the 34th day of its storage life. However ascorbic content in untreated control fruits reduced drastically within only 12 days of their shelf life as shown in Table 5. This eventually resulted in the lesser shelf life of the untreated fruits.

The experiments conducted by (Jeong *et al*., 2002) on avocado fruits showed similar results with respect to the ascorbic acid content of avocado fruits.

3.1.7 Effect on total phenolic content of tomato fruits cv. Vaishali

The decrease in total phenolic content of the untreated fruits was slightly rapid as compared with treated fruits as shown in Table 6. Moreover, fruits treated with the highest 1-MCP concentration had shown significant retention of total phenolic content and a decrease in the total phenolic was very gradual i.e. from 3.87 to 3.28 mg GAE/g at the end of its shelf life of 34 days.

The total phenolic content showed a very gradual change both in 1-MCP treated as well as in untreated tomato fruits. However, the change was significantly lower in the tomato fruits treated with 1-MCP. The experimental research of (Su and Gubler 2012) reported similar effects of 1-MCP on tomato fruits of cv. *Vaishali*.

3.1.8 Effect on lycopene content of tomato fruits cv. Vaishali

The lycopene values mentioned in mg/100 g in Table 7, clearly depict that the untreated tomato fruits showed a sudden increase in lycopene content due to rapid ripening. The higher lycopene concentration of the

Table 4. Effect on titrable acidity (%) of tomato fruits cv. *Vaishali*

Treatments	Storage Period (Days)									
	0	4	8	12	16	20	24	28	32	34
T_0	0.37	0.31	0.27	0.11	*	*	*	*	*	*
T_1	0.38	0.32	0.29	0.24	0.13	*	*	*	*	*
T_2	0.32	0.26	0.21	0.19	0.16	0.12	*	*	*	*
T_3	0.36	0.31	0.29	0.26	0.23	0.20	0.18	*	*	*
T_4	0.35	0.32	0.30	0.28	0.26	0.24	0.22	0.20	0.18	0.16

Each value is the average of three determinations. (*) indicates fruit discarded due to spoilage

Table 5. Effect on ascorbic acid content (mg/100 g) of tomato fruits cv. *Vaishali*

Treatments	Storage Period (Days)									
	0	4	8	12	16	20	24	28	32	34
T_0	77.13	69.21	47.10	27.22	*	*	*	*	*	*
T_1	75.28	69.01	49.74	30.17	27.14	*	*	*	*	*
T_2	76.39	70.11	61.27	43.82	39.76	30.08	*	*	*	*
T_3	75.87	71.21	63.24	45.61	41.75	36.48	31.54	*	*	*
T_4	76.98	73.57	67.94	61.24	54.95	49.57	43.34	38.46	33.71	30.08

Each value is the average of three determinations. (*) indicates fruit discarded due to spoilage

Table 6. Effect on total phenolic content of tomato fruits cv. *Vaishali*

Treatments	Storage Period (Days)									
	0	4	8	12	16	20	24	28	32	34
T_0	3.87	3.64	3.07	2.73	*	*	*	*	*	*
T_1	3.98	3.87	3.73	3.59	3.21	*	*	*	*	*
T_2	3.93	3.89	3.78	3.65	3.41	3.37	*	*	*	*
T_3	3.86	3.71	3.61	3.56	3.41	3.38	3.33	*	*	*
T_4	3.87	3.81	3.77	3.73	3.69	3.65	3.61	3.52	3.41	3.28

Each value is the average of three determinations. (*) indicates fruit discarded due to spoilage

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Table 7. Effect on lycopene content of tomato fruits cv. *Vaishali*

Treatments	Storage Period (Days)									
	0	4	8	12	16	20	24	28	32	34
T_0	7.87	9.19	10.23	12.47	*	*	*	*	*	*
T_1	6.91	8.13	9.47	11.54	12.34	*	*	*	*	*
T_2	7.27	9.14	9.94	11.29	12.07	12.62	*	*	*	*
T_3	7.82	8.15	8.89	9.93	10.87	11.45	12.58	*	*	*
T_4	6.89	7.46	8.43	9.69	10.59	11.28	11.67	11.96	12.13	12.64

Each value is the average of three determinations. (*) indicates fruit discarded due to spoilage

tomatoes corresponds to the increased ripening. The lycopene concentration in untreated tomato fruits showed an exponential increase due to the rapid ripening of the untreated tomato fruits. However, the tomatoes in 1-MCP treated T_4 lot of the experiment underwent a slow ripening mechanism which resulted in their higher shelf life.

The higher shelf life of the 1-MCP treated tomato fruits also maintained their lycopene content in the desirable range. The lycopene content in the research experiments carried out by (Su and Gubler, 2012) reported similar results.

4. Conclusion

From the present investigation, it can be concluded that 1-Methylcyclopropene (1-MCP) at the concentration of 2.5 µL/L was found superior among the rest of the treatments of 1-Methylcyclopropene. The tomatoes treated at 2.5 µL/L of 1-Methylcyclopropene (1-MCP) concentration showed the highest shelf life of 34 days with maximum retention of overall acceptability parameters as compared to other chemicals. However, the tomatoes treated at 2.0 µL/L concentration of the 1-Methylcyclopropene also showed significant improvement in shelf life by lengthening its period of storage up to 24 days which was significantly higher than the T_1 and T_2 samples of lower 1-Methylcyclopropene concentration but not as effective as T_4 treatment. Therefore, 1-MCP treated tomatoes at the concentration of 2.5 µL/L recorded the highest shelf life of 34 days whereas absolute control tomatoes recorded the least shelf life of 12 days among all the treatments. It may be concluded from the current experiments that 1-MCP at 2.5 µL/L concentration and 20°C storage temperatures maintains the shelf life of tomatoes with better retention of overall physico-chemical parameters as compared to other chemicals.

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References

Chavan, R.F. and Sakhale, B.K. (2020). Studies on the effect of exogenous application of salicylic acid on post-harvest quality and shelf life of tomato fruit Cv. Abhinav. *Food Research*, 4(2), 1444-1450. https://doi.org/10.26656/fr.2017.4(5).131

Das, R., Parveen, S., Bora, A. and Giri, P.K. (2020). Origin of high photoluminescence yield and high SERS sensitivity of nitrogen-doped graphene quantum dots. *Carbon*, 160(1), 273-286. https://doi.org/10.1016/j.carbon.2020.01.030

Fanasca, M. (2020). Perspectives on the Italian BL and Yuri Manga Market: Toward the Development of Local Voices. *Mechademia*, 13(1), 153-158. https://doi.org/10.5749/mech.13.1.0153

Guillén, F., Castillo, S., Zapata, P.J., Martínez-Romero, D., Valero, D. and Serrano, M. (2006). Efficacy of 1-MCP treatment in tomato fruit: 2. Effect of cultivar and ripening stage at harvest. *Postharvest Biology and Technology*, 42(3), 235-242. https://doi.org/10.1016/j.postharvbio.2006.07.005

Jeong, J., Huber, D.J. and Sargent, S.A. (2002). Influence of 1-methylcyclopropene (1-MCP) on ripening and cell-wall matrix polysaccharides of avocado (*Persea americana*) fruit. *Postharvest Biology and Technology*, 25(3), 241-256. https://doi.org/10.1016/S0925-5214(01)00184-3

Lohani, S., Trivedi, P.K. and Nath, P. (2004). Changes in activities of cell wall hydrolases during ethylene-induced ripening in banana: effect of 1-MCP, ABA and IAA. *Postharvest Biology and Technology*, 31 (2), 119-126. https://doi.org/10.1016/j.postharvbio.2003.08.001

Mir, N., Canoles, M., Beaudry, R., Baldwin, E. and Mehla, C.P. (2004). Inhibiting tomato ripening with 1-methylcyclopropene. *Journal of the American Society for Horticultural Science*, 129(1), 112-120. https://doi.org/10.21273/JASHS.129.1.0112

Opiyo, A.M. and Ying, T.J. (2005). The effects of 1-

methylcyclopropene treatment on the shelf life and quality of cherry tomato (Lycopersicon esculentum var. cerasiforme) fruit. *International Journal of Food Science and Technology*, 40(6), 665-673. https://doi.org/10.1111/j.1365-2621.2005.00977.x

Su, H. and Gubler, W.D. (2012). Effect of 1-methylcyclopropene (1-MCP) on reducing postharvest decay in tomatoes (*Solanum lycopersicum* L.). *Postharvest Biology and Technology*, 64(1), 133-137. https://doi.org/10.1016/j.postharvbio.2011.06.005

Tian, M.S., Prakash, S., Elgar, H.J., Young, H., Burmeister, D.M. and Ross, G.S. (2000). Responses of strawberry fruit to 1-methylcyclopropene (1-MCP) and ethylene. *Plant Growth Regulation*, 32(1), 83-90. https://doi.org/10.1023/A:1006409719333

https://doi.org/10.26656/fr.2017.7(5).736