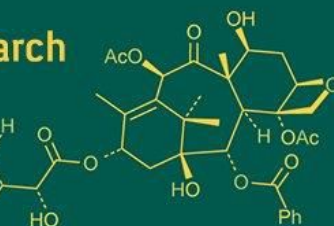


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Effect of 1-MCP and storage conditions on biochemical constituents and shelf life of sapota fruits

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Abstract

Sapotas have a shorter shelf life than other fruits since they are perishable. Sapota's shelf life can vary based on a number of factors, including freshness, storage conditions, and transportation. To extend the postharvest life and preserve the quality of the fruit, proper postharvest care is necessary. An experiment was carried out in the winter and summer of 2020-21 at ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India, to increase the sapota's shelf life. The fruits were maintained at room temperature and at a low temperature ($12.0 \pm 0.5^\circ\text{C}$) after being treated with varying concentrations of 1-MCP (0, 20, 40, 60, 80, and 100 nL L⁻¹). Twelve treatments, consisting 1-MCP @ 0 nL L⁻¹ + ambient temperature (T₁), 1-MCP @ 0 nL L⁻¹ + low temperature (T₂), 1-MCP @ 20 nL L⁻¹ + ambient temperature (T₃), 1-MCP @ 20 nL L⁻¹ + low temperature (T₄), 1-MCP @ 40 nL L⁻¹ + ambient temperature (T₅), 1-MCP @ 40 nL L⁻¹ + low temperature (T₆), 1-MCP @ 60 nL L⁻¹ + ambient temperature (T₇), 1-MCP @ 60 nL L⁻¹ + low temperature (T₈), 1-MCP @ 80 nL L⁻¹ + ambient temperature (T₉), 1-MCP @ 80 nL L⁻¹ + low temperature (T₁₀), 1-MCP @ 100 nL L⁻¹ + ambient temperature (T₁₁) and 1-MCP @ 100 nL L⁻¹ + low temperature (T₁₂). Every five days interval, the biochemical constituents of sapota fruit were evaluated. The result revealed that the maximum TSS in T₁, T₃, T₂ and T₄ which was at par with T₅, T₇, T₉ at 5th and 10th day, total sugars in T₁, T₂ and T₄ which was at par with T₃, T₅, T₇, T₉ at 10th day and titratable acidity in T₁₂ were noted at 5th, 10th, 15th and 20th day of storage, respectively during both the seasons. The fruits with the longest shelf life (22.39 days) were those treated with 1-MCP at 100 nL L⁻¹ and kept at a low temperature. The treatment T₁₀ (1-MCP at 80 nL L⁻¹ + low temperature $12 \pm 0.5^\circ\text{C}$) had the highest overall sensory assessment score across all organoleptic criteria, including color, flavor, texture, taste, and overall acceptability, during both seasons, according to the overall view of the results.

Keywords: 1-MCP, storage condition, Sapota, Kalipatti

Introduction

In India, the tropical evergreen fruit-bearing sapota tree [*Manilkara achras* (Mill.) Fosberg] is commonly referred to as Chikoo. In some places, it is also referred to as Sapodilla Plum, Chico, Zapote, Nispero, etc. (Yahia and Gutierrez-Orozco, 2011) [33]. It belongs to the family Sapotaceae. It is thought that Sapota originated in Central America or Southern Mexico (Siddiqui *et al.*, 2014) [29]. Fruit is a fleshy berry variable in shape like round, globular, conical and oval. The fully ripe fruit is delicious and sweet chiefly used for fresh table purpose. Sapota is a rich source of sugars (12-18%), proteins (0.7 g/100 g), ascorbic acid (6.0 mg/100 g), phenols (15.35 mg gallic acid equivalents/100 g) and carotenoids (1.69 mg β -carotene/100 g). It is also rich in minerals such as phosphorus (27 mg/100 g), calcium (28 mg/100 g), iron (2.0 mg/100 g), potassium (193 mg/100 g) and copper (0.086 mg/100 g) (Ugalat *et al.*, 2012) [32].

As a climacteric fruit, sapota has a short shelf life, and about 30-35 per cent of fruits are lost during harvesting, storage, grading, transportation, packaging and distribution which resulting in significant post-harvest losses in India (Khurana and Kanawjia, 2006) [11]. It's ripening is characterized by an increased rate of respiration, and then a burst of ethylene biosynthesis during ripening. The production of ethylene in climacteric fruits, which means an initial concentration of ethylene causes an increase in production of ethylene. 1-methylcyclopropene (1-MCP) is an effective inhibitor of ethylene action and binds irreversibly to ethylenereceptors. The affinity of 1-MCP for ethylene receptors is approximately ten times greater than that of ethylene, making it effective at much lower

concentrations. The effective concentration of 1-MCP differs among fruit species and is influenced by the objective of application, including delay of ripening, prolongation of storage life and maintenance of fruit quality; for example, in apple and Japanese pear (Kashimura *et al.*, 2010) [10], papaya (Manenoi *et al.*, 2007) [16], sapota (Thakriya *et al.*, 2022) [31], pear (Calvo and Sozzi, 2009) [5] and plum (Luo *et al.*, 2009) [14]. Consequently, this study was carried out to evaluate the effectiveness of this non-sophisticated technology in extending the postharvest life of sapota under ambient and low-temperature storage conditions with minimal environmental impact.

Materials and Methods

The current investigation was conducted at the Centre of Excellence on Post-Harvest Technology, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India, during the winter and summer seasons of 2020-21 on sapota cv. Kalipatti. The sapota fruits were treated with different concentrations of 1-MCP and stored under ambient temperature and low-temperature conditions (12.0 ± 0.5 °C). All twelve treatments were repeated three times. Observations were recorded at five-day intervals. The pooled experimental data were subjected to statistical analysis using the analysis of variance (ANOVA) technique as described by Panse and Sukhatme (1985) [19]. Fruits stored under ambient temperature were discarded after 10 days due to over-ripening.

Table 1: Treatment details of experiment

Treatments	Treatment detail
T ₁	1-MCP @ 0 nL L ⁻¹ + ambient temperature
T ₂	1-MCP @ 0 nL L ⁻¹ + low temperature
T ₃	1-MCP @ 20 nL L ⁻¹ + ambient temperature
T ₄	1-MCP @ 20 nL L ⁻¹ + low temperature
T ₅	1-MCP @ 40 nL L ⁻¹ + ambient temperature
T ₆	1-MCP @ 40 nL L ⁻¹ + low temperature
T ₇	1-MCP @ 60 nL L ⁻¹ + ambient temperature
T ₈	1-MCP @ 60 nL L ⁻¹ + low temperature
T ₉	1-MCP @ 80 nL L ⁻¹ + ambient temperature
T ₁₀	1-MCP @ 80 nL L ⁻¹ + low temperature
T ₁₁	1-MCP @ 100 nL L ⁻¹ + ambient temperature
T ₁₂	1-MCP @ 100 nL L ⁻¹ + low temperature

Application of 1-MCP

Sapota fruits were treated with a 1-MCP solution prepared by dissolving 25 mg of 1-MCP powder (98% active ingredient) in 1 L of distilled water to obtain a concentration of 1000 nL L⁻¹. Different concentrations of 1-MCP (20, 40, 60, 80, and 100 nL L⁻¹) were prepared in the same manner. The solution was used within 10 minutes of preparation. The fruits were placed in airtight plastic polythene containers (25 µm thickness) along with a cup containing the solution of known 1-MCP concentration. The treatments were applied for 24 hours at 20 °C. After treatment, the fruits were transferred to both storage conditions.

Storage of fruit

After the application of 1-MCP treatments, all fruits were packed in corrugated fibreboard (CFB) boxes and stored under ambient conditions and low-temperature storage (12.0

± 0.5 °C with 80-85% relative humidity) at the Centre of Excellence on Post-Harvest Technology, ASPEE College of Horticulture, Navsari Agricultural University, Navsari.

Results and Discussion

TSS (°Brix)

It is observed from Fig. 1 that the increase in TSS was observed as the storage period increase. Significantly maximum TSS content was recorded in treatment T₁ (23.07 °Brix) and T₃ (23.43 °Brix) which was at par with T₅, T₇ and T₉ at 5th and 10th day, respectively. The maximum TSS content was noted in treatment T₂ (23.10 °Brix) at 15th day and T₄ (23.40 °Brix) at 20th day. According to Moo-Huchin *et al.* (2013) [17] in sapota, the total soluble solids content of 1-MCP treated fruits was significantly higher as compared with that of untreated fruit. They inferred that the effect on treated fruits could be attributed to their low respiration rate (Blankenship and Dole, 2003) [4]. 1-MCP showed a significant effect on total soluble solids of Alphonso mangoes (Gaikwad *et al.*, 2020) [9]. Slow increase in TSS and sugars of fruits during storage in those treated with 1-MCP may be due to the slower breakdown of complex organic metabolites into simple molecules during extended period of storage. Similar results were witnessed by Qiuping *et al.* (2006) [23] in sapota, Sepahvand *et al.* (2013) [27] in pomegranate, Reddy *et al.* (2017) [26] in mango, Baswal *et al.* (2021) [3] in mandarin and Cheng *et al.* (2020) [6] in ber.

Total sugars (%)

It is evident from Fig. 2 that significantly maximum total sugars were recorded in treatment T₁ at 5th day (17.26 %) and 10th day (18.34 %) which was at par with T₃, T₅, T₇ and T₉ at 10th day of storage. On 15th and 20th day of storage, the maximum total sugars content was noted in treatment T₂ (18.27 %) and T₄ (18.40 %). The total sugars were greater at ambient temperature due to higher rate of respiration. This finding is in agreement with the reports of Moo-Huchin *et al.* (2013) [17] and Kumar *et al.* (2016) [13] in sapota; Shi *et al.* (2013) [28] in apricot; Yasunaga *et al.* (2018) [34] in mango and Baswal *et al.* (2021) [3] in mandarin.

Titrateable acidity (%)

The decreasing trend was observed in titrateable acidity as the storage period increase (Fig. 3). Results indicated that the maximum titrateable acidity was noted in treatment T₁₂ at 5th day (0.250 %), 10th day (0.194 %), 15th day (0.127 %) and 20th day (0.101 %). Whereas, the minimum titrateable acidity was observed in treatment T₁ at 5th day (0.107 %) and 10th day (0.065 %), T₂ at 15th day (0.067 %) and T₄ at 20th day (0.061 %). The sapota fruit stored at lower temperature were recorded the highest acidity as compared to the ambient temperature. This might be due to slower down the process of respiration and oxidation at lower temperature which leads to minimize the utilization of organic acids. Comparable results have also been documented by Tandel (2009) [30], Praveena *et al.* (2013) [22] and Kumar *et al.* (2016) [13] in sapota, Prasanna *et al.* (2000) [21] in custard apple, Rathore *et al.* (2007) [24] and Yasunaga *et al.* (2018) [34] in mango.

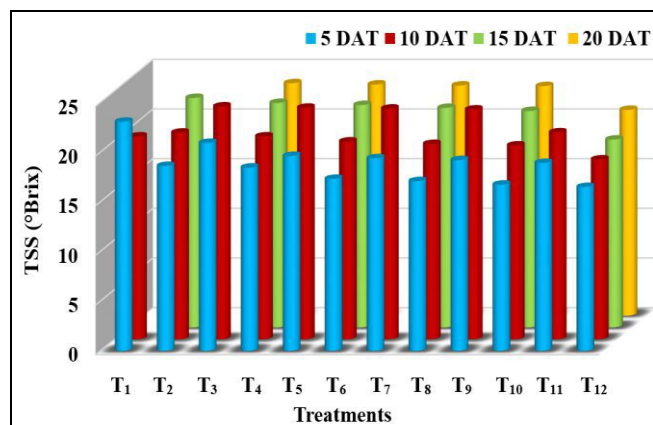


Fig 1: Effect of 1-MCP and storage conditions on TSS (°Brix) of sapota cv. Kalipatti

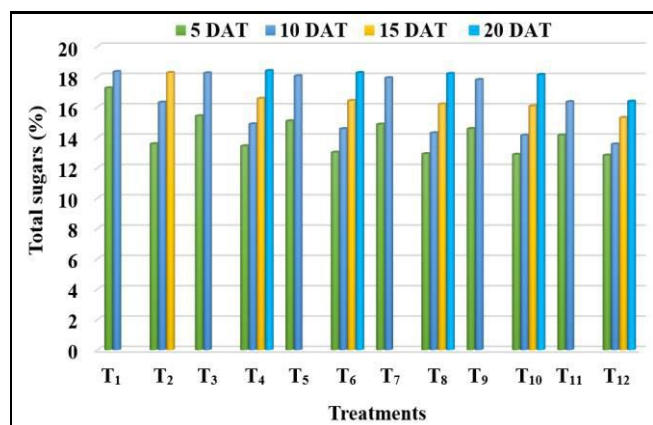


Fig 2: Effect of 1-MCP and storage conditions on total sugars (%) of sapota cv. Kalipatti

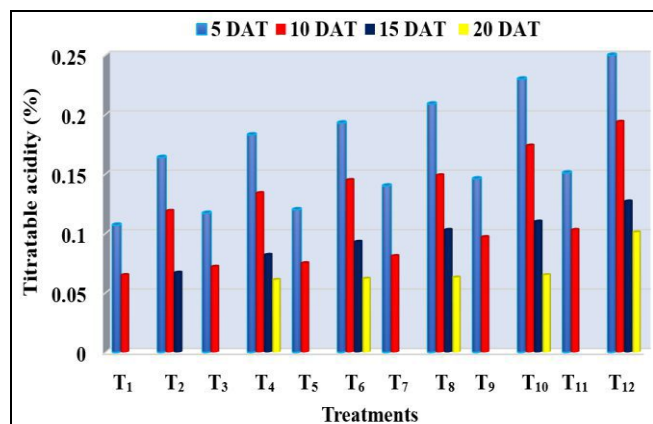


Fig 3: Effect of 1-MCP and storage conditions on titratable acidity (%) of sapota cv. Kalipatti

Shelf life (days)

It is evident from Fig. 4 that the application of 1-MCP at 100 nL L⁻¹ and stored at low temperature (12.0 ± 0.5 °C) resulted in the maximum shelf life of 22.39 days. 1-MCP is a compound capable of inhibiting ethylene action and has been shown to effectively reduce the rate of post-harvest deterioration in fruits, thereby offering significant potential for extending fruit shelf life (Moo-Huchin *et al.*, 2013) [17]. The positive effect of 1-MCP on fruit shelf life has also been reported by other researchers *viz.*, Penchaiya *et al.* (2006) [20], Ayele *et al.* (2012) [2] and Faasema *et al.* (2014) [8] in mango.

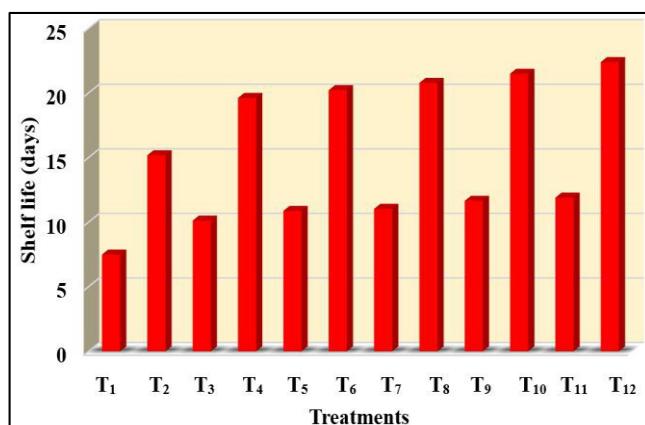


Fig 4: Effect of 1-MCP and storage conditions on shelf life (days) of sapota cv. Kalipatti

Overall Sensory Evaluation

From the Table 2, the maximum overall sensory evaluation score was noted in treatment T₁₀ *i.e.*, colour (8.81), flavour (8.53), texture (8.33), taste (8.28) and overall acceptability (8.52). Whereas, the minimum overall sensory evaluation score was obtained in treatment T₁ *i.e.*, colour (6.28), flavour (5.97), texture (6.17), taste (6.17) and overall acceptability (6.19). According to Kumar *et al.* (2015) [12] in mango, 1-MCP application can be used effectively to reduce the respiration rates and fruit softening during low temperature storage which extend storage life without adverse effects on quality of ripen fruits. Reduction in temperature of fruits which retarded the ripening and kept the fruits fresh and firm till the end of their shelf life resulted in higher organoleptic score in sapota (Rathva *et al.*, 2017) [25]. Findings of Mahajan *et al.* (2010) [15] in pear, El-Abbasy *et al.* (2013) [7] in citrus, Alvarez-Herrera *et al.* (2016) [1] in Dragon fruit and Ohashi *et al.* (2016) [18] in papaya also witnessed in the present study.

Table 2: Effect of 1-MCP and storage conditions on overall sensory evaluation of sapota cv. Kalipatti (average score of two seasons)

Treatments	Overall sensory Evaluation				
	Colour	Flavour	Texture	Taste	Overall acceptability
T ₁	6.28	5.97	6.17	6.17	6.19
T ₂	6.83	6.61	6.59	6.50	6.65
T ₃	7.28	7.00	7.11	7.03	7.15
T ₄	7.86	7.44	7.45	7.36	7.53
T ₅	7.58	7.25	7.31	7.19	7.35
T ₆	7.83	7.53	7.56	7.50	7.60
T ₇	7.97	7.64	7.69	7.67	7.74
T ₈	8.36	8.08	8.00	7.95	8.09
T ₉	8.17	7.92	7.84	7.83	7.95
T ₁₀	8.81	8.53	8.33	8.28	8.52
T ₁₁	7.11	6.78	6.75	6.70	6.86
T ₁₂	7.28	6.89	6.92	6.89	6.99

Conclusion

Based on the current investigation's results, it can be concluded that, the fumigation with 1-MCP at 80 nL L⁻¹ under low-temperature conditions (20 °C for 24 hours) followed by storage at 12 ± 0.5 °C was found to be the most effective in extending shelf life and maintaining acceptable quality parameters of sapota fruits, with a higher overall sensory evaluation score.

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