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Research Article

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Effect of Postharvest Application of Putrescine on Shelf Life and Quality of Guava Fruit cv. Hisar Safeda under Cold Storage Conditions

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Abstract

Guava (Psidium guajava L.) cv. Hisar Safeda is a commercially important tropical fruit known for its high nutritional value but suffers from rapid postharvest deterioration. Uniform, bruise-free and disease-free fruits were harvested and treated with putrescine (0.5, 1.0, 2.0, 3.0 and 4.0 mM), while untreated fruits served as control. The treated fruits were packed in corrugated fiber board (CFB) boxes lined with paper and stored at 6°C with 85–90% RH. Physical and biochemical parameters were recorded at 5 days of interval during cold storage Results demonstrated that 2.0 mM putrescine was most effective in maintaining fruit quality, showing significantly lower physiological weight loss (10.08%), spoilage, higher fruit firmness, and superior preservation of chlorophyll content compared to control treatment. The study concludes that postharvest application of 2.0 mM putrescine significantly extends storage life and maintains quality parameters of guava cv. Hisar Safeda under cold storage conditions

Keywords: Guava, Putrescine, Postharvest treatment, Cold storage, Fruit quality, Shelf life

1. Introduction

Guava (Psidium guajava L.), belonging to the family Myrtaceae, is widely recognized as the "Apple of the Tropics" due to its exceptional nutritional profile and commercial significance [1]. India stands as the global leader in guava production, contributing over 40% of world output with cultivation spanning 358.14 thousand hectares and yielding 5,349.98 thousand metric tonnes annually [2]. The Hisar Safeda cultivar is particularly valued for its attractive appearance, white pulp, and acceptable taste profile [3]. Nutritionally, guava surpasses many fruits, containing four times more vitamin C than oranges while serving as an excellent source of niacin, thiamine, calcium, phosphorus, and iron [4]. Despite its nutritional superiority, guava faces significant postharvest challenges due to its climacteric nature, resulting in rapid ripening, softening, flavour loss, colour changes, and microbial spoilage [5]. This rapid deterioration creates substantial bottlenecks in postharvest management and marketing operations, necessitating effective preservation strategies.

Polyamines, including putrescine, spermidine, and spermine, represent low molecular weight aliphatic amines present in living cells that play crucial roles in cellular processes such as division, differentiation, and growth [6]. Among polyamines, putrescine has garnered considerable attention for its capacity to prolong fruit shelf life by inhibiting ethylene biosynthesis, reducing respiration rates, and stabilizing cell membranes, thereby delaying ripening and senescence [7]. Previous research has demonstrated putrescine's effectiveness in maintaining quality across various fruits including pitaya, lime, pear, and papaya [8-11]. These treatments enhance antioxidant enzyme activities and delay microbial growth, contributing to extended storage potential.

2. Materials and Methods

Matured and uniform guava fruits cv. Hisar Safeda were harvested from the orchard, Khu Ber Vala and treated with putrescine. For further investigations of storage, guava fruits 1.5 kg per replication fruit for reach replication were selected, washed, dried, and disinfected with 100 ppm sodium hypochlorite solution packed and stored with 5% ventilation in corrugated fiber board (CFB) boxes. Various physical and chemical observations regarding the quality and storage potentials were done on the day of harvesting along 5, 10, 15, and 20 days of storage. Storage was maintained at 6°C and 85-90% relative humidity.

The physiological loss in weight (PLW) of the fruit was determined with formula given by Srivastava and Tandon (1968) on the basis

of initial weight of the fruit and loss in weight that occurred and were expressed in percent [12]. Spoilage was assayed by counting number of fruits get spoiled and/or display fungal mycelia or sporulation and is expressed as per cent spoilage of fruits. Fruit firmness of flesh was measured on two paired sides of fruits with the help of 'Penetrometer' (Model FT-327, QA Supplies, Norfolk, VA, USA) after removing about 1 cm2 peel on both sides of the fruits. The pressure required to force a stainless-steel probe of 8 mm in diameter into peach flesh was recorded. It was measured in terms of kg/cm2. Total soluble solids (TSS) content was determined with the help of an Erma hand refractometer, Japan and expressed in per cent after making the temperature correction at 20°C. Titratable acidity (TA) was estimated by the method described by AOAC (2000) [13]. TSS/TA was then calculated by dividing the TSS (%) value by the corresponding TA (%) value, which served as an indicator of the balance between sweetness and acidity influencing the flavour quality of guava fruits. The pH of the juice was measured by dipping the electrode of pH meter inside the juice (150ml) for a few seconds, and stabilized pH reading was recorded. Before every observation, the bulb of pH meter was washed with double-distilled water to eliminate the residual effect. Estimation of chlorophyll 'a' and 'b' content in guava fruit was estimated by the method described by Barnes et al 1992 [14].

Statistical analysis The experiment was laid out in a completely randomized design (CRD) with three replications for each treatment. Mean was separated using LSD test. Differences were considered significant at the level $p \leq 0.05$ using statistical analysis system software Statistix 10 (Windows).

3. Results and Discussion

3.1 Physiological Loss in Weight

Physiological weight loss increased progressively throughout storage across all treatments, but putrescine applications significantly reduced losses compared to control (Figure 1). The minimum average weight loss was recorded in fruits treated with 2.0 mM putrescine, followed by 3.0 mM and 4.0 mM treatments, which were statistically comparable. Control fruits exhibited maximum weight loss, statistically similar to the 0.5 mM putrescine treatment. Storage duration significantly influenced weight loss patterns, with minimum losses observed on day 5 and maximum losses on day 20. The 2.0 mM putrescine treatment maintained superior performance throughout storage, showing the lowest weight loss on day 5 and day 20, compared to control fruits. These results align with findings by Martinez-Romero et al (2002), who suggested that putrescine modifies cell wall characteristics and tissue water permeability, thereby reducing transpiration losses [15].

3.2 Spoilage (%)

Putrescine treatments significantly reduced spoilage incidence compared to control fruits throughout the storage period (Figure 2). The lowest mean spoilage occurred in fruits treated with 2.0 mM putrescine, followed by 1.0 mM and 3.0 mM treatments. Control fruits showed maximum spoilage, nearly three times higher than the best treatment. Spoilage increased progressively during storage. Notably, the 2.0 mM putrescine treatment maintained zero spoilage until day 10. At storage termination, 2.0 mM putrescine-treated fruits showed least spoilage compared to spoilage in control and other treatment fruits. The antimicrobial effects of putrescine likely contribute to reduced pathogen development, as reported by Singh et al (2022) in pears and Khosroshahi et al (2007) in strawberries [16,17].

3.3 Fruit Firmness (kg/cm2)

Fruit firmness decreased consistently throughout storage in all treatments, but putrescine applications significantly delayed softening processes (Figure 3). The 2.0 mM putrescine treatment maintained highest average firmness compared to control. Initial firmness was uniform across treatments, but by day 5, fruits treated with 2.0 mM putrescine retained higher firmness versus lower fruit firmness in control. This superior performance continued throughout storage was in the 2.0 mM treatment. Firmness retention results from putrescine's ability to bind with pectic substances in cell walls, inhibiting the activity of wall-degrading enzymes including polygalacturonase, pectinesterase, and pectin methylesterase [18]. Similar benefits have been reported in mango vand papaya, confirming putrescine's effectiveness across fruit species [19,11].

3.4 Total Soluble Solids (%)

TSS content increased until day 15 in putrescine-treated fruits, then declined. The 2 mM treatment showed minimum average TSS (Figure 4). Peak TSS occurred on day 15 16.77%, declining to 12.32% by day 20. Control and 0.5 mM treatments peaked earlier (day 10). Final TSS retention was highest in 2 mM treatment versus lowest TSS in control fruits. TSS increase results from polysaccharide conversion through dehydration and hydrolysis processes. Putrescine delays this conversion, maintaining lower TSS levels longer, as reported by Wannabussapawich and Serayheap (2018) in mango, Mabunda et al (2023) in papaya, and Singh et al (2022) in pear [20,21].

3.5 Titratable Acidity (%)

Titratable acidity decreased consistently during storage across all treatments. Maximum average acidity was maintained by 2 mM putrescine treatment, while control showed minimum retention (Figure 5). The 2 mM treatment consistently retained higher acidity throughout storage Acidity reduction occurs due to organic acid utilization in metabolic processes and tricarboxylic acid cycle for respiration [22]. These results align with findings by Jawandha et al (2012) in mango and Mabunda et al (2023) in papaya [23,21].

3.6 TSS: Acid Ratio

The 2 mM putrescine treatment maintained the lowest TSS:acid ratio , indicating better balance preservation, while control showed highest ratio (Figure6) . This ratio increased progressively from day zero to day 15. Lower TSS:acid ratios indicate better quality

retention, as putrescine delays TSS increase while preserving acidity through reduced respiration and ethylene synthesis [24]. The findings by Singh et al (2020) in pear fruit, Razzaq et al (2014) in mango fruits aligns with the above [19].

3.7 Juice pH

Juice pH increased throughout storage due to acid utilization, with 2 mM putrescine treatment maintaining lowest average pH versus control (Figure 7). The 2 mM treatment showed minimal pH increase as compared to control. The pH increases result from H^+ ion concentration reduction during acid utilization [25]. Similar pH control has been reported in banana and pomegranate [26].

3.8 Chlorophyll 'a' and 'b' Content (mg/100g FW)

Both chlorophyll 'a' and 'b' decreased progressively during storage. The 2 mM putrescine treatment retained highest chlorophyll 'a' and 'b' compared to control (Figure 8 and 9). Final retention was superior in 2 mM treatment for both chlorophyll 'a' and 'b' versus control. Chlorophyll degradation represents characteristic ripening in climacteric fruits. Putrescine's protective effect through peroxidase activity inhibition has been documented by , with similar benefits reported in pear and mango [27-30].

4. Conclusion

On the basic of the results obtained in present investigation, it is inferred that the application of putrescine after the harvesting of guava cv. Hisar Safeda significantly maintained the shelf life and quality. Among the various concentrations, putrescine (2mM) was found to be the most effective in order to delay the ripening and extending the life of storage (20 days under cold storage) of guava fruits. Putrescine (2mM) showed a significant reduction in weight loss, spoilage loss, juice pH while maintained maximum firmness, TSS, TA, TSS:acid ratio and chlorophyll 'a' and 'b content.

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