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# Impact of postharvest melatonin treatments on textural profile and colour attributes in guava (*Psidium guajava* L.)

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**Abstract**
The effect of melatonin on various functional characteristics of guava (*Psidium guajava* L.) cv. Allahabad safeda was investigated. The guava fruits were treated with different concentrations of melatonin, 200 µM, 400 µM, 600 µM and 800 µM melatonin, and stored at ambient storage conditions (28±2 °C; 70-80% R.H.). The experiment was laid out in completely randomized design, replicated thrice and functional parameters were recorded at four days interval up to twelfth day of storage period. Treatments with higher concentration of melatonin i.e. 800 µM melatonin treatment significantly reduced the loss of weight acting as best treatment. A significant role is of peel color in determining fruits quality. The fruits treated with higher concentrations of melatonin, 800 µM showed uneven ripening. Even after 12$^{th}$ day of storage period, the fruits did not degrade chlorophyll because of internal $CO_2$ injury. The textural characters including springiness, hardness and adhesiveness of guava was also maintained by melatonin treated fruits then untreated fruits. Other textural properties including cohesiveness was minimally maintained by melatonin treated guavas.

**Keywords:** Guava, melatonin, textural characteristics, weight loss, color

## 1. Introduction

Guava (*Psidium guajava* L.), belonging to Myrtaceae family a native of tropical America, is a significant fruit crop grown across tropical and subtropical areas of the world. Because of its delicious taste, pleasent flavour, digestive properties and enriched nutritional value it is an outstanding table fruit highly valued by the consumer. Additionally, ascorbic acid, phenolics, and carotenoids, which have significant antioxidant capacities, are found in abundance in the fruit (Musa *et al*., 2011) [20]. Additionally, guava consumption can lower blood pressure, triglycerides, and serum cholesterol while increasing levels of good cholesterol (Mangaraj *et al*. 2014) [19]. Its high pectin content also lowers the risk of cardiovascular diseases. Despite the fruit's high nutraceutical content and several health benefits, it is difficult to keep it at room temperature for an extended amount of time. The fruit quickly ripens and softens after being harvested due to its climacteric character, exhibiting strong respiration, ethylene production, and metabolic processes that cause degradation. The fruit becomes soft and mealy after 3 days of storage at room temperature, rendering it unusable for marketing (Kanwal *et al*. 2016) [14]. The fruit's thin and fragile skin makes it particularly prone to bruising harm as well as microbiological attack. Guava is susceptible to chilling injury at temperatures below 10 °C, which results in symptoms including skin pitting and browning of the skin and flesh (Etemadipoor *et al*. 2020) [5]. As a result, it is extremely difficult to increase guava's shelf life at low temperatures. Because to these factors, a sizeable amount of the overall guava crop is lost after harvest, and because to its short postharvest life, transportation to distant markets is challenging (Jha *et al*. 2015) [13]. There have been many postharvest handling techniques created during the last few decades to increase fruit's shelf life. It's interesting to note that exogenous melatonin treatment can improve fruit disease resistance and chilling tolerance in addition to delaying fruit ripening and senescence (Gao *et al*., 2018; Li *et al*., 2019b; Liu, Huang, *et al*., 2020) [7, 15, 17]. Additionally, the melatonin therapy had a significant impact on fruit quality preservation and shelf-life extension, showing promise for commercial use.

Melatonin (N-acetyl-5-methoxytryptamine, MT), was first discovered in the pineal gland, a type of bioactive molecule synthesized with tryptophan as a matrix (Hu et al., 2018) [10]. Exogenous melatonin has been shown in prior research to be an advantageous hormone for maintaining the quality of delicious cherries (Wang *et al*., 2019) [24] and delaying the senescence of peach fruit (Gao *et al*., 2016) [8].

Melatonin has been shown to have a variety of roles in plants, including scavenging free radicals and promoting plant resilience to biotic and abiotic stressors (Arnao & Hernández-Ruiz, 2015) [3]. After harvest, melatonin treatment can enhance the quality of tomatoes (Sun *et al*., 2016) [22], lessen decay and preserve the quality of strawberries (Aghdam & Fard, 2017; Liu, Zheng, Sheng, Wei, & Lei, 2018) [1, 16], postpone the senescence and chilling injury of peaches (Cao, Song, Shao, Bian, Chen, & Yang, 2016; Gao *et al*., 2017; Hui, Zheng *et al*., 2016) [4, 6, 12] decline the physiological degradation of cassava (Ma, Zhang, Zhang, & Wang, 2016) [18] and ripening of banana delayed (Hu *et al*., 2017) [11] during storage. Melatonin also has a role in the regulation of plant growth and affects the biosynthetic pathways of other plant hormones (Arnao & Hernández-Ruiz, 2007; Sun *et al*., 2015) [2, 23]. By up-regulating the expression of 1-aminocyclopropane-carboxylic acid synthase 4 (ACS4) during tomato ripening, melatonin boosted ethylene production (Sun *et al*., 2015) [23]. Melatonin, however, etiolated lupin hypocotyls (Arnao & HernándezRuiz, 2007) [2] and decreased ethylene production in pears (Rui *et al*., 2018) [21]. Thus, ethylene synthesis in plants can be induced or inhibited by melatonin depending on the mechanism. The influence of various melatonin concentrations on the functional characteristics of guava fruit was investigated in the current study.

## 2. Materials and Methods

### 2.1 Fruit materials and treatments

Fresh guava fruits (*Psidium guajava* L.) cv. Allahabad safeda were harvested at commercial maturity stage (peel colour break stage, when skin colour changes from dark green to light green) from a commercial guava grower in Varanasi district. Fruits that are uniform in size, weight, and colour were chosen for the experiment.

For preparing melatonin solution, it was dissolved in ethanol and then diluted to 200 µM, 400 µM, 600 µM, and 800 µM for treatment. The fruits were treated using sodium hypochlorite 0.05% by immersing for 2-3 min for disinfection followed by rinsing using distilled water and air-dried. Twenty fruits in each replication were treated with different concentrations of melatonin solution for determination of weight loss, textural properties and color of the sample. Treatment using distilled water served as the control. After that, the fruits were air-dried at room temperature for 1 h and then stored at ambient storage conditions (28±2 °C; 70- 80% R.H.). The functional quality attributes were recorded at 4 days interval up to 12 days of storage period.

### 2.2 Measurement of quality attributes including weight loss, color and textural profile

The weight loss of each guava was recorded at each sampling point. Weight loss was calculated by the formula given as: $(A - B)/A \times 100$, where A represented the initial weight of each guava just before storage and B is the weight of fruit after special period storage.The result was calculated by taking the average of twenty fruits.

The Hunterlab Colorimeter was used to gauge the fruit's surface color (Hunterslab Technical Manual, 2008) according to (L, a, b) values. The L stood for lightness, a-greenness, and b-yellowness values in the 400–700 nm range, with a 10 nm spectral resolution and a 1 nm wavelength precision.

A handheld penetrometer (TA.XT Plus, Stable Micro Systems Ltd., UK) with a load cell of 50 kg and a compression plate probe with a diameter of 75 mm was used to assess the pulp's textural profile near the fruit's equator, where a portion of rind (1.5 cm and 4 mm deep) had been excised. Prior to compression, the speed of the probe was standardised and maintained at 2.0 mm/s. A 25 °C room temperature was used for the texture analysis. The firmness was defined as the penetrating force at its highest. For each guava, three readings were taken. The textural properties include springiness, cohesiveness, adhesiveness and hardness.

### 2.3 Statistical analysis

Completely randomized design was used for the experiment with three replications and the results were described as the mean±standard deviation (SD). The data were analysed from various estimations during storage were statistically evaluated for significance ($p<0.05$) of the treatment using analysis of variance (ANOVA) and the means were separated by Duncan’s multiple range test using SAS 9.4 software.

## 3. Results and Discussion

### 3.1 Weight loss

Weight loss, calculated as percentage loss compared to the initial weight, increased immediately as increasing storage conditionin regards with different treatment and continued throughout storage (Fig. 1A). Significant differences in weight loss was observed after 4th day, 8th day and 12th day of storage among different treatments. It was seen that with increasing concentrations of melatonin treatments the percentage of weight loss reduced at different storage conditions. The treatment T4 (melatonin 800 µM) had the least reduction in weight loss and the maximum reduction was observed in T0 (control) at all the stages of observation. According to our finding, during postharvest ripening of guava, exogenous melatonin controlled the expression of ACO and ACS, which suppressed ethylene production. Thus, it can be concluded that melatonin suppressed ethylene biosynthesis in order to delay fruit ripening. The investigation of bananas under natural conditions (Hu *et al*., 2017) [11] and pears (Rui *et al*., 2018) [21] found similar findings. Additionally, melatonin significantly reduced the rate of ethylene synthesis in etiolated lupin seedling roots by up to 65% (Arnao & Hernández Ruiz, 2007) [2]. This suppressed ethylene synthesis prevented the respiration process from increasing, which helps to prevent water loss from fruits and maintain the weight loss process in fruits.

### 3.2 Color

Peel color plays a significant role in determining a fruit's quality, including its level of maturity and time of harvest. The color of the fruit peel has a significant impact on consumer preference. A number of physio-chemical processes, such as the breakdown of chlorophyll and an increase in the carotenoid pigments of the peel brought on by enzymatic oxidation and photodegradation, may be responsible for the development of peel color during storage. Browning of the tissues is indicated by a decline in L value. 800 µM melatonin caused the least amount of browning in comparison to untreated and lower concentrations of melatonin treated samples (Table 1). Positive a-values suggest red color, while negative a-values indicate greenness. The loss of fruit greenness is indicated by the negative value's progressive reduction over the course of storage. Regardless of the treatment, the negative a-value dropped from the date of harvest until the end of their storage life. However, higher concentrations of melatonin (800 µM) demonstrate maximal preservation of negative a value or greenness up to later storage conditions as compared to untreated one. The rise in yellowness from the day of harvest till the end of their storage life is indicated by a positive b-value. Both untreated and treated fruits experienced an increase in b-value as of the day of harvest, while fruits treated with 800 µM melatonin had a lower b-value in comparison to control and other treatments.

**Table 1:** Effect of different concentrations of melatonin on surface color in guava fruit under ambient storage condition

| **Treatments** | **Storage days** | | |
|---|---|---|---|
| L | 4TH DAY | 8TH DAY | 12TH DAY |
| T0 | 67.22±0.26ª | 72.58±0.22ª | 72.25±0.17ª |
| T1 | 67.41±0.27ª | 68.27±0.13ᶜ | 71.41±0.32ᵇ |
| T2 | 65.43±0.15ᵇ | 67.44±0.14ᵈ | 67.60±0.15ᶜ |
| T3 | 67.55±0.10ª | 72.27±0.19ª | 67.19±0.10ᶜᵈ |
| T4 | 67.13±0.06ª | 71.04±0.41ᵇ | 66.72±0.12ᵈ |
| TREATMENTS | STORAGE DAYS | | |
| a | 4TH DAY | 8TH DAY | 12TH DAY |
| T0 | 4.33±0.16ª | 15.06±0.24ª | 17.97±0.37ª |
| T1 | -2.66±0.12ᵇ | 10.31±0.23ᵇ | 12.34±0.36ᵇ |
| T2 | -9.32±0.38ᶜ | -4.53±0.22ᶜ | -3.22±0.24ᶜ |
| T3 | -11.21±0.20ᵈ | -7.43±0.17ᵈ | -5.46±0.16ᵈ |
| T4 | -14.38±0.21ᵉ | -11.42±0.21ᵉ | -9.52±0.22ᵉ |
| TREATMENTS | STORAGE DAYS | | |
| b | 4TH DAY | 8TH DAY | 12TH DAY |
| T0 | 45.28±0.39ª | 47.40±0.26ª | 47.50±0.44ª |
| T1 | 42.66±0.19ᵇ | 43.42±0.35ᵇ | 43.90±0.70ᵇ |
| T2 | 36.55±0.14ᶜ | 37.95±0.18ᶜ | 38.26±0.17ᶜ |
| T3 | 35.60±0.15ᵈ | 37.22±0.11ᶜ | 37.68±0.12ᶜ |
| T4 | 35.12±0.18ᵈ | 36.02±0.27ᵈ | 36.40±0.11ᵈ |

Each value is the mean for three replicates. Within a column, means followed by different letters are significantly different ($p<0.05$) according to the DMRT post-hoc analysis. Here T0 = control, T1= Melatonin 200 µM, T2= Melatonin 400 µM, T3= Melatonin 600 µM, T4= Melatonin 800 µM.

### 3.3 Textural profile

Fruit textural property is frequently considered one of the most important parameters among different significant quality attributes, assessed by the consumer and is therefore crucial to the acceptance of the entire product. Guava experiences a rapid loss of textural properties during senescence, which significantly shortens its postharvest life and makes it more vulnerable to fungus contamination. In case of hardness the initial values for control and coated samples were comparable. Uncoated guavas started to lose their hardness on the fourth day of storage (Fig. 1.B). The hardness of coated guavas also decreased gradually, but on and after the fourth day of storage hardness values for coated samples were progressively higher than the control samples. With regard to coated samples, melatonin treated (800 µM) was more effective in preventing decline of fruit hardness than the other treatments at ambient condition. 800 µM melatonin treated fruits showed a significant difference with untreated fruits. Similarly in case of cohesiveness (Fig. 1.C) of uncoated guavas were seen higher than coated guavas and its value rapidly decreased after fourth day of treatment. The percentage of loss of cohessiveness in control treated fruits was higher than that of treated with higher concentrations of melatonin. The adhesiveness values (Fig. 1.D) showed a pattern opposite to cohesiveness, where the coated samples revealed higher adhesiveness value than that of uncoated samples, showed a significant difference between 800 µM melatonin treated fruit and untreated fruit. The springiness values differed significantly on 4th, 8th and 12th days after storage. The springiness was significantly higher for T4 (melatonin 800 µM) as compared to other treatments. The percentage of springiness loss (Fig. 1.E) in higher concentration of melatonin treated fruits was much maintained than that loss in untreated fruits. The ability of melatonin-treated fruits to retain their firmness may be attributed to the fruit's softening enzymes' lower activity, which is brought on by a decrease in ethylene production. According to Zhai *et al*. (2018) [25], melatonin inhibited the expression of the genes for polygalacturonase and cellulase in three cultivars of pears, delaying the breakdown of the cell wall. They further proposed that melatonin controls fruit textural changes by preventing the synthesis of ethylene. A number of physiological and biochemical changes take place during the ripening process, including the breakdown of the cell wall components, which causes the fruit to soften and the breakdown of the starch into soluble sugar. Melatonin's influence on quality alterations, such as firmness, starch, and sugar, further supports its function in fruit ripening.

### 4. Conclusion

Fruits and vegetables with longer shelf lives will benefit the farmer in timing the market and several works have shown that shelf life is improved generally with melatonin treatments. The current investigation proved that varied melatonin treatment concentrations could improve the quality of guava fruit. According to physical, color and textural atrtributes studied, it can be said that guava fruits treated with melatonin (800 µM) solution at harvest, had the best fruit quality attributes retained up to 12 days of ambient storage. The introduction of melatonin treatment can enhance both visual attributes and various quality parameters by delaying senescence and slowing respiration rate.

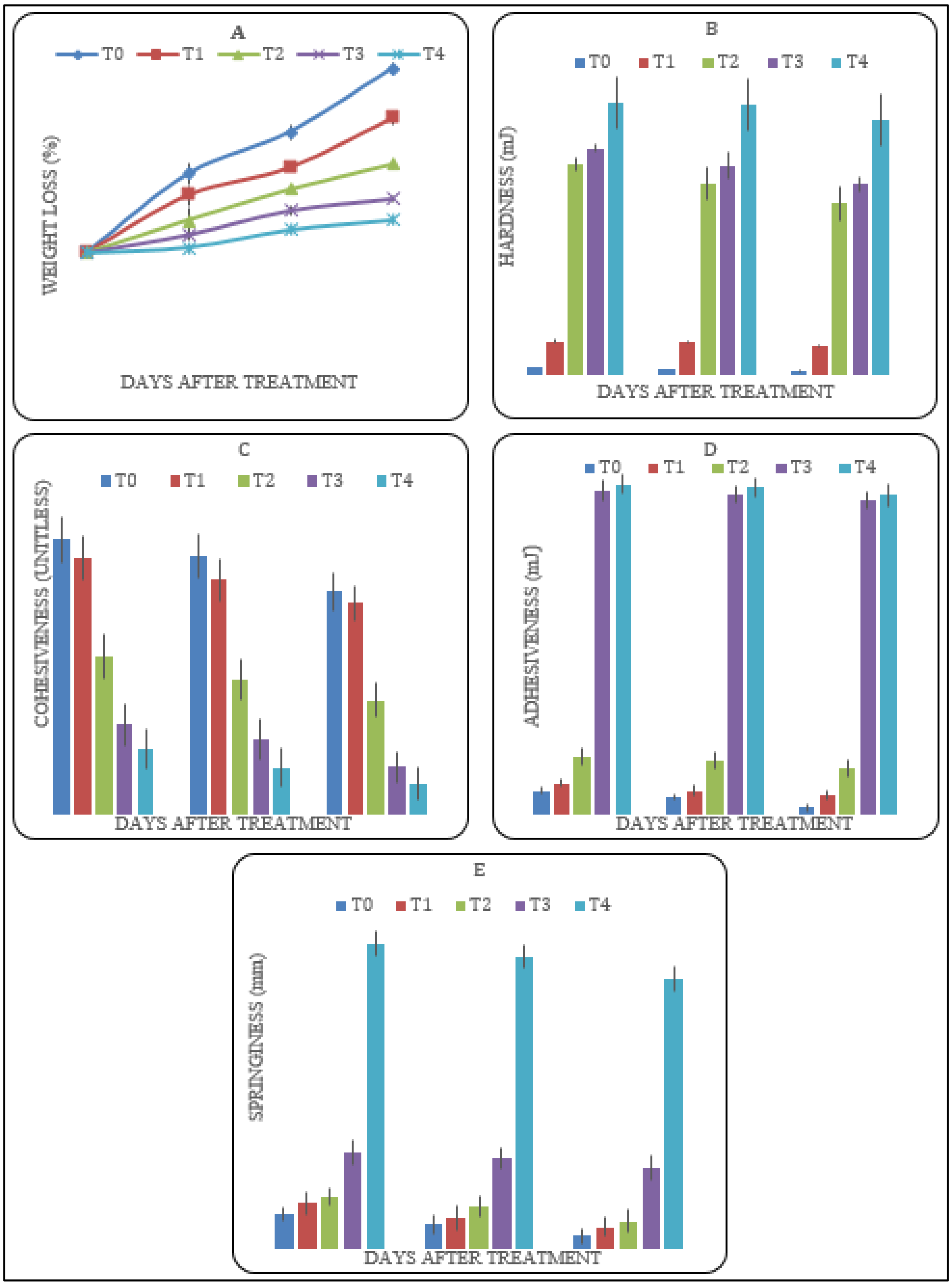


**Fig 1:** Effect of melatonin treatments on weight loss (A), hardness (B), cohesiveness (C), adhesiveness (D) and springiness (E) of guava fruits. Each value is the mean for three replicates, and vertical bars indicate the standard error. Here T0 = control, T1= Melatonin 200 µM, T2= Melatonin 400 µM, T3= Melatonin 600 µM, T4= Melatonin 800 µM.

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