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Physical Performance of *Cucumis melo* var. inodorus Fruit under Different Storage Conditions

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ABSTRACT

Melon is an economically important horticultural crop, widely cultivated for its sweet taste and nutritional benefits. However, its postharvest quality is strongly affected by storage conditions, particularly temperature, which can alter the fruit's physiology, weight, texture, and shelf life. This study aims to evaluate the effect of storage temperature on the physical quality and shelf life of *Cucumis melo* var. inodorus. The study used a Completely Randomized Design with storage temperature treatments, namely, room temperature and low temperature, with five replications. Observed variables included fruit length, fruit diameter, fruit weight, skin and flesh thickness, flesh color, texture, and shelf life during the storage period. The results showed that storage at low temperature was able to maintain weight, skin and flesh thickness, firmness, and delayed color changes, while room temperature accelerated water loss, tissue softening, and color changes. Correlation analysis revealed that greater fruit diameter was positively correlated with both fruit weight and shelf life, whereas high temperature had a negative influence on these traits. Overall, storing melon at low temperatures extended its shelf life by approximately eight days compared to room temperature, while also preserving the fruit's physical quality. These findings provide practical guidance for farmers, distributors, and retailers to minimize losses, maintain consumer quality, and enhance the market competitiveness of *Cucumis melo* var. inodorus.

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ABSTRAK

Melon merupakan komoditas hortikultura bernilai ekonomi tinggi dan banyak dibudidayakan karena rasanya manis serta kandungan nutrisi yang lengkap. Namun, kualitas buah melon saat pascapanen sangat dipengaruhi oleh kondisi penyimpanan, terutama suhu sehingga menyebabkan perubahan fisiologi buah, bobot, tekstur, dan umur simpan. Penelitian ini bertujuan untuk mengevaluasi pengaruh suhu penyimpanan terhadap mutu fisik dan umur simpan buah melon tipe Inodorus. Penelitian menggunakan Rancangan Acak Lengkap dengan perlakuan suhu penyimpanan yaitu suhu ruang dan suhu rendah yang diulang sebanyak lima kali. Variabel yang diamati meliputi panjang buah, diameter buah, bobot buah, tebal kulit dan daging, warna daging, tekstur, serta umur simpan selama periode penyimpanan. Hasil penelitian menunjukkan bahwa penyimpanan pada suhu rendah mampu mempertahankan bobot, ketebalan kulit dan daging, kekerasan, serta memperlambat perubahan warna, sedangkan penyimpanan pada suhu ruang mempercepat kehilangan air, pelunakan jaringan, dan perubahan warna. Analisis korelasi menunjukkan diameter buah yang lebih besar berpengaruh positif terhadap bobot dan umur simpan, sementara suhu tinggi menurunkan keduanya. Secara keseluruhan, penyimpanan suhu rendah memperpanjang umur simpan Cucumis melo var. inodorus sekitar delapan hari dibandingkan suhu ruang dan mempertahankan mutu fisik buah. Temuan ini memberikan informasi terkait panduan praktis bagi petani, distributor, dan pengecer untuk meminimalkan kerugian, menurunkan kehilangan hasil panen, menjaga kualitas, dan meningkatkan daya saing pasar untuk buah Cucumis melo var. inodorus.

INTRODUCTION

Horticulture is one of the agricultural sub-sectors with high economic value, encompassing ornamental plants, vegetables, medicinal plants, and fruit (Bay & Pakaenoni, 2021). Melon is among the most popular horticultural crops due to its promising economic prospects and competitive market value (Huda *et al*., 2025; Setiawati & Bafdal, 2020). Currently, various melon cultivars have been developed with differences in fruit size, shape, taste, aroma, and skin appearance, either netted or non-netted (Susanti *et al*., 2024).

Netted melons are often classified into the Cantalupensis type, whereas non-netted melons are categorized as the *Cucumis melo* var. inodorus (Habibah *et al*., 2026). *Cucumis melo* var. inodorus are characterized by yellow or white skin, a mild aroma, and relatively longer shelf life, presumably due to their lower ethylene synthesis (Schemberger *et al*., 2020). Furthermore, national melon production data show a decline of 8.79% during 2021-2023 (BPS-Statistics, 2024). One of the contributing factors is suboptimal postharvest handling (Hutabarat *et al*., 2019). The *Cucumis melo* var. inodorus was chosen because it combines desirable commercial traits such as longer shelf life and firm flesh. It also exhibits lower ethylene synthesis, making it an ideal model for studying temperature effects on postharvest quality.

Improper postharvest management negatively affected fruit quality, shelf life, and market value, leading to significant losses for both farmers and agribusiness actors (Wang *et al*., 2024). In developing countries, postharvest losses of horticultural products, including melons, are estimated to reach 15%, primarily due to limited storage facilities and inadequate handling techniques (Cassani & Gomez-Zavaglia, 2022). Therefore, the application of appropriate storage technologies, such as modified atmosphere storage, is essential to extend shelf life while reducing postharvest damage (Lv *et al*., 2024).

Although numerous studies have been conducted on melons, research focusing on the physical performance of *Cucumis melo* var. inodorus under different storage conditions remains limited. Such information is essential as a preventive measure to preserve the physiological characteristics of melons, thereby ensuring consistent quality for consumers. Based on this background, the present study aims to evaluate the physical performance of *Cucumis melo* var. inodorus under various storage conditions. The findings are expected to provide technical guidance for farmers and agribusiness stakeholders in extending storage duration and maintaining fruit quality.

METHOD

The study was conducted from April to July 2024 at the Laboratory of the Faculty of Agriculture, Universitas Perjuangan Tasikmalaya. An experimental method was applied through a Completely Randomized Design (CRD) with two storage treatments: low temperature (3-10 °C) and room temperature (20-27 °C). Each treatment consisted of five melons replications, and each replication included five melons, resulting in a total of 50 melons.

The experiment began with harvesting mature melons from farmers. The harvested fruits were selected based on specific criteria: (1). Physiological maturity, indicated by the presence of a distinct abscission layer and uniform size (1.5-2.0 kg), (2). Skin color, showing a bright yellow surface with no green patches, evaluated visually using a standardized color chart, (3). Aroma, characterized by a faint but noticeable sweet scent typical of ripe melons, and (4). Leaf senescent, confirmed by more than 70% of the plant's leaves turning yellow and showing signs of drying.

The selected fruits were then sorted and graded to obtain a uniform weight of 1.5-2.0 kg for use in the experiment. Before storage, all rooms were sanitized with technical acetone to minimize microbial contamination. The storage conditions consisted of room temperature (in the laboratory) and low temperature storage using a Polytron Showcase SCN180L, with the temperature adjusted accordingly. To ensure proper environmental conditions, measurements of temperature, relative humidity, and CO_2 concentration were conducted using an air quality detector every two days.

The variables observed included fruit length (cm) and fruit diameter (cm), measured with a digital caliper. Fruit weight (kg) was determined by weighing each melon using a JOIL digital scale with an accuracy of 3 kg x 0.1. Observations were conducted every two days during the storage period. Skin thickness (cm) and flesh thickness (cm) were measured using a ruler at the beginning of storage (0 days after storage-DAS). The final measurements were taken after the end of storage, which occured on day 45 for fruits stored at room temperature and on day 53 for fruits stored at low temperature. Shelf life (DAS) was recorded from the initial storage until the fruit was no longer suitable for consumption, characterized by dark spots and discoloration, soft and watery flesh, and fungal growth around the stem end.

Data were analyzed using the F-test followed by the Least Significant Difference (LSD) test at the 5% significance level. Correlation analysis was performed and visualized in a heatmap to determine relationships among variables. Data analysis was conducted using Statistical Tools for Agricultural Research (STAR) version 2.0.1 and Microsoft Excel 2019.

RESULTS AND DISCUSSION

Environmental Conditions

Storage environments showed distinct differences in temperature, relative humidity, and CO_2 concentration, which directly influenced fruit physiology during storage. Temperature in the room storage remained relatively stable (20-27 °C), while low temperature storage fluctuated between 3-10 °C. The instability in low-temperature storage was likely due to uneven air circulation. Although low temperatures generally reduce respiration and enzymatic activity (Pace & Cefola, 2021), fluctuations close to chilling thresholds (< 4 °C) may predispose melons to chilling injury.

Room storage maintained relative humidity levels between 37-73%, while low temperature storage ranged from 50-86%. Both conditions were below optimal relative humidity for melons (85-95%) (Zuo *et al.*, 2025). Low humidity accelerated transpiration and weight loss, whereas excessively high humidity encouraged microbial growth, both leading to faster quality deterioration.

CO_2 concentration increased steadily throughout storage, and room storage reached a maximum of 2436 ppm, while low temperature storage peaked at 4152 ppm. Although CO_2 can suppress ethylene production and slow respiration (Breemer *et al.*, 2024; Wang *et al.*, 2024), excessive accumulation under fluctuating low temperatures may contribute to off-flavors and surface disorders, similar to chilling-related damage. Overall, while controlled environmental parameters can extend the shelf life of horticultural product, the instability observed under low temperature storage in this study reduced its effectiveness for *Cucumis melo* var. inodorus.

Changes in Physical Quality in *Inodorus* Melon during Storage

The physical quality of *Cucumis melo* var. inodorus showed progressive changes during storage, with variations depending on storage temperature. Fruit length decreased slightly in both treatments, with a reduction of 1.17% at ambient temperature and 2.99% under low temperature storage. This reduction was linked to water loss during respiration and chilling injury that occurred below 4 °C, where changes in lipid phases of cell membranes increased permeability, leading to tissue shrinkage and deformation (Ifmalinda *et al.*, 2023; Zainal *et al.*, 2017). Similarly, fruit diameter gradually declined, reaching 1.73% at ambient storage and 1.66% at low temperature.

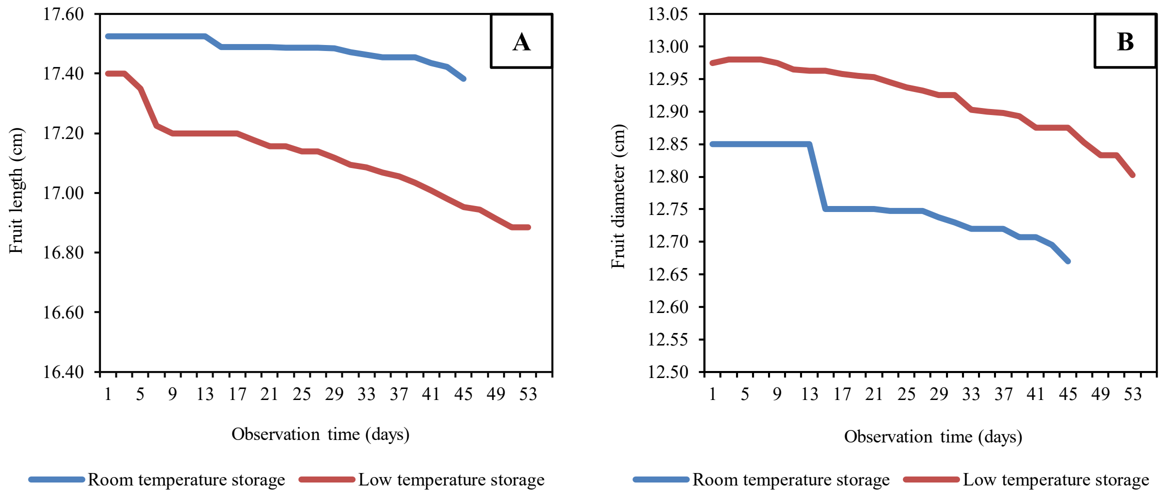

Figure 1. Changes in fruit length (A) and fruit diameter (B) of *Cucumis melo* var. inodorus during storage at room temperature and low temperature

Although both conditions induced shrinkage, low temperature storage was more effective in maintaining fruit diameter due to reduced respiration and delayed enzymatic activity (Imahori & Bai, 2024). The trend of changes in fruit length and diameter of *Cucumis melo* var. inodorus stored under room and low temperatures is presented in Figure 1.

Fruit weight loss was one of the most apparent indicators of postharvest deterioration. Weight reduction reached 7.27% at ambient storage compared to 6.70% under low temperature storage. Weight loss was driven by respiration, which was more intense at higher temperatures, thereby accelerating enzymatic metabolism and ethylene activity that degraded sucrose into glucose and fructose (Wu *et al*., 2024). These findings highlight that cold storage is more effective in maintaining fruit mass for up to two months. The fruit weight loss increased progressively during storage, with higher reduction under room temperature compared to low temperature. These changes are illustrated in Figure 2.

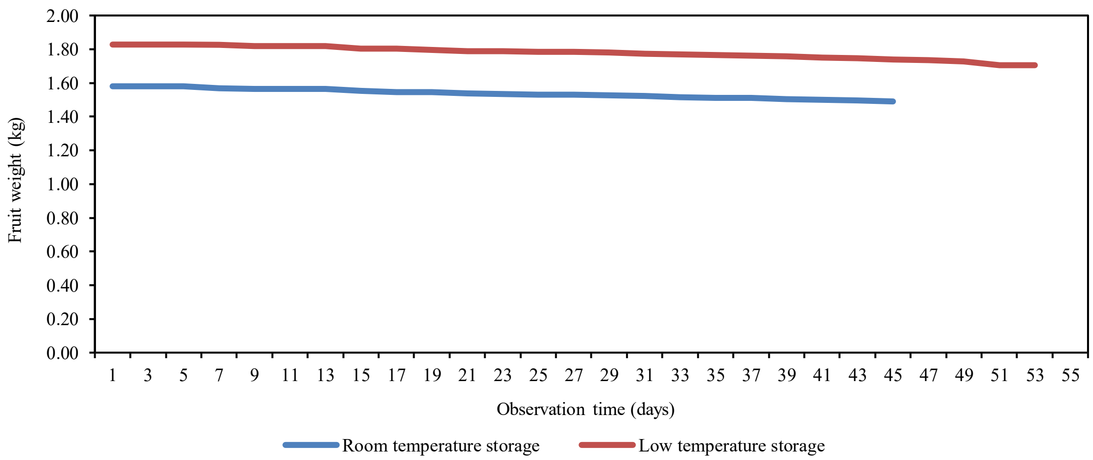

Figure 2. Fruit weight loss of *Cucumis melo* var. inodorus during storage at room temperature and low temperature

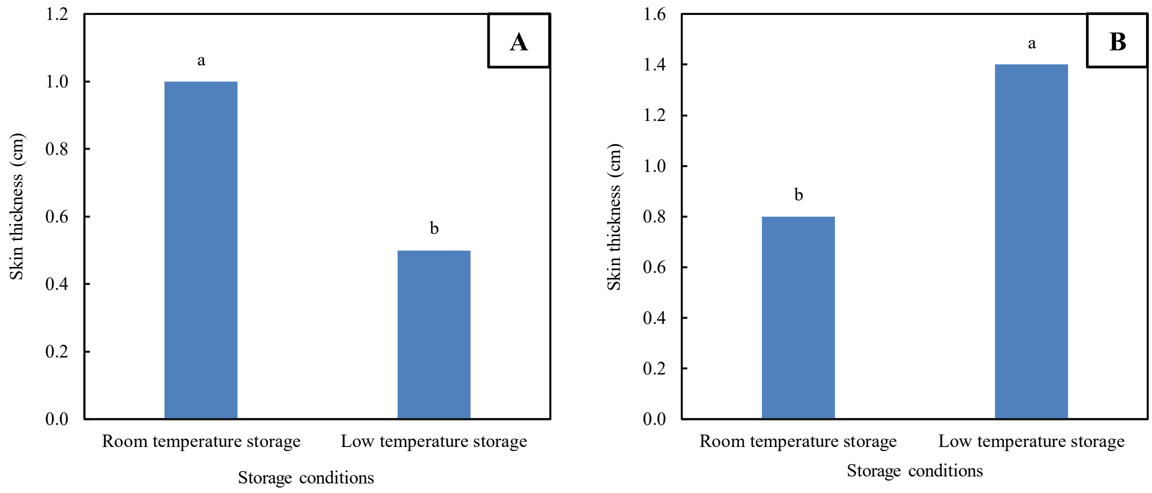

Figure 3. Skin thickness of *Cucumis melo* var. inodorus at the beginning (A) and end (B) of storage under room temperature and low temperature conditions. Different lowercase letters indicate significant differences according to the LSD test at $p < 0.05$.

Skin thickness exhibited contrasting trends between storage conditions. At ambient temperature, skin thickness declined from 1.0 cm to 0.8 cm, reflecting the softening process driven by enzymatic cell wall degradation (Kirana *et al*., 2022). In contrast, fruit stored at low temperature showed an increase from 0.5 to 1.4 cm, possibly due to delayed ripening and reduced enzymatic activity that preserved rind firmness. Changes in skin thickness of *Cucumis melo* var. inodorus at the beginning and at the end of storage are presented in Figure 3.

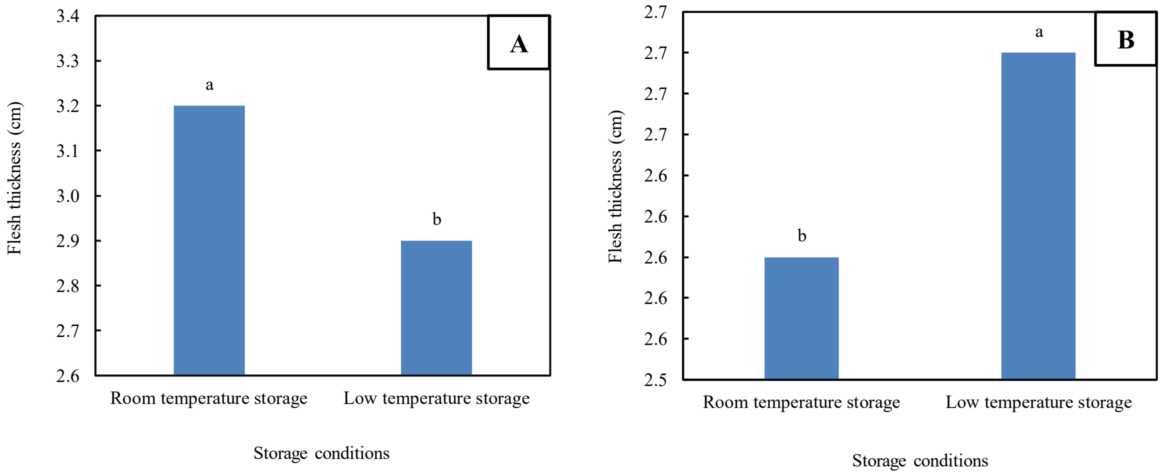

Figure 4. Flesh thickness of *Cucumis melo* var. inodorus at the beginning (A) and end (B) of storage under room temperature and low temperature conditions. Different lowercase letters indicate significant differences according to the LSD test at $p < 0.05$.

Flesh thickness also declined during storage, from 3.2 cm to 2.6 cm at ambient temperature and from 2.9 cm to 2.7 cm under low temperature. The reduction was more pronounced under ambient conditions, aligning with increased enzymatic activity, such as pectinase and cellulase, at higher temperatures that accelerated cell wall degradation

(Nurhayati *et al*., 2019). The comparative changes in flesh thickness of *Cucumis melo* var. inodorus stored under different temperature conditions are shown in Figure 4.

Color changes in melon flesh were modest but evident as storage progressed. Initially, the flesh exhibited a fresh, bright orange hue, which gradually faded to a paler shade under both ambient and low temperature. This change is attributed to modifications in carotenoid pigments, particularly β-carotene, which decrease as ripening advances (Diao *et al*., 2023). Similar trends were observed in melons stored at varying temperatures, where elevated storage temperature accelerated the metabolic decline of pigment stability (Masyin *et al*., 2023). The appearance and changes in flesh color of *Cucumis melo* var. inodorus stored at room and low temperatures at the beginning and end of storage are summarized in Table 1.

Table 1. Flesh Color Appearance of *Cucumis melo* var. inodorus at The Beginning and End of Storage under Room and Low Temperature

Storage condition	Observation time	Flesh appearance	Description
Low temperature	Initial		The melon flesh was white along the edges near the rind and bright, fresh orange in the central portion.
	Final		The flesh color gradually faded from bright orange to pale over time and across storage conditions. At the end of storage, the flesh appeared pale orange (peach), while the edges near the rind remained white.
Room temperature	Initial		The melon flesh was white at the edges near the rind and bright, fresh orange in the flesh.
	Final		The melon flesh color faded from bright orange to pale over time and during storage, with brown spots and mold appearing on the top of the fruit.

Fruit texture followed a declining trend in both storage treatments. Fresh melons initially exhibited firm, crisp, and juicy flesh, but progressively softened due to moisture loss, microbial activity, and enzymatic degradation of cell wall polysaccharides. The degradation of hemicellulose and conversion of protopectin into water-soluble pectin contributed to tissue softening, while increased β-galactosidase activity further enhanced cell wall loosening (Li *et al*., 2024).

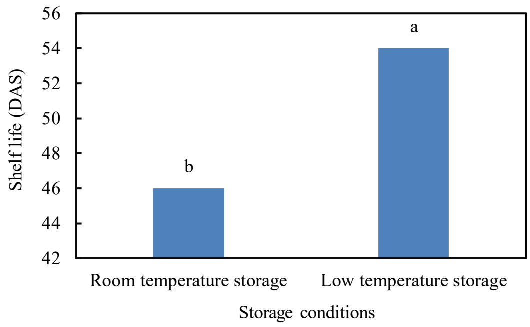

Figure 5. Shelf life of melon stored at low and room temperature. Different lowercase letters indicate significant differences according to the LSD test at $p < 0.05$

Shelf life was directly affected by storage conditions. Ambient storage resulted in a shelf life of 46 days, whereas low temperature storage extended it to 54 days. The extended shelf life under low temperature is consistent with reduced respiration, slower enzymatic activity, and inhibition of microbial growth, all of which delaye senescence and spoilage (Dahlan *et al*., 2024; Pace & Cefola, 2021). Overall, these results confirm that cold storage effectively preserves the physical attributes of *Cucumis melo* var. inodorus, although extremely low temperatures (<4 °C) may induce chilling injury that compromises fruit quality. The shelf life of *Cucumis melo* var. inodorus at room temperature and low temperature is presented in Figure 5.

Relationship Among Fruit Physical Variables

To better understand the relationships among the observed physical quality parameters of *Cucumis melo* var. inodorus during storage, correlation analysis was performed. Correlation analysis quantifies the strength and direction of linear relationships between pairs of variables. These analyses provide insight into which fruit characteristics most strongly influence overall quality and shelf life. The correlation analysis of the observed physical quality parameters of *Cucumis melo* var. inodorus during storage is presented in Table 2.

The correlation analysis revealed several important relationships among the physical characteristics of *Cucumis melo* var. inodorus and their shelf life. Fruit length was found to negatively influence fruit diameter, fruit weight, and shelf life, with correlation coefficients of r= -0.407, r= -0.675, and r= -0.846, respectively. This indicates that longer fruits tended to have a smaller diameter and lower weight, ultimately shortening their storage life. In contrast, fruit diameter exhibited a strong positive correlation with fruit weight (r= 0.926), suggesting that an increase in diameter contributes significantly to higher fruit mass. Elevated storage temperatures were strongly and negatively associated with fruit weight (r= -0.893), highlighting the critical role of temperature management in maintaining fruit quality. Additionally, greater fruit weight and diameter were strongly correlated with extended shelf life (r= 0.959 and r= 0.794, respectively), indicating that optimal physical attributes contribute to prolonged storage longevity.

Table 2. Correlation Coefficients (*r*) among Physical Quality Parameters of *Cucumis melo* var. inodorus Fruit during Storage

	FL	FD	FW	Temp	RH	CO_2	SL
FL	1	-0.407	-0.675	0.749	0.414	0.005	0.846
FD	-0.407	1	0.926	-0.754	-0.523	0.117	0.794
FW	-0.674	0.926	1	-0.893	-0.568	0.132	0.959
Temp	0.75	-0.754	-0.893	1	0.543	-0.151	-0.916
RH	0.414	-0.523	-0.568	0.543	1	0.086	-0.539
CO_2	0.005	0.117	0.132	-0.151	0.086	1	0.116
SL	-0.846	0.794	0.959	-0.916	-0.539	0.116	1

Remarks: FL (fruit length); FD (fruit diameter); FW (fruit weight); Temp (temperature); RH (relative humidity); CO_2 (concentration of CO_2); SL (shelf life). The darker blue color indicates a stronger positive correlation, whereas a darker red color indicates a stronger negative correlation.

In summary, storage conditions markedly affected the physical quality of *Cucumis melo* var. inodorus. Low temperature storage was more effective in maintaining fruit length, diameter, weight, skin and flesh thickness, and overall freshness, compared to room-temperature storage. Correlation analysis indicated that fruit size and weight were closely linked to shelf life, while high storage temperature accelerated quality deterioration through increased respiration and metabolic activity. These findings underscore the importance of proper storage management in maintaining melon quality and extending postharvest longevity. Therefore, implementing low temperature storage along the supply chain is essential to minimize postharvest losses and ensure consistent fruit quality for consumers.

CONCLUSION AND RECOMMENDATIONS

The results of this study indicate that storage temperature significantly affects the physical quality and shelf life of *Inodorus* melon. Melons stored at low temperatures maintain fruit length, diameter, weight, skin and flesh thickness, color, and texture better than those stored at room temperature. Correlation analysis further revealed that larger fruit size and weight were associated with longer shelf life, while higher storage temperatures accelerated deterioration due to increased respiration and metabolic activity. Overall, low temperature storage effectively slowed physiological and biochemical changes, thereby extending the postharvest longevity of *Inodorus* melon. For optimal postharvest quality, it is recommended to store melons at low temperatures (around 3-5 °C) with proper humidity control, and to implement careful handling practices to minimize chilling injury and maintain fruit integrity. Future research could explore complementary postharvest treatments, such as edible coatings or modified atmosphere storage, to further enhance melon quality under different storage conditions.

CONTRIBUTIONS STATEMENTS

Nurul Habibah carried out the laboratory experiment, designed the research, and collected the data. Nasrudin coordinated the research, analyzed the data, and supervised the study. R. Arif Malik Ramadhan contributed to supervision and assisted in conducting the research. All authors were actively involved in the preparation, drafting, and critical review of the manuscript before submission.

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