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EVALUATION OF PLASTIC PACKAGING THICKNESS ON THE QUALITY OF CHILI (*Capsicum frutescens L*)

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ABSTRACT
Bird eye chili (Capsicum frutescens L) is a significant spice in Sumbawa because of its versatility in culinary. However, the increased production of this commodity in Sumbawa was not followed by the sufficient postharvest handling which leads to losses during this stage. Therefore, this study aimed to address this matter by evaluating the effect of polyethylene plastic thickness on the quality of the chili. The study was designed in completely randomized design with three packaging treatments (0.08, 0.12, and 0.18 mm) and three replications then stored at room temperature for 8 days. The data of weight loss, colour degradation, and spoilage were statistically analyzed. The results showed that different thickness of plastic packaging had significantly affected the quality of chili. The 0.18 mm plastic film proved most effective in minimizing weight loss and spoilage while maintaining the color quality of chilies throughout an 8-day storage period, outperforming the 0.08 mm and 0.12 mm films. These findings emphasize the critical role of selecting appropriate plastic thickness in postharvest packaging practices for chili preservation.

1. Introduction

Bird eye chili (*Capsicum frutescens L*) has a significant role in agriculture where it is one of the most extensively cultivated and consumed spices in Indonesia (particularly Sumbawa, West Nusa Tenggara) due to its culinary versatility application and nutritional value. The production of chili in Sumbawa was extremely increased from 25,033 quintals in 2023 to 41,820.99 quintal in 2024 (Department of Agriculture and Plantations of NTB, 2025). This spice has an antimicrobial and anti-inflammatory effect because of its capsaicinoids (impart spiciness, vitamin C and A), antioxidants, and minerals content (Azlan, *et al.,* 2022). However, the high moisture content (70-80%) in chili is responsible for its high perishability and susceptibility to microbes when exposed to inappropriate environmental conditions. Therefore, post-harvest losses can reach 20–30% which largely stemming from insufficient storage and packaging practices, which result in diminished quality, nutrient loss, and economic setbacks (Islami & Rahmadhia, 2024).

Postharvest losses of chili are primarily associated with several factors, including weight loss, color degradation, textural softening, and microbial spoilage (Salvia et al., 2020). Weight loss and spoilage mainly occur due to transpiration and respiration processes, which accelerate moisture loss, induce shriveling, reduce freshness, and facilitate microbial invasion. In addition, the degradation of chlorophyll and uneven carotenoid synthesis lead to undesirable color changes that diminish consumer acceptance (Maskey et al., 2020). Collectively, these physiological and biochemical changes contribute to a shortened shelf life and reduced nutritional quality of chili. Therefore, the application of appropriate packaging strategies is essential to minimize postharvest losses and maintain product quality during storage.

Appropriate packaging effectively reduces spoilage by regulating gas exchange, minimizing moisture loss, and suppressing microbial activity (Siswanto *et al.,* 2022). Among many types of packaging, plastic materials (particularly polyethylene (PE) remain the most widely utilized due to their cost-effectiveness, versatility, and favourable barrier properties. The functional performance of this film is strongly influenced by its thickness, which determines permeability to oxygen (O_2), carbon dioxide (CO_2), and water vapour (Fikiru *et al.,* 2025). Generally, thicker films provide superior barrier capacity, leading to reduced respiration rates and delayed physiological aging, whereas thinner films permit greater gas diffusion, which may accelerate ripening processes and increase susceptibility to deterioration under certain conditions (Balanon *et al.,* 2023).

Numerous researches on different type of plastics and other material packaging, various storage conditions, and biodegradable films have been conducted globally (Balanon *et al.,* 2023; Fikiru *et al.,* 2025; Siswanto *et al.,* 2022). However, a gap remains exist where the thickness of the PE plastics used in traditional packaging in region with high humidity and large number of smallholder farmers in chili-producing like Sumbawa is yet to be explored. Therefore, this study aimed to evaluate the effect PE thickness to the quality of the chili. Consequently, addressing this matter could lead to reduced food waste and enhanced economic viability.

2. Materials and methods

2.1. *Biomaterials and chemicals*

Fresh chilis and plastic packaging with various thickness (0.08, 0.12, and 0.18 mm) were bought from the local traditional market in Sumbawa, Indonesia.

2.2. *Preparation of sample*

The sample preparation was performed based on the method by Rehulina (2025) with modification. The chili was washed and set aside until the water in the surface area of the chili were drained. The chili was weighted at 50 grams then wrapped in plastics with three different thickness (0.08, 0.12, and 0.18 mm) and stored at room temperature of Sumbawa (29-30^oC). The samples were observed within 8 days after the packaging due to the rapid rate of spoilage.

2.3 *Quality assessment*

2.3.1. *Determination of weight loss*

A commonly applied approach for assessing weight loss is based on a formula derived from the Association of Official Agricultural Chemists (AOAC) standard procedures. In this study, the initial weight of chili samples was recorded at the start of storage, followed by measurement after eight days, allowing researchers to quantify the extent of weight reduction over the storage period. Then, the weight loss was measured using the formula below (Siswanto *et al.,* 2022):

$$Weight\ loss\ (\%) = \frac{initial\ - final\ weight}{initial\ weight}\ x\ 100$$

2.3.2. *Determination of spoilage*

This study used visual trait to examine the deterioration of the chili. The observed symptoms include fruit shriveling, the appearance of localized soft areas, initial fungal development, exudation of fluids, and extensive mold infestation. Then, the spoilage was measured using the formula below (Putri *et al.,* 2020):

$$Spoilage\ (\%) = \frac{Remaining\ fresh\ chili}{initial\ number\ of\ \ chili}\ x\ 100$$

2.3.3. Determination of colour degradation

The color degradation measurement was conducted using the method by Bawana *et al.,* (2022). The color of chili samples was evaluated using the CIE L*–a*–b* color space system using colorimeter app. In this framework, the a* parameter indicates chromaticity along the red–green axis, with positive values corresponding to red hues and negative values to green hues. The b* parameter reflects chromaticity along the yellow–blue axis, where positive values denote yellow tones and negative values denote blue tones. Meanwhile, L* represents lightness on a scale from 0 to 100, with lower values signifying darker appearance and higher values indicating lighter coloration of the food product.

3. Results and discussions

3.1.*Weight loss of the chili*

The weight loss data is illustrated in **Fig. 1**. The results showed that the loss of chili weight was significantly affected by thickness of the plastic used for packaging. It is noticeable that there was a non-linear pattern where 0.12 mm shows the highest weight loss, with 0.08 mm lower and 0.18 mm increasing again. This pattern showed the interaction between film thickness and the atmosphere inside the packaging. at 0.12 mm, the film may create O_2 and RH conditions that sustain higher respiration and transpiration, maximizing water loss, whereas 0.08 mm vents moisture and lowers RH (reducing transpiration), and 0.18 mm suppresses respiration and may reach near-saturation RH (shifting losses toward surface wetness and mold rather than continued mass loss) (Romansyah *et al.,* 2023; Baddigam *et al.,* 2025)

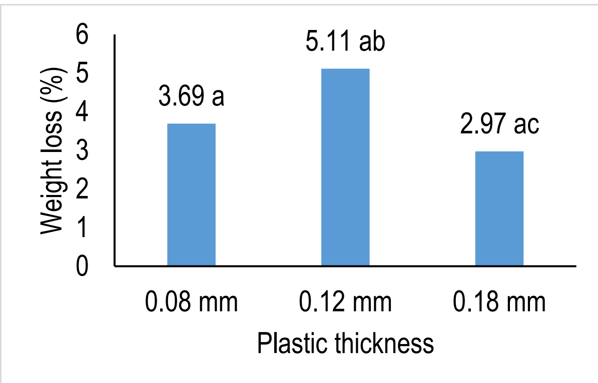


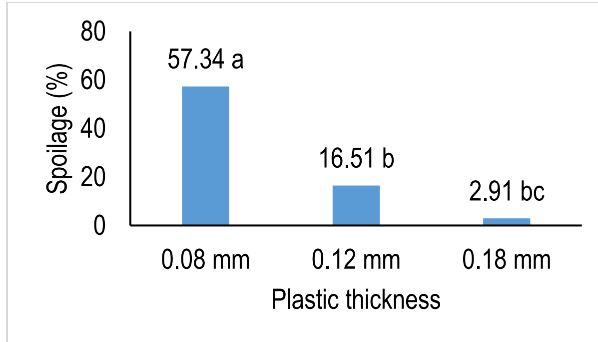
Fig 1. The weight loss of chili during storage.

**Bar containing means with the same letters are not significantly different (p < 0.05)*

3.2.*Spoilage of the chili*

The percentage of spoiled chili during storage is shown in **Fig. 2**. The results showed that different thickness of plastic packaging was significantly affect the spoilage of the chili where it decreased linearly with the increased of the plastic thickness. Thinner films facilitated higher vapor transmission, which lowered relative humidity and consequently slowed transpiration. Conversely, the thickest films suppressed physiological weight loss by severely restricting gas exchange and metabolic respiration (Hanani et al., 2023).

Despite the non-linear weight loss, spoilage followed a strictly inverse relationship with thickness; the robust barrier of thicker films created a low-oxygen, high-stability microenvironment that effectively hindered microbial colonization (Fikiru et al., 2025). This suggests that while physiological mass loss is sensitive to specific atmospheric balances, microbial decay is primarily governed by the physical barrier's ability to limit external exposure and stabilize internal conditions.



**Bar containing means with the same letters are not significantly different (p < 0.05)*

Fig. 2. The spoilage of chili during storage

3.3. Color of the chili

The changed color of chili during storage was indicated by the value of L, a, and b as shown in **Table 1**. Statistical analysis showed that plastic thickness did not significantly affect the lightness (L*) of chili during storage ($p > 0.05$).

Table 1. Effect of plastic packaging thickness on color parameters (L, a, and b*) of chili during storage

Plastic thickness (mm)	L* value	a* value	b* value
0.08	59.00a	0.10a	0.10a
0.12	61.33a	0.11ab	0.11bc
0.18	54.33a	0.14bc	0.14ac

Values are expressed as mean ± SD. Means within the same column followed by the same superscript letters are not significantly different (p < 0.05).

The a* parameter reflects the green-to-red spectrum, where higher positive values correspond to greater redness. In this study, redness increased progressively with plastic thickness, ranging from 0.10 to 0.14. The 0.18 mm film was particularly effective in enhancing or maintaining red pigmentation, likely due to its ability to create a modified atmosphere that either accelerates carotenoid synthesis or slows pigment degradation (Balanon et al., 2023).

Similarly, the b* parameter represents the blue-to-yellow spectrum, with higher values indicating stronger yellow or orange hues. Results showed a marked increase in yellowness as film thickness increased, reaching its highest value (0.14) under the 0.18 mm treatment. The concurrent rise in both a* and b* values suggesting a shift toward a deeper orange-red coloration, which reflects enhanced synthesis of secondary metabolites, particularly carotenoids, during storage. These findings highlight that thicker plastic packaging not only preserves but also promotes pigment accumulation, thereby improving the visual quality of chili fruits (Pola et al., 2021).

4. Conclusions

This study concluded that polyethylene plastic with various thickness significantly affected the weight loss, spoilage, and color degradation of chili stored at room temperature. The 0.18 mm plastic had successfully maintained low weight loss, spoilage, and preserved the color of the chili for 8 days compared to the 0.08 and 0.12 mm plastic packaging. Thus, this results highlight the importance of selecting the thickness of plastic used in chili packaging handling.

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