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The effect of packaging type on the physical properties of husked corn and corn peeled

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ABSTRACT

Sweet corn is a perishable horticultural commodity with a limited shelf life of approximately 2-3 days at room temperature. This study aimed to analyse the effect of packaging type and storage temperature on the physical and organoleptic properties of sweet corn husk and corn peeled forms. The research method used was a completely randomised design (CRD) factorial pattern with two main factors: storage temperature (room temperature and low temperature 3°C) and packaging type (no packaging, PP plastic, and hollow PP plastic). The observation parameters included organoleptic tests of aroma, colour, texture, and shelf life for 14 days. The results showed that the combination of low-temperature storage (3°C) and the use of polypropylene (PP) plastic packaging significantly extended the shelf life and maintained the physical quality of sweet corn. The aroma of corn could be maintained at its maximum (score 5) until the 8th day at cold temperatures. The use of hollow PP plastic for corn husk proved to be most effective in maintaining yellow colour stability until the 14th day. Meanwhile, for the texture parameter, the use of non-hollow PP plastic provided the best protection for shelled corn by suppressing the transpiration rate compared to no packaging. Overall, the integration of low temperature and PP plastic packaging is the most optimal preservation method to inhibit post-harvest quality deterioration of sweet corn.

Keyword: corn packaging type, physical organoleptic properties, storage temperature

ABSTRAK

Jagung manis merupakan komoditas hortikultura yang mudah rusak dengan umur simpan terbatas sekitar 2–3 hari pada suhu ruang. Penelitian ini bertujuan menganalisis pengaruh jenis kemasan dan suhu penyimpanan terhadap mutu fisik dan organoleptik jagung manis pascapanen. Penelitian menggunakan rancangan acak lengkap (RAL) faktorial dengan dua faktor utama: suhu penyimpanan (mulai dari suhu rendah 3°C) dan jenis kemasan (tanpa kemasan, kemasan PP, dan plastik PP berlubang). Parameter yang diamati meliputi uji organoleptik terhadap aroma, warna, tekstur, serta umur simpan selama 14 hari. Hasil penelitian menunjukkan bahwa kombinasi suhu rendah (3°C) dan penggunaan kemasan plastik PP berlubang secara nyata memperpanjang umur simpan dan mempertahankan mutu fisik jagung manis. Aroma jagung dapat dipertahankan pada tingkat kesukaan minimum (skor 5) hingga hari ke-8 pada suhu dingin. Penggunaan plastik PP berlubang untuk jagung dengan kulit pembungkus terbukti paling efektif dalam mempertahankan warna kuning cerah hingga hari ke-14. Sementara itu, untuk parameter tekstur, penggunaan plastik PP non-berlubang memberikan perlindungan terbaik bagi jagung tanpa kulit dengan menekan laju transpirasi dibandingkan tanpa kemasan. Secara keseluruhan, kombinasi suhu rendah dan kemasan plastik PP merupakan metode penyimpanan paling optimal untuk menghambat penurunan mutu pascapanen jagung manis.

Kata kunci: jenis kemasan jagung, sifat fisik dan organoleptik, suhu penyimpanan

1. Introduction

Indonesia has abundant agricultural resources, one of which comes from horticultural commodities such as vegetables and fruits (Prastyo, 2025). However, the characteristics of horticultural products often pose challenges in the storage and distribution processes. After harvesting, horticultural products still undergo various biochemical, physical, and physiological changes that can affect product quality. (Sundari 2023). The damage to vegetable and fruit crops is still quite high, and this damage will certainly cause economic losses (Waryat, 2020). Vegetables are a strategic commodity in supporting national food security because they play an important role in meeting food needs and improving community nutrition. Vegetables and fruits are sources of carbohydrates, plant-based proteins, vitamins, and minerals that are beneficial to health, while also having high economic value (Ashadi, 2022). Horticultural products such as vegetables and fruits that have been harvested still undergo respiration. Vegetables and fruits are classified as perishable foods because they have high water content, continue to undergo respiration after harvest, and contain enzymes and hormones that trigger damage to the material (Sukma, 2018). This decline in quality can be caused by various factors, including loss of water content, mechanical damage, and environmental influences such as temperature and humidity (Chen, 2024).

Post-harvest handling of fruits and vegetables in Indonesia has not received sufficient attention. This can be seen from the 25%–28% post-harvest damage rate (Maslahatul, 2024). Post-harvest includes activities such as sorting, cleaning, storage, packaging, and transportation, which aim to maintain the quality and freshness of the product until it reaches consumers (Rizzo, 2025). Post-harvest includes activities such as sorting, cleaning, storage, packaging, and transportation, which aim to maintain the quality and freshness of the product until it reaches consumers (Pokhrel, 2020). Post-harvest handling efforts that are still less than optimal have a negative impact on product quality, because many fruits and vegetables with perishable nature experience weight loss, nutritional loss, even physical damage and microbial attacks during transportation and storage, resulting in high yield losses and reduced economic value of the product (Shankar, 2024).

Therefore, horticultural products, especially fruits and vegetables, require special handling to protect them from damage and extend their shelf life. Cold storage has long been known as an effective method to slow down the deterioration process and maintain the quality of post-harvest vegetables (Wang, 2025). Conventionally, post-harvest handling applied by the general public to vegetables and horticultural products is generally still minimal and does not include the packaging stage (Rajapakshe, 2026). The absence of packaging makes products more susceptible to damage, both physical and physiological. As a result, the rate of quality degradation increases significantly, shortening shelf life and compromising product quality during distribution and storage (Martin, 2024). According to (Pham, 2025) Common practices carried out by the community are limited to trimming, namely cutting or removing parts of leaves or plant tissue that show signs of damage, followed by a sorting and grading process based on criteria of size, shape or visual quality.

Postharvest procedures can remove damaged parts and sort products according to quality class, this approach has not been able to effectively slow the rate of quality decline caused by internal physiological processes such as respiration and transpiration and external factors such as temperature, humidity, and microbial contamination during storage and distribution. Studies and reviews on postharvest physiology indicate that the combination of internal mechanisms and environmental conditions remains a major challenge in long-term quality control (Ferdousi, 2024). Therefore, to extend the shelf life and maintain the quality of post-harvest vegetables, the application of appropriate packaging is very important. Packaging not only functions as a physical protector against mechanical damage, but can also regulate the microenvironment around the product, reduce water loss, inhibit excessive respiratory activity, and minimize microbial contamination (Awulachew, 2022). Thus, integrating packaging into the post-harvest chain is a crucial strategy for maintaining vegetable quality, ensuring they remain edible and have optimal economic value. Appropriate packaging can slow down the quality degradation process while maintaining the freshness and nutritional value of vegetables during distribution and storage (Asjula, 2023).

Packaging plays an important role in protecting products from physical damage, loss of water content, and environmental influences such as temperature and humidity (Akbar, 2025). Packaging serves to protect corn from physical and biological damage, while maintaining its physical properties during the shelf life (Odjo 2022). Excessive impact, pressure, or friction can cause corn kernels to crack, bruise, or become damaged, reducing their market value and accelerating further deterioration. Corn that experiences mechanical damage is also more susceptible to attack by microorganisms, which can accelerate spoilage (Chen 2021).Environmental factors, such as temperature and humidity, also play a major role in determining the physical quality of corn during storage (Wen, 2020). Therefore, selecting the type of packaging that is able to control the interaction between corn and its surrounding environment is an important factor in maintaining the physical quality of corn during storage (Liu, 2021).

Fresh sweet corn has a very limited shelf life, only 2-3 days when stored at room temperature of 28-30°C (Lapanga, 2020). Various types of damage that occur can affect the freshness of sweet corn, even though consumers want sweet corn to remain fresh. The use of plastic as a packaging material not only serves to maintain moisture and reduce water loss, but also protects the product from mechanical damage and prevents contamination by dust (Ansar, 2020). Efforts to extend shelf life can be made by controlling temperature and using appropriate packaging. Temperature control plays an important role in slowing down chemical reactions, enzyme activity, and the growth of microorganisms that can cause product damage (Mafe, 2024).

Storage at low temperatures has been proven to reduce the rate of respiration and microorganism growth, thereby slowing down the decay process, although some commodities, such as potatoes, can suffer physiological damage if cooled excessively (Nurhidayat, 2022). The selection of packaging type must be adjusted to storage conditions to optimize inhibition of respiration rate and maintain corn quality during the storage period (Valle, 2021). Based on this, the combination of cold storage using a refrigerated showcase and packaging with perforated and non-perforated plastic is important for further study. This research is expected to provide information on the influence of temperature and packaging type on the physical properties of peeled and whole sweet corn, thus providing a reference for more effective post-harvest handling to extend shelf life and maintain product quality.

2. Materials and Method

2.1 Equipment and materials

The equipment used in this study consisted of: a cooling showcase, non- perforated polypropylene (PP) plastic, perforated polypropylene (PP) plastic, storage containers, and name labels.The materials used in this study include: whole sweet corn husk and sweet corn peeled.

2.2 Research implementation

Sweet corn that had been selected based on uniformity of size and level of ripeness was treated according to the experimental design. The corn was then packaged according to the treatment and stored at room temperature and low temperature (3ºC). Observations were carried out by 10 semi-trained people and conducted periodically during the storage period to observe changes in the quality of the sweet corn. Observations were conducted descriptively and qualitatively over a period of 14 days.

(a) (b)

Figure 1. (a) Corn husk and peeled corn on day 0; (b) Corn husk and peeled corn on day 14.

2.3 Research method

This research experiment was designed using a Completely Randomized Design (CRD) with a two-factor factorial pattern. The first factor was room temperature storage, and the second factor was low temperature storage at 3°C, each of which was applied to sweet corn with husks and sweet corn without husks.

First factor (T): Room temperature storage:

1. T_0 = No treatment

Second factor (K): Low-temperature storage (3°C)

2. K_1 = PP plastic packaging
3. K_2 = Hollow PP plastic packaging

2.4 Observation parameters

2.4.1 Organoleptic aroma (SNI 01-2346-2006)

Aroma is a very important component in determining the quality or degree of acceptance of a food product. Aroma testing is an organoleptic parameter in food products. The assessment criteria are as follows:

Table 1. Organoleptic aroma test

Score	Aroma
5	Very Like
4	Like
3	Neutral
2	Not so fond
1	Strongly dislike

2.4.2 Organoleptic colour (SNI 01-2346-2006)

Colour is a very important component in determining the quality or degree of acceptance of a food product. Colour testing is an organoleptic parameter in food products. The assessment criteria are as follows:

Table 2. Organoleptic colour test

Score	Colour
5	Very Like
4	Like
3	Neutral
2	Not so fond
1	Strongly dislike

2.4.3 Organoleptic texture (SNI 01-2346-2006)

Texture is a very important component in determining the quality or degree of acceptance of a food product. Texture testing is an organoleptic parameter in food products. The assessment criteria are as follows:

Table 3. Organoleptic texture test

Score	Texture
5	Very Like
4	Like
3	Neutral
2	Not so fond
1	Strongly dislike

2.5 Shelf life

The shelf life is calculated from the start of storage of sweet corn with husks and sweet corn without husks until damage occurs (days). Damage to the two types of sweet corn during storage is indicated by brown spots and a change in texture to cracks and loss of freshness.

2.6 Data analysis

This study was analysed using one-way analysis of variance (ANOVA). If the ANOVA F value indicated significance, further investigation was conducted using Duncan's multiple range test (DMRT) for comparing multiple samples at a 95% confidence level (Pramasari, 2024).

3. Results and Discussion

3.1 Aroma of corn husks and peeled corn

Changes in the aroma of corn peeled during storage under three treatment conditions, namely no treatment, storage at 3°C with PP plastic, and storage at 3°C with perforated PP plastic. Aroma values were measured using a sensory rating scale (possibly a hedonic or descriptive scale), where higher numbers indicate a better or fresher aroma. This can be seen in **Figure 2.**

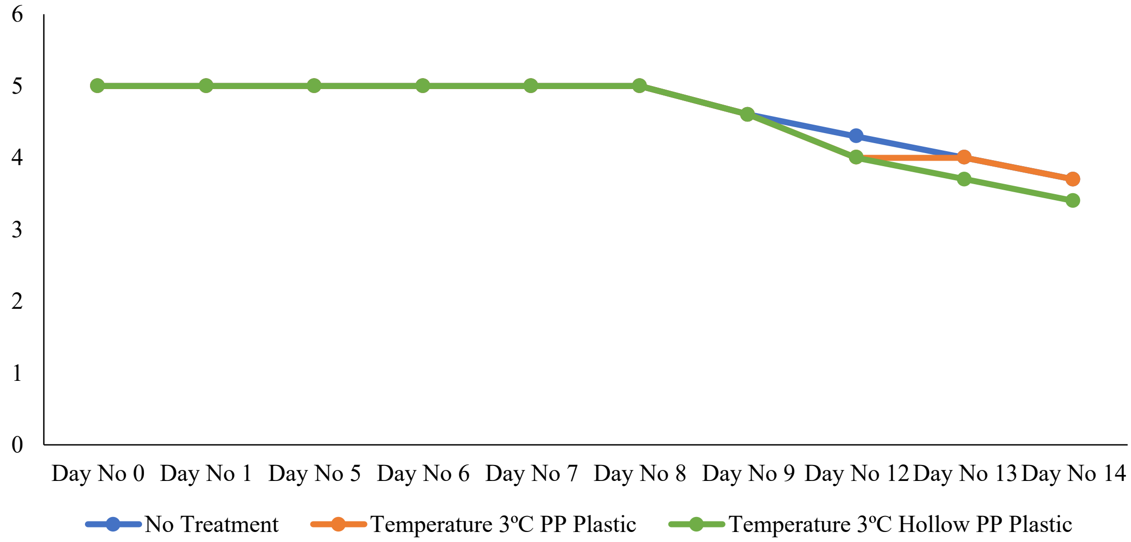

Figure 2. Organoleptic results of corn husk aroma

Scientifically, the results from day 0 to day 8 show that all treatments have the same and maximum aroma value (score 5). This indicates that in the early stages of storage, there has been no significant change in the volatile compounds that make up the aroma of corn husk. During this period, enzymatic activity, respiration, and microorganism growth were still very limited, both in untreated corn and in corn stored at low temperatures in plastic packaging (Sa'idah, 2024).

From day 9 to day 14, there was a decrease in aroma value in all treatments, indicating the beginning of quality degradation. This decrease was caused by physiological and biochemical processes such as continued respiration, oxidation of volatile compounds, and possible microbial activity, which produced an un- fresh aroma. The decline in aroma was most evident on day 14, especially in the hollow PP plastic treatment, which showed the lowest value (3.4). This can be explained by the fact that hollow packaging allows for greater gas exchange (Jung, 2021), thereby accelerating respiration and oxidation of aroma compounds. Meanwhile, the untreated and PP plastic treatments at 3°C showed a relatively slower and similar decline in aroma until the end of storage. Low temperatures play an important role in inhibiting the rate of respiration and enzymatic reactions, thereby maintaining aroma better than conditions that allow excessive air circulation. Thus, this table scientifically shows that storage temperature and packaging type affect the aroma stability of corn cobs during storage, especially during longer storage periods.

Figure 3 illustrates the changes in aroma quality of peeled corn under different packaging treatments and storage temperatures during the observation period. Aroma is an important sensory attribute that reflects the freshness and acceptability of sweet corn during storage (Yactayo, 2022). The interaction between temperature and packaging type significantly influenced the ability of the product to maintain its characteristic aroma throughout the storage duration.

Based on the observations in Figure 3, the aroma of peeled corn in all treatments showed excellent quality from day 0 to day 8 of storage, with a consistent aroma score of 5. A decline in aroma began to be seen on day 9, where untreated corn experienced a decrease in score to 4.6, while corn stored at 3°C using PP plastic and hollow PP plastic was still able to maintain an aroma score of on day 12, the aroma value in all treatments decreased and was at a score of 4, then tended to be stable until the end of the observation. On days 13 and 14, all treatments showed the same aroma value of 4.

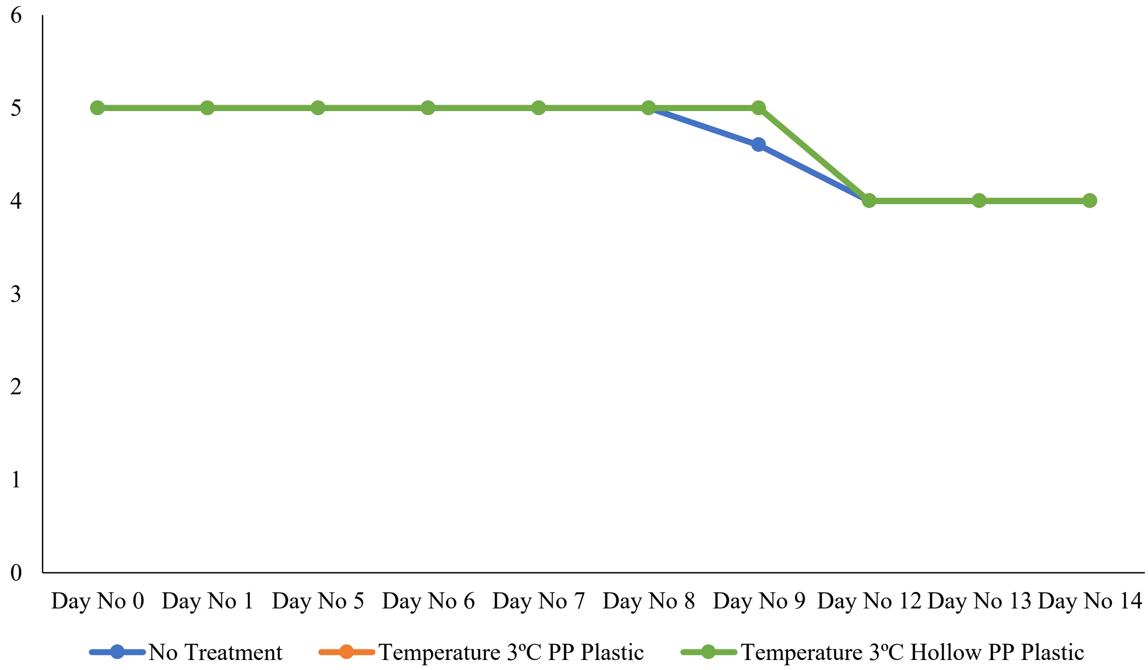

Figure 3. Organoleptic aroma test

This indicates that storage at 3°C, both with PP plastic and hollow PP plastic, was able to maintain the aroma of corn peeled more stable than without treatment, especially in the middle of the storage period. This decrease in aroma is likely related to enzyme and microbial activity that still occurs even at low temperatures, so that the volatile compounds that contribute to the aroma experience slow degradation (Xiao 2024). The use of plastic packaging can reduce exposure to oxygen and moisture, which plays an important role in maintaining the quality of the aroma (Bai, 2024). According to (Li, 2023), packaging types with high-barrier film can better maintain quality and sensory properties at low storage temperatures.

Table 4 presents the changes in texture quality of peeled corn subjected to different packaging treatments and storage temperatures during the storage period. Texture is one of the most important quality parameters affecting consumer acceptance, as it is closely related to freshness and moisture retention in sweet corn (Li, 2020). The effectiveness of each packaging method in maintaining texture stability under varying temperature conditions can be observed through the data shown in Table 4. The results of the analysis of variance (ANOVA) showed that all treatments had a very significant effect on the aroma changes of corn peeled and corn husk, as evidenced by a significance value of (Sig. < 0.05). This shows that different treatments have a significant effect on aroma fluctuations during storage, so that treatment variations cannot be statistically ignored (Chang, 2022). For corn, the peeled highest F value was achieved by the 3°C PP plastic treatment (F = 55.133), followed by hollow PP plastic at 3°C (F = 47.657) and no treatment (F = 31.733), which identified that variations in storage duration under these conditions caused very noticeable fluctuations in aroma (Prabowo, 2024). Biologically, this can be explained by the ability of PP plastic packaging to reduce contact with oxygen and retain moisture, thereby slowing down oxidative and microbiological reactions that affect the volatile compounds that make up the aroma (Wang, 2025). Meanwhile, in the untreated peeled corn group, the F value was recorded at 37.533 with a value of (Sig. < 0.05). However, the treatment of peeled corn with PP plastic at 3°C and hollow PP plastic at 3°C had a group variance (Within Groups) value of 0.00. This indicates a high level of data homogeneity, leading to the conclusion that the use of plastic packaging at low temperatures can suppress aroma degradation to achieve a uniform level of stability. This stability likely occurs because plastic packaging and cold temperatures synergistically suppress the rate of degradation of volatile compounds, so that the aroma of corn remains consistently maintained throughout the storage period (Ekpa, 2021).

According to Bai (2024), the process of aroma adsorption by polymers, as well as the thermodynamic interactions and transport of aroma molecules, play a crucial role in determining aroma stability during storage. Lower temperatures tend to slow the rate of diffusion and degradation reactions, thus contributing to longer-term retention of aroma compounds.

Table 4. ANOVA of the aroma of corn husk and corn peeled

Treatments	Sum Of Squares	Df	Mean Square	F	Sig.
Without Corn Husk Treatment	37.560	99	3.173	31.733	0.00
3ºC-Polypropylene plastic for corn husks	29.310	99	2.757	55.133	0.00
3ºC-Corn Husk Perforated Polypropylene Plastic	40.360	99	3.707	47.657	0.00
Without Corn Peeled Treatment	21.390	99	1.877	37.533	0.00
3ºC-Polypropylene plastic for corn Peeled	21.000	99	2.333		
3ºC-Corn Peeled Perforated Polypropylene Plastic	21.000	99	2.333		

Based on Duncan's multiple range test at the 5% level, changes in the aroma of cob corn and shelled corn showed a significant pattern of degradation as storage duration increased across all treatment types. In corn cobs, the best aroma quality (score 5) remained consistent from day 0 to day 8, but gradually declined from day 9 and reached its lowest value on day 14, both in untreated conditions and in 3°C PP plastic packaging and 3°C hollow PP plastic packaging. These Duncan test results confirm that although the use of plastic packaging and low temperatures can reduce data variance, the storage duration factor remains a critical variable that causes a shift in the sensory characteristics of aroma from the excellent category towards degradation in the final storage phase (Alhamdan, 2025). According to Alhassan (2024), storage at low temperatures (e.g., 4°C) tends to slow down chemical reactions that damage aroma and texture compared to higher temperatures, thereby reducing the variability of initial quality data.

3.2 Colour of peeled corn and corn husk

The colour of corn husks changed during storage under various treatments. This can be seen in Figure 5. At the beginning of storage, namely on day 0, day 1, and day 5, all treatments showed the same colour score (5), indicating that the corn husks still had a bright yellow colour and were in good condition. This is consistent with the understanding that in the early post-harvest phase, colour changes tend to be minimal because the degradation of the main pigments is not yet dominant (Topan, 2023). Entering day 6, This decrease indicates the beginning of pigment degradation which is influenced by physiological and environmental processes, such as respiration, oxidation, and moisture loss (Zhang, 2023). In contrast, sweet corn husks stored at 3°C in polypropylene (PP) plastic packaging or hollow PP plastic packaging retained their colour at higher values. This suggests that low temperatures play a role in slowing the rate of biochemical reactions that contribute to colour changes during storage (Kumar, 2020).

As storage time increased, the decline in corn cob colour became more apparent. On days 7 to 9, the untreated treatment showed a faster decline in colour compared to the other two treatments. Storage at 3°C, whether using PP plastic or hollow PP plastic, proved to be more effective in maintaining the colour of corn husks. The faster colour reduction in the untreated treatment is thought to be due to high oxygen exposure and fluctuations in environmental humidity, which can accelerate the pigment oxidation process (Liu, 2022). Meanwhile, the use of PP plastic packaging has been proven to provide protection against oxygen entry and maintain micro-humidity around the product, so that the pigment stability and colour retention of sweet corn husks can be maintained better than peeled sweet corn (Calabrese, 2024).

Until day 14, the lowest colour value was found in the untreated treatment, while the 3°C temperature treatment with hollow PP plastic produced the highest colour value. These results indicate that the combination of low temperature and packaging type plays a significant role in slowing the colour loss of sweet corn husks. Hollow PP plastic is thought to create a more optimal gas exchange balance than conventional PP plastic, thereby reducing the accumulation of respiratory gases without causing excessive moisture loss (Liu, 2025). This shows that the use of low temperatures and plastic packaging, especially hollow PP plastic, can slow down the colour deterioration of corn husks during storage. According to (Adhikari, 2020), the use of plastic packaging at low temperatures can create passive modified atmospheric conditions by regulating the concentration of oxygen (O_2), carbon dioxide (CO_2), and relative humidity inside the packaging. This condition contributes to suppressing the post-harvest respiration rate and slowing down the pigment degradation process, so that color changes and quality decline of corn husks during storage can be minimized (Wang, 2024).

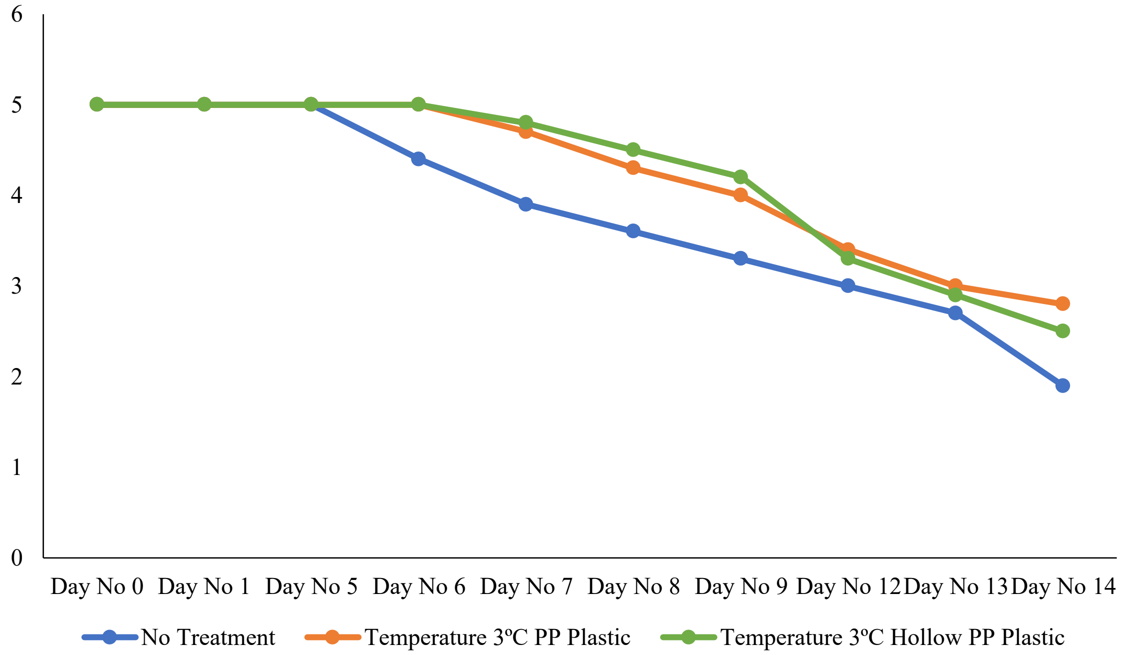

Figure 5. Organoleptic test results for corn peeled colour.

The colour of peeled corn shows changes in colour during storage under various treatments, namely no treatment, storage at 3°C using PP plastic, and storage at 3°C using hollow PP plastic. On days 0, 1, and 5, all treatments had the same colour value of 5, indicating that the peeled corn still had excellent colour. On day 6, the colour value began to decline, especially in the untreated treatment, while the two treatments at 3°C were still able to maintain a relatively higher colour. As storage time increased, the colour of the shelled corn gradually decreased. The untreated treatment showed the fastest colour decrease compared to the other treatments. Storage at 3°C with PP plastic and hollow PP plastic was able to slow down colour changes, with hollow PP plastic tending to produce slightly higher colour values. According to (Taladuker, 2020), products packaged with PP plastic showed more stable colour values and longer storage times at low temperatures compared to unpackaged or poorly packaged products. On day 14, the untreated treatment had the lowest colour value, while the 3°C treatment with PP plastic still showed better colour than the other treatments.

The main difference between the two types of corn lies in the observation object, namely shelled corn and corn with husks. In general, shelled corn experienced a faster colour decline than corn in the cob under the same treatment. This can be seen from the colour values of shelled corn, which tended to be lower in the final days of storage. The cob on the corn previously served as a natural protector that helped maintain the colour of the corn for longer. According to (Mondal, 2022), the physical structure of corn affects its visual quality during storage. Corn stored without husks (shelled) tends to undergo colour changes more quickly than corn that is still in the husk, due to exposure to air and more intense enzymatic activity on the surface of the exposed kernels. This colour change is related to the degradation of pigment compounds and biochemical reactions during storage, which are influenced by moisture and corn kernel hardness (Pandiselvam, 2023). However, both tables show the same pattern, namely that storage at 3°C, especially with hollow PP plastic, is the most effective treatment for maintaining corn colour during storage.

Colour is an important visual quality parameter that influences consumer preference and indicates the level of freshness during storage (Zhang, 2024). The analysis was conducted to determine whether packaging type and storage conditions significantly affected the colour stability of both corn types throughout the storage period. The ANOVA results for the colour characteristics of corn husk and shelled corn under different packaging treatments and storage temperatures are presented in Table 5.

Table 5. ANOVA of the colour corn husk and shelled corn

Treatments	Sum Of Squares	Df	Mean Square	F	Sig.
Without Corn Husk Treatment	122.110	99	11.134	45.758	0.00
3ºC-Polypropylene plastic for corn husks	82.000	99	7.533	47.764	0.00
3ºC-Corn Husk Perforated Polypropylene Plastic	68.110	99	6.512	61.695	0.00
Without Corn Peeled Treatment	123.440	99	10.916	38.984	0.00
3ºC-Polypropylene plastic for corn Peeled	98.750	99	8.228	29.980	0.00
3ºC-Corn Peeled Perforated Polypropylene Plastic	92.590	99	8.388	44.146	0.00

The results of the ANOVA test on colour parameters in cob corn and shelled corn showed that all treatment groups had a statistically significant effect, indicated by a value (sig. < 0.05) in each packaging category. The high F-count values for all treatments indicate that variations in color changes during storage were caused more by treatment and storage time than by random variations within the groups. The high F-count values in all groups, peaking at the Hollow PP Plastic 3°C Husked Corn treatment ($F = 61.695$), confirmed that there were very clear differences in average colour between observation times in each treatment. With a total degree of freedom (df) of 99 per group, these data consistently prove that differences in storage methods, both untreated and using PP plastic (regular and hollow) at 3°C, have a significant impact on corn colour changes during the study period.

Based on the results of the ANOVA test and Duncan's post-hoc test on the colour parameters of cob corn and shelled corn, all treatment groups showed a statistically significant effect (Sig. < 0.05) on colour changes during storage. Color changes occur progressively and are influenced by the interaction between temperature, type of packaging, and the physical condition of the material (husk or peel). Color changes in corn during storage are generally related to the degradation of natural pigments, especially carotenoids and xanthophylls, which play a role in giving corn kernels their yellow color (Brenes 2020). Carotenoids are very susceptible to oxidation, exposure to light, and high temperatures, so that during storage there can be a decrease in color intensity due to the oxidative degradation process (Seregelj, 2022).

In general, the average colour values in all treatments tended to decrease as the storage duration increased. According to Zhao (2024), the combination of low temperature and proper packaging techniques effectively inhibits pigment degradation or oxidation processes that cause colour changes in corn commodities. Overall, the results of this study reinforce the concept that temperature control and proper packaging are critical factors in maintaining the visual quality of corn during storage. Hollow PP plastic at 3°C showed the most significant color change response, indicating a strong influence of storage method on corn color stability.

3.3 Texture of peeled corn and corn husk

Observations showed that the texture of peeled corn decreased with increasing storage time in all treatments. From day 0 to day 1, the texture value was still at the maximum score (5), this indicates that the corn is still very fresh, firm, and has an intact tissue structure. This condition reflects that at the beginning of storage, there have been no significant physiological or physical changes in the corn tissue (Yewle, 2023). However, from day 5 onwards, there was a significant decrease in texture, especially in the untreated treatment. Unprocessed peeled corn showed the fastest rate of texture decline, with texture values decreasing consistently to (1.9) on day 14. This decrease indicates that the tissue damage process begins to occur more intensively as storage time increases. This decline is thought to be caused by high respiration and transpiration rates due to the absence of packaging protection and low temperatures, resulting in faster water loss and tissue softening (Umeoha, 2024). According to (Bovi, 2018), a high respiration rate increases O_2 consumption and CO_2 production, thereby accelerating tissue degradation, while transpiration causes water vapour to escape from the production tissue. The absence of intensive packaging protection also exacerbates this loss because there is no restriction on water vapour flow, and the water content and storage temperature greatly affect the rate of this process. The detailed results of colour observations for husked corn and peeled corn are presented in Figure 6 and Figure 7, respectively.

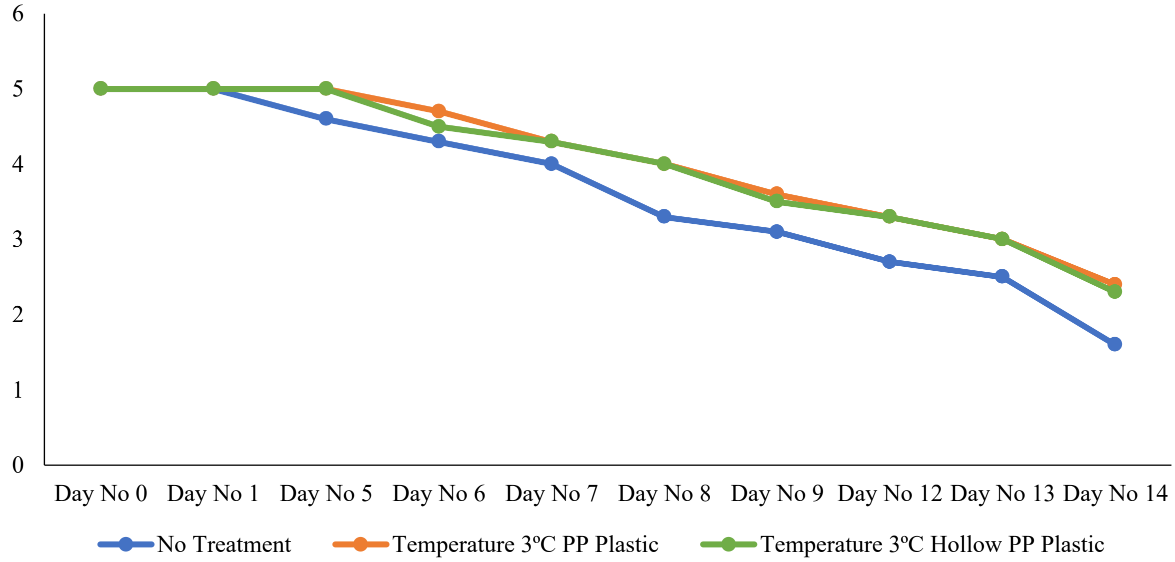

Figure 6. Texture of corn husk

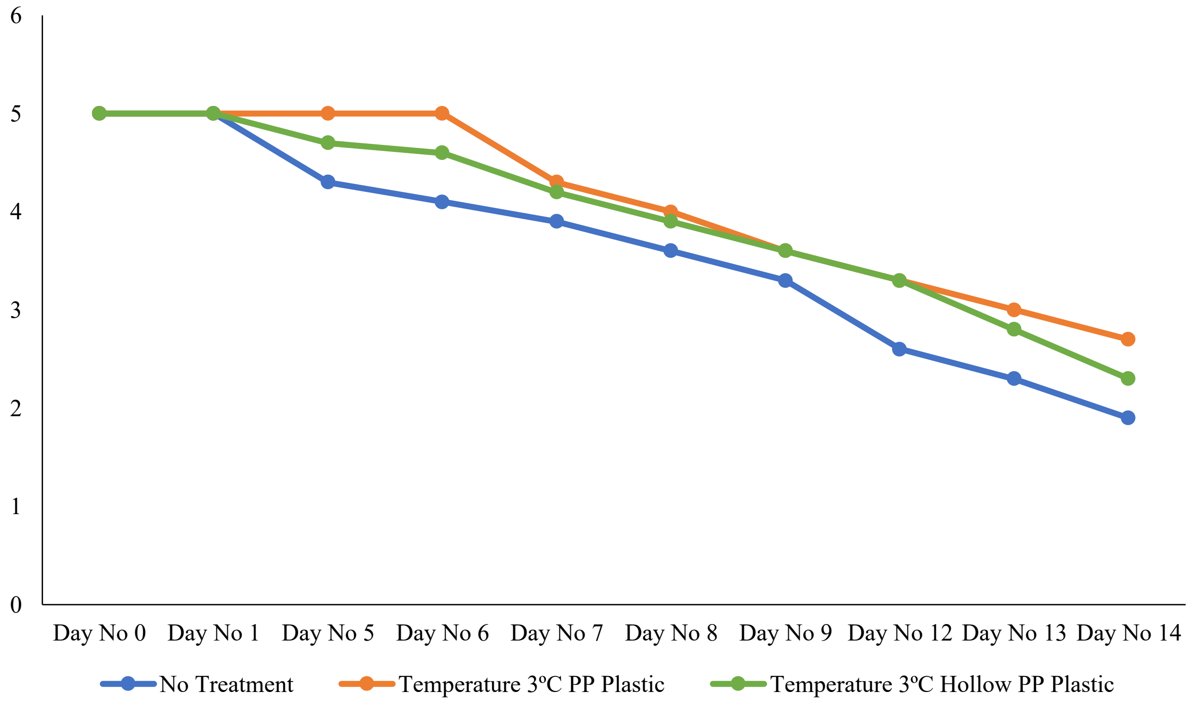

Figure 7. Texture of peeled corns

Conversely, storage at 3°C with PP plastic was able to maintain better texture compared to other treatments. This can be seen from the texture value, which remained relatively high until day 14 (2.7). PP plastic acts as a barrier to gas and water vapour exchange, thereby suppressing the respiration rate and maintaining tissue hardness. Hollow PP plastic also showed the ability to maintain texture, although slightly lower than non-hollow PP plastic, which was likely due to the presence of holes that allowed greater air exchange (Sonawane, 2022). According to Yuen (2025), the barrier properties of PP plastic against gases are important in inhibiting respiration and maintaining product texture, which is in line with the role of PP plastic as a barrier to gas/water exchange.

The pattern of texture decline in corn with husks shows a similar trend to corn without husks, but with a relatively slower rate of decline. The presence of husks provides natural protection against water loss and mechanical damage, so that texture can be maintained longer. According to Kumar (2021), corn with husks experiences a slower drying rate than corn without husks, because the husks act as a protective layer that slows down the transfer of water mass out of the corn tissue. Untreated corn with husks still experienced a significant decrease in texture, reaching a value of 1.6 on the 14th day. However, this value is still comparable and even slightly better than that of unpeeled corn without treatment. Treatment at 3°C with PP plastic showed the best results in maintaining the texture of corn with husks, with a final value of 2.4 on the 14th day. Meanwhile, hollow PP plastic produced a similar texture value (2.3), indicating that the combination of husks and low temperature is quite effective even with hollow packaging. According to (Pal, 2018), composite films with high gas barriers (including PP derivatives) can slow down changes in the sensory quality of corn when stored at low temperatures, extending the shelf life compared to ordinary films. These results indicate that the combination of physical treatment (the presence of husks), low temperature, and packaging type significantly affects the texture quality of corn during storage. According to Aini (2023), the application of 3°C temperature with PP plastic packaging is recommended to extend the shelf life of corn, especially if the corn is stored in a husked condition, which is more susceptible to quality deterioration.

Texture is an important quality parameter that reflects the freshness and physical condition of corn during storage. Changes in texture may occur due to moisture loss, respiration rate, and environmental conditions throughout the storage period. The effects of packaging type and storage temperature on texture stability are presented in Table 6.

Table 6. ANOVA of the peeled corn and corn husk

Treatments	Sum Of Squares	Df	Mean Square	F	Sig.
Without Corn Husk Treatment	143.790	99	13.254	48.690	0.00
3ºC-Polypropylene plastic for corn husks	88.910	99	8.646	70.099	0.00
3ºC-Corn Husk Perforated Polypropylene Plastic	92.000	99	8.933	69.310	0.00
Without Corn Peeled Treatment	120.000	99	11.578	65.949	0.00
3ºC-Polypropylene plastic for corn Peeled	88.190	99	8.166	49.993	0.00
3ºC-Corn Peeled Perforated Polypropylene Plastic	95.640	99	8.716	45.605	0.00

Analysis of variance (ANOVA) of corn texture parameters showed that storage duration had a highly significant effect (Sig. < 0.05) on all treatment groups, both for cob corn and shelled corn varieties. The high F-count value in all models indicates that the time variable is the main determining factor in the degradation of the physical integrity of this commodity. In general, there is a linear downward trend in texture values as the storage period increases, which represents the softening of parenchyma tissue due to post-harvest respiration and transpiration activities (Zhao, 2023). In the corn husk group, the treatment without packaging (control) showed that the use of PP plastic packaging at a temperature of 3°C was significantly able to mitigate the decline in physical quality. Duncan's test results showed that in the 3°C Hollow PP Plastic treatment, maximum texture stability could be fully maintained until the 5th day before finally experiencing a significant decline in the following days. Meanwhile, in the Peeled Corn group, packaging intervention using PP Plastic at 3°C emerged as the most effective preservation method, as evidenced by the achievement of the highest texture value of 2.7 on day 14. According to Sanchez (2021), storage at a temperature as close to 0°C as possible consistently extends the shelf life and maintains the post-harvest quality of horticultural products (including texture). Interestingly, in this group, the use of non-hollow plastic showed better performance in maintaining corn kernel hardness compared to hollow plastic. According to Mushtaq (2025), the combination of low-temperature storage + controlled packaging (film packaging) maintains the post-harvest quality of corn, including texture. This shows that micro-atmosphere regulation inside non-perforated plastic packaging is more optimal in suppressing the metabolic rate of shelled corn compared to perforated packaging systems at low temperatures. Overall, the integration of polymer packaging techniques (PP plastic) and low-temperature regulation (3°C) has been empirically proven to extend the shelf life of corn by maintaining texture parameters more consistently compared to conventional storage without treatment

4. Conclusions

The combination of low-temperature storage (3°C) and the use of Polypropylene (PP) plastic packaging significantly extend the shelf life and maintains the physical quality of sweet corn cobs and shelled corn compared to room temperature storage without treatment. The analysis results show that cold temperatures effectively suppress the rate of respiration and degradation of volatile compounds, so that the distinctive aroma of corn can be maximally preserved until the 8th day. The use of PP plastic packaging, especially the hollow type for corn with husks, proved to be most effective in maintaining the stability of the bright yellow colour and mitigating pigment oxidation until the 14^{th} day. Meanwhile, for the texture parameter, the use of non-hollow PP plastic provided the best protection for shelled corn by suppressing the rate of transpiration and water loss that causes tissue softening. The presence of natural husks supported by micro-atmospheric regulation in plastic packaging at low temperatures is the most optimal preservation method to inhibit the decline in the organoleptic quality of sweet corn after harvest.

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