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Identification of Packaging Types and Methods for Packaging of Pakcoy *(Brassica rapa L.)*

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ABSTRACT

The freshness of vegetables is highly dependent on storage methods and post-harvest handling. Pakcoy (*Brassica rapa L.)* is a green vegetable from the Brassicaceae family characterized by broad leaves and crisp stems. Fresh vegetable packaging aims to maintain quality and extend shelf life. The objectives of this study were to determine the effects of plastic type, storage duration, and packaging methods on the organoleptic quality of fresh pakcoy. The methods used were sealing packaging and vacuum packaging. The results obtained showed that packaging with the best ability to maintain the organoleptic quality of pakcoy was found in LDPE and HDPE plastics. In conclusion, the type of plastic affects the organoleptic quality of vegetables by regulating the gas and moisture. Low-permeability plastics, such as PET, may accelerate quality degradation. The longer the storage time, the more the organoleptic quality of fresh vegetables decreases, such as changes in color, texture, aroma, and appearance.

INTRODUCTION

Fresh vegetables are one of the richest sources of nutrients, including vitamins, minerals, fiber, and antioxidants, which play an important role in maintaining a healthy body. Regular consumption of fresh vegetables contributes to immune function, support digestive health, and reduce the risk of chronic diseases such as diabetes, high blood pressure, and heart disease. The freshness of vegetables is highly dependent on the storage methods and handling after harvest. Therefore, to maintain their nutritional content, vegetables must be stored at the right temperature and consumed while they are fresh (Iriyani and Nugrahani, 2017). One method for packaging fresh vegetables is using food-grade plastic packaging.

Food grade plastic packaging is a type of packaging that is specially made to store and protect food without reducing quality or posing health risks. This plastic is made from materials that meet food safety standards, such as polyethylene terephthalate (PET), high-density polyethylene (HDPE), polypropylene (PP), and low-density polyethylene (LDPE); and thus does not contain harmful substances that can migrate into food. Food-grade packaging is widely used in the food and beverage industry because of its lightweight nature, moisture resistance, and good chemical resistance. With technological advancements, some types of food-grade plastics can be recycled or made from biodegradable materials, making them more

environmentally friendly (Gunawan et al., 2021). One application of food-grade plastic in the food industry is through the use of sealing and vacuum-sealing technology, which aims to extend the shelf life of products.

The packaging of fresh vegetables aims to maintain their quality and extend their shelf life. Sealing is a packaging method designed to protect vegetables from air and contamination and often uses plastic to prevent condensation (Ilhami et al., 2024). Vacuum sealing can remove air from packaging to slow respiration and inhibit microbial growth. This technique is more effective in maintaining freshness, especially in vegetables that are not sensitive to pressure (Aceh et al., 2020). Both packaging methods have specific capabilities for maintaining the freshness and quality of vegetables. Therefore, research on identifying types of packaging and packaging methods for fresh vegetables is important to understand the packaging methods and types of plastic packaging appropriate for maintaining the quality and shelf life of perishable fresh vegetables.

RESEARCH METHODS

Sealing Packing

Sealing packaging is performed by first preparing the tools and materials. The green mustard greens (pakcoy) were then cleaned. Initial organoleptic evaluation was performed based on appearance, aroma, texture, and color. Subsequently, the sealing tool is turned on and inserted into the plastic according to the type of plastic treatment. The plastic was then sealed using a sealing machine. Next, it was stored at room temperature for 5 days, and on the 5th day, the organoleptic properties of the pakcoy were observed based on appearance, aroma, texture, and color, and the results were recorded in the results table. The results obtained were organoleptic observations on days 0 and 5.

Vacuum Sealing Packaging

Vacuum-sealing packaging is performed by first preparing the tools and materials. The green mustard greens (pakcoy) were then cleaned. Next, they were organoleptically observed based on appearance, aroma, texture, and color. After that, the vacuum sealing machine is turned on by pressing the on/off button, then the vacuum time is set for 20 seconds, and the sealing time is set for 1.3 seconds, and the vegetables were placed into plastic packaging according to treatment.

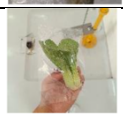
The plastic was then sealed using a vacuum sealing machine. Next, it was stored at room temperature for 5 days, and on the 5th day, organoleptic observations of the pakcoy were conducted based on appearance, aroma, texture, and color, and the results were recorded in the results table. The results obtained were organoleptic observations on days 0 and 5.

RESULTS AND DISCUSSION

The results obtained in the study identification of packaging types and methods for fresh vegetables are presented in Table 1.

Table 1. Organoleptic Observation Results of Pakcoy Using Sealing and Vacuum Sealing Packaging Methods

Type of Plastic	Treatment		Organoleptic Observation				
			Appearance	Aroma	Color	Texture	Image
PET	0 day	Vacuum sealing	Fresh not wilted	Fresh	Green	Crisp	

Type of Plastic	Treatment		Organoleptic Observation				
			Appearance	Aroma	Color	Texture	Image
	5 day		Watery rotten	Pungent	Green old	Very Soft	
	0 day	Sealing packaging	Fresh not wilted	Fresh	Green	Crisp	
	5 day		Watery	Rotten and pungent	Yellowish black	Soft	
HDPE	0 day	Vacuum sealing	Fresh not wilted	Fresh	Green	Crisp	
	5 day		Wilted and Dewy	Rotten	Yellow	Slightly Soft	
	0 day	Sealing packaging	Fresh not wilted	Fresh	Green	Crisp	
	5 day		Fresh not wilted	Fresh	Green slightly yellowish	Crisp	
PP	0 day	Vacuum sealing	Fresh not wilted	Fresh	Green	Crisp	
	5 day		Watery	Pungent rotten smell	Dark green	Soft	
	0 day	Sealing packaging	Fresh not wilted	Fresh	Green	Crisp	
	5 day		Watery and Wilted	Rotten	Yellowing	Soft	
LDPE	0 day	Vacuum sealing	Fresh not wilted	Fresh	Green	Crisp	
	5 day		Slightly wilted	Slightly musty	Pale green with hint of yellow	Slightly hard	
	0 day	Sealing packaging	Fresh not wilted	Fresh	Green	Crisp	

Type of Plastic	Treatment	Organoleptic Observation				
		Appearance	Aroma	Color	Texture	Image
	5 day	There are water droplets on the surface of the packaging	Fresh	Yellowing	Slightly soft	

Description: Primary Research Data, 2025.

Sealing packaging

Sealing packaging is a method of sealing packaging that aims to maintain product quality and safety. This technique prevents contamination, leakage, and the entry of air or moisture that can damage the product. Sealing packaging is performed using a tool called a sealer. Sealing is a product packaging tool that functions to close or seal plastic packaging by heating the edges until they adhere tightly. This process is done to prevent the entry of air, maintain moisture, and protect the product from contamination, thereby extending shelf life, maintaining crispness and preserving the taste of the product. The food industry uses sealing to package snacks, dry products, and other materials that require protection from air exposure to prevent their spoilage. Sealing also helps make packaging neater, more airtight, and maintain product quality for a longer period of time (Kusnandar et al., 2021).

The sealing machine utilizes heating and automatic cutting principles to tightly seal packages. This principle aligns with the sealing mechanism, when the machine is activated, the heating element generates high temperatures that can melt the packaging material in contact with it. This ensures that the packaging is securely sealed, preventing leaks and maintaining the cleanliness of the contents inside. Additionally, the automatic cutting feature serves to remove excess packaging material after sealing, resulting in a neater package (Nyoto et al. 2022). Packaging-sealing testing involves several steps and treatments. Sealing packaging sealing begins with washing the pakcoy, organoleptic observation based on (appearance, aroma, texture, and color), packaging in plastic according to treatment, airflow closure using a sealing device, storage at room temperature for 5 d, and final organoleptic observation based on (appearance, aroma, texture, and color). Sealing packaging testing was conducted to evaluate the ability of the packaging to maintain product quality. This process began with washing the pakcoy to remove dirt that could affect its quality (Lilir et al. 2021).

Subsequently, initial organoleptic observations were conducted to determine the condition before storage. Next, the pakcoy was packaged in plastic according to the treatment given, and then sealed using a sealing tool to prevent air from entering, which can accelerate damage (Purnomo and Sitakar, 2023). The packaged products were stored at room temperature for 5 d to simulate storage conditions. The final stage involved conducting a final organoleptic observation using the same parameters to assess the quality changes during storage. The main advantage of sealing is its efficiency in packaging, making the process more practical and faster. Additionally, its use is safer because the packaging material is simply placed on the heating element until the indicator light turns on, thereby reducing the risk of injury. Sealing also produces neat and aesthetically pleasing seals, enhancing the appeal of the packaging. Furthermore, sealing helps maintain product cleanliness by preventing dust from entering and extends the shelf life because a tight seal can inhibit the entry of air and water vapor.

Products packaged using sealing have a higher selling value due to their more attractive and hygienic appearance (Kurniawan et al., 2023). However, some sealing tools used in the packaging process are still very standard, such as hand sealing, which is not durable for sealing packages. Imperfections in sealing can cause packaging to be loose, increasing the risk of contamination in food products and potentially reducing their quality and

shelf-life. As a result, producers and industries cannot produce products in large quantities because of concerns that the products will not last long, thereby limiting business development opportunities (Abrina Anggraini and Asnah, 2021). Packaging using sealing methods plays a role in maintaining the quality of vegetables by preserving their freshness and nutritional value.

The sealing packaging method can be applied to several vegetables, such as lettuce (Mamonto et al., 2019) and long beans (Hamdan et al., 2023). The sealing method can also inhibit the growth of microorganisms that cause damage and help maintain the texture, color, and taste. Additionally, this method inhibits oxidation and the growth of microorganisms that can reduce product quality. This aligns with the statement by Budianto et al. (2022) that sealing packaging extends the shelf life of vegetables without reducing their texture, flavor, and nutritional content.

Vacuum Sealing Packaging

Vacuum sealing is a packaging method that involves removing air from inside the packaging before sealing it tightly. This technique aims to prevent oxidation, inhibit the growth of microorganisms, and maintain product freshness for a longer period (Nurwathi et al., 2023). The vacuum sealing packaging method was performed using a vacuum sealing machine. Vacuum sealing is a food packaging tool that works by removing air from the packaging using vacuum pressure to slow the oxidation process and inhibit bacterial growth. By reducing the oxygen in the packaging, microorganisms take longer to develop, making the product more durable and shelf-stable. The use of this method not only extends the shelf life of the product, but also helps maintain the freshness, texture, and taste of food for longer (Cahyono et al., 2021). The vacuum sealing mechanism begins with placing the product in a prepared plastic package.

Subsequently, the packaging is placed in a vacuum packager machine, which functions to control and remove the air inside. Once the air is removed, the machine closes and seals the packaging tightly using an automatic sealing system. This process ensures that the packaging is more airtight, allowing the product to last longer and maintain its quality. The packaging is then removed again and checked to ensure it is perfectly sealed, and then placed in a box or cardboard box ready for distribution (Anderson et al., 2021). Testing vacuum-sealing packaging involves several steps and treatments. Vacuum-sealing packaging began with washing the pakcoy, conducting organoleptic observations based on (appearance, aroma, texture, and color), packaging in plastic according to the treatment, sealing the airflow using a vacuum-sealing machine, storing at room temperature for 5 days, and conducting final organoleptic observations based on (appearance, aroma, texture, and color). Washing removes dirt that could potentially accelerate spoilage (Lilir et al., 2021).

The initial organoleptic assessment was used as a reference before storage. The process of packaging with plastic and vacuum sealing reduces oxygen levels, thereby inhibiting the growth of microorganisms and slowing the oxidation process (Ayu et al., 2022). Storage for five days at room temperature allowed for the analysis of product stability under normal conditions. The final stage, namely organoleptic observation after storage, was conducted to assess changes in color, texture, aroma, and appearance to determine the effectiveness of vacuum sealing in maintaining pakcoy quality.

Vacuum sealing packaging methods have various advantages, such as increasing the durability or shelf life of products, reducing the risk of loss or shrinkage of ingredients, and maintaining flavor for longer periods. Through vacuum sealing, distributors have broader opportunities to expand their market reach because products packaged in this way are more durable and can be shipped to various regions without experiencing a decline in quality (Rizki et al., 2023). Additionally, this tool optimizes production efficiency by reducing packaging volume after vacuum sealing.

However, despite the significant benefits of vacuum sealing for producers, there are still some drawbacks to the vacuum-sealing machines available on the market. One of these is the relatively long time required for the vacuum and sealing processes, as well as operational difficulties, particularly in adjusting parameters such as vacuum duration and sealing temperature. Additionally, some of these machines are large and heavy, making them difficult to move and requiring a sufficiently large space. The relatively high price also poses a challenge, making them less suitable for Small and Medium Enterprises (SMEs) (Anderson et al., 2021).

Vacuum packaging helps maintain the quality of meat and vegetables by preventing moisture loss, keeping them fresh, and preventing wilting. This method is particularly suitable for leafy greens, such as spinach, water spinach, and lettuce, which tend to shrink and change texture when exposed to air. By reducing the oxygen content in the packaging, the growth of aerobic microorganisms that can cause spoilage can be controlled, thereby extending the shelf life of food ingredients compared with conventional packaging. This is in line with the statement by Mikael et al. (2020), who stated that vacuum can inhibit oxidation, microorganisms, and the organoleptic properties of products.

Appearance

Appearance is an organoleptic parameter that can be observed directly and can influence the interest and preference of panelists towards food products (Akbar et al., 2020). The principle of testing the appearance parameter involves assessing the panelists' preference for product characteristics based on the visual appearance of the material (Auliata et al., 2021). Organoleptic testing of appearance was conducted by observing pakcoy samples before and after storage using PET packaging, sealing, and vacuum sealing methods. he organoleptic evaluation results are presented in Table 1. The results obtained on pakcoy samples using PET plastic with sealing treatment on day 0 of storage showed a fresh appearance without wilting, while on day 5 of storage, they became watery (Table 1). The results obtained from the pakcoy samples using PET plastic with vacuum-sealing packaging treatment on day 0 of storage showed a fresh appearance without wilting, while on day 5 of storage, they became watery. Based on the results obtained, it is known that sealing and vacuum sealing treatments do not have significant differences, both before and after storage, namely the change in appearance from fresh and not wilted to watery.

According to research conducted by Lengkey et al. (2023), pakcoy greens appear fresh and do not wilt. The results obtained in this study were consistent with those reported in the literature. Pakcoy has a fresh appearance and does not wilt before storage because it is still in a state of good physiological activity after harvesting. The high water content in its cells maintains turgor pressure, allowing the leaves to remain firm (Nugroho and Setiawan, 2022). Additionally, the presence of a cuticle layer on the leaf surface helps reduce water loss through transpiration. Other factors influencing freshness include environmental conditions during distribution, such as low temperature and appropriate humidity, which can help slow respiration and water evaporation from plant tissues (Silaen, 2021). Low temperatures (5 °C) can inhibit the rate of respiration (Purwanto, 2018). Appropriate humidity levels (90%-95%) can reduce excessive water loss from plant tissues, thereby maintaining the freshness of the leaves and preventing them from wilting quickly (Waryat and Handayani, 2020). The optimal storage temperature for pakcoy is 0°C-9°C which can last up to 10 days (Arimurti and Nur'aini, 2023). However, after a storage period of 5 d, pakcoy vegetables begin to undergo changes in appearance, becoming watery. After being stored for a certain period of time, such as 5 days, pakcoy vegetables undergo physical changes, becoming watery owing to a combination of physiological, enzymatic, and microbiological factors.

During storage, pakcoy continues to undergo respiration and transpiration, which causes gradual water loss and decreases turgor pressure in the cells, weakening the tissue (Simatauw et al., 2024). Enzyme activity, such as that of pectinase and cellulase, also

increases, playing a role in the degradation of cell wall components such as pectin and cellulose, causing intercellular spaces to widen and the tissue to become softer. Over time, the cell membrane loses its ability to maintain its structure, causing the fluid in the vacuoles to leak out, making the surface of the pakcoy appear wet (Nurhilmi, 2019). Additionally, the growth of decay-causing microorganisms, such as bacteria, molds, and fungi, accelerates the degradation process by producing enzymes that break down organic compounds in the pakcoy tissue, further exacerbating softening and increasing surface Moisture (Mudaffar and Haruna, 2024).

Therefore, it can be concluded that Both sealing and vacuum-sealing using PET packaging were less effective in maintaining the appearance of pak choi during a 5-day storage period. PET packaging with the sealing method is less effective in maintaining the appearance of pakcoy during storage due to its low gas permeability, making it unable to optimally regulate the gas balance within the packaging. Pakcoy continues to respire after harvest, producing carbon dioxide (CO_2) and requiring oxygen (O_2) in specific quantities. PET, which has high resistance to gas, causes CO_2 to become trapped, while O_2 levels decrease, which can lead to anaerobic conditions and accelerate decay and changes in the physical properties of pak choi (Zulfahmi et al., 2021). The use of PET packaging with vacuum sealing is less than optimal for maintaining the physical appearance of pakcoy during storage because of its limitations in regulating oxygen and moisture levels inside the packaging. As a green leafy vegetable with high water content, pakcoy is susceptible to cell tissue damage due to pressure from the vacuum process, which can cause fluid leakage from the cells. This is consistent with the statement by Nuryati et al. (2021) that humidity in PET packaging can trigger condensation, causing pakcoy to become watery or slimy.

Texture

Organoleptic texture testing was conducted by observing pakcoy samples before and after storage using PET packaging, sealing, and vacuum sealing methods. The results obtained on pakcoy samples using PET plastic with sealing treatment on day 0 of storage showed a crisp texture, whereas on day 5 of storage, the texture became soft. The results obtained from pakcoy samples using PET plastic with vacuum-sealing packaging treatment on day 0 of storage showed a crispy texture, while on day 5 of storage, the texture changed to very soft. Based on the results obtained, sealing and vacuum sealing treatments do not have significant differences, both before and after storage, namely the change in texture from crispy to soft and very soft.

According to research conducted by Yulianti et al. (2023), fresh pakcoy green cabbage has a crisp texture. The results obtained from testing were consistent with those obtained from the literature. Fresh pakcoy cabbage has a crisp texture because the water content in its cells is still high, and the turgor pressure in the tissue remains optimal. This pressure occurs when water in the vacuoles presses against the cell walls, maintaining the rigidity and firmness of the plant structure, including that of the pakcoy (Balqis and Mustakim, 2025). Additionally, cell wall components, such as cellulose and hemicellulose, play a role in maintaining the strength and elasticity of the tissue. While pakcoy is still fresh, the water balance within the cells is maintained, keeping its texture crisp (Daud et al., 2023). However, after a storage period of 5 days, the pakcoy vegetables began to undergo texture changes, becoming soft. The texture changes observed in the testing align with the research conducted by Lengkey et al. (2023), who stated that during a storage period of 18 days, pakcoy undergoes texture changes, becoming soft or even very soft.

Aroma

Organoleptic aroma testing was conducted by observing pakcoy samples before and after storage using PET packaging, sealing, and vacuum sealing methods. The results obtained from pakcoy samples using PET plastic with sealing treatment on day 0 of storage showed a fresh aroma, while on day 5 of storage, it became pungent and rotten. The results obtained

from pakcoy samples using PET plastic with vacuum sealing treatment on day 0 showed a fresh aroma, whereas on day 5, the aroma became pungent and rotten. Based on the results obtained, sealing and vacuum sealing treatments have no significant differences, both before and after storage, namely a change in aroma from fresh to foul and pungent. According to research conducted by Lengkey et al. (2023), before storage, pakcoy had a fresh aroma characteristic of green mustard. The results obtained from testing were consistent with those obtained from the literature. Before storage, pakcoy has a fresh aroma characteristic of green mustard because it still contains volatile compounds such as glucosinolates and isothiocyanates, which give the characteristic odor to plants of the Brassicaceae family.

Freshness after harvesting keeps these volatile compounds active and prevents them from undergoing changes due to storage or exposure to low temperatures. In addition, the high water content in the leaves helps maintain aroma because the respiration process is still ongoing, thus maintaining the stability of the chemical components within them (Wibawa and Kartini, 2025). However, after a storage period of 5 days, pakcoy vegetables began to experience a change in aroma, becoming rotten and pungent. The aroma changes in the present study are in agreement with those reported by Arimurti and Nur'aini (2023), who reported that aroma changes occur in pakcoy during storage, specifically developing a rotten aroma. The pungent rotten aroma in pakcoy results from the decomposition process caused by microorganisms and enzyme activity. After harvest, pakcoy continues to undergo respiration, causing changes in the compounds within its cells (Fertiasari et al., 2023). Bacteria, molds, and yeasts begin to break down organic compounds, such as carbohydrates, proteins, and fats in pakcoy, producing volatile compounds, such as ammonia and hydrogen sulfide, which cause unpleasant odors. Additionally, the high water content in pakcoy supports the growth of spoilage microorganisms, especially if storage is conducted under inappropriate conditions, such as inappropriate temperature or excessive humidity (Daud et al. 2023). Therefore, it can be concluded that the use of PET packaging with sealing and vacuum sealing methods is less effective in maintaining the aroma of pakcoy during a 5-day storage period. PET packaging with vacuum sealing is less optimal for maintaining pakcoy aroma during storage because PET has low gas and water vapor permeability compared to other packaging materials such as PP and PE.

Color

Organoleptic color testing was conducted by observing pakcoy samples before and after storage using PET packaging, sealing, and vacuum sealing methods. The results obtained for pakcoy samples using PET plastic with sealing treatment on day 0 of storage showed a green color, while on day 5 of storage, the color changed to blackish yellow. The results obtained on pakcoy samples using PET plastic with vacuum sealing treatment on day 0 of storage showed a green color, which changed to dark green on day 5. Based on the results obtained, sealing and vacuum sealing treatments have significant differences, namely a change in color from green to dark green. Vacuum sealing changed the color from green to dark yellowish-black. According to research conducted by Yama et al. (2020), pakcoy vegetables have a fresh green color. The results obtained from testing were consistent with those obtained from the literature. The fresh green color of pakcoy before storage is caused by the presence of natural pigments, namely chlorophyll pigments, which are still stable in the chloroplasts of the cells. Chlorophyll a and b pigments play a role in reflecting green light on pakcoy plants, making their leaves appear bright. The stability of these pigments is supported by the integrity of the cell structure, including the cell membrane and vacuoles, which maintain turgor pressure and chlorophyll distribution.

In addition, environmental factors such as controlled temperature and minimal exposure to ethylene gas also slow down the chlorophyll degradation process (Purwasita and Soeparjono, 2022). However, after a storage period of 5 days, pakcoy vegetables began to experience color changes to dark green and blackish yellow. The color change in the test was consistent with the findings of Lengkey et al. (2023), who found that during storage, pakcoy

underwent a color change to yellow and brownish green. During storage, the color change of pakcoy to yellow is caused by the degradation of chlorophyll, which is influenced by enzyme activity, oxidation reactions, and changes in the cell structure. The process begins with the chlorophyllase enzyme breaking down chlorophyll into chlorophyllid, a pigment that is more prone to degradation than chlorophyll (Santoso et al., 2023). Over time, during storage, the peroxidase and lipoxygenase enzymes become more active, accelerating the oxidation of chlorophyllid and converting it into colorless compounds or dull green pigments, such as pheophytin, which forms due to the loss of magnesium ions under acidic conditions (Kristanti et al., 2015). Additionally, unfavorable environmental factors, such as high temperatures and low humidity, accelerate cell membrane damage, leading to the release of chlorophyll-degrading enzymes into the cytoplasm of the cells. Thus, the fresh green color of pakcoy begins to fade and gradually turns yellow and brownish-green (Indrasti et al., 2019). Therefore, it can be concluded that the use of PET packaging with sealing and vacuum sealing methods is less effective in maintaining color retention in pakcoy during a 5-day storage period. The use of PET packaging with the sealing method is suboptimal for packaging pakcoy during 5 d of storage because PET has low gas permeability. This can cause moisture to be trapped inside the packaging, so that pakcoy, which is a green leafy vegetable with a high respiration rate, continues to produce carbon dioxide (CO_2) and water vapor.

CONCLUSION

The type of plastic affects the organoleptic quality of vegetables by regulating the gas and moisture. Low-permeability plastics, such as PET, may accelerate the decline in freshness, texture, color changes, and rancid aroma. The longer the storage time, the greater the decline in the organoleptic quality of fresh vegetables, such as changes in color, texture, aroma, and appearance. Sealing protects vegetables from external contamination, whereas vacuum sealing reduces oxygen availability and further slows deterioration.

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