6 (1) (2026) 1-5

Jurnal Sains, Teknologi dan Manajemen

http://journal.unkartur.ac.id/index.php/stmj

THE EFFECT OF PACKAGING TYPE ON THE QUALITY AND SHELF LIFE OF CHILI SAUCE FROM SKIPJACK TUNA AND MILKFISH

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Info artikel

Catatan pelacakan artikel:

Dikirimkan: 01-01-2026

Revisi: 14-01-2026

Diterima: 17-01-2026

Kata kunci:
Bandeng, cakang, ikan, kemasan, sambal.

Abstrak

Penelitian ini bertujuan menganalisis pengaruh jenis kemasan terhadap kualitas dan umur simpan sambal ikan cakalang (*Katsuwonus pelamis*) dan bandeng (*Chanos chanos*). Tiga jenis kemasan yang digunakan meliputi plastik polietilen (PE) sebagai kemasan berkualitas rendah, kemasan pouch sebagai kemasan sedang, dan kemasan vakum sebagai kemasan berkualitas tinggi. Tahapan penelitian meliputi produksi sambal, pengemasan, analisis kadar air selama empat hari, serta uji organoleptik selama tujuh hari penyimpanan. Hasil penelitian menunjukkan bahwa jenis kemasan berpengaruh signifikan terhadap kadar air, tekstur, aroma, dan masa simpan produk. Sambal yang dikemas menggunakan plastik PE mengalami peningkatan kadar air tertinggi dan penurunan mutu tercepat, dengan masa simpan hanya dua hari. Sebaliknya, kemasan vakum menunjukkan kestabilan kadar air serta mempertahankan kualitas sensorik hingga hari ketujuh. Perubahan warna, bau, dan tekstur pada kemasan berkualitas rendah disebabkan oleh aktivitas mikroba dan proses oksidasi lemak yang mempercepat kerusakan. Pengemasan vakum terbukti efektif memperlambat oksidasi dan menekan pertumbuhan mikroba melalui pengurangan oksigen di dalam kemasan. Dengan demikian, pemilihan jenis kemasan yang tepat, khususnya kemasan vakum, sangat berperan dalam menjaga kualitas fisik, kimia, dan organoleptik sambal ikan serta memperpanjang umur simpannya.

Abstract

This study aims to analyze the effect of packaging type on the quality and shelf life of skipjack tuna (Katsuwonus pelamis) and milkfish (Chanos chanos) chili sauce. Three types of packaging were used: polyethylene (PE) plastic as low-quality packaging, pouch packaging as medium-quality packaging, and vacuum packaging as high-quality packaging. The research stages included chili sauce production, packaging, water content analysis for four days, and organoleptic testing for seven days of storage. The results showed that packaging type significantly affected the water content, texture, aroma, and shelf life of the product. Chili sauce packaged using PE plastic experienced the highest increase in water content and the fastest quality decline, with a shelf life of only two days. In contrast, vacuum packaging showed stable water content and maintained sensory quality until the seventh day. Changes in color, odor, and texture in low-quality packaging were caused by microbial activity and fat oxidation processes that accelerate deterioration. Vacuum packaging has been proven effective in slowing oxidation and suppressing microbial growth by reducing oxygen inside the packaging. Thus, selecting the right type of packaging, especially vacuum packaging, plays a crucial role in maintaining the physical, chemical, and organoleptic quality of fish chili sauce and extending its shelf life.

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p-ISSN 2746-0207
e-ISSN 2807-7865

1. Introduction

Food safety is a crucial aspect in ensuring the supply of food for the community. It serves as a primary requirement for preventing foodborne illnesses that may arise from contaminated food. Therefore, food safety must be ensured before evaluating the nutritional content or functional properties of food. One processed product that must also meet safety requirements is chili sauce (Dian *et al*., 2020).

Chili sauce or *sambal* is a condiment that has become an integral part of Indonesian culinary culture. It is generally made from chili peppers, with or without additional spices, and has varying levels of spiciness, ranging from mild to very hot. To enhance the flavor, ingredients such as shrimp paste (*terasi*) or fermented soybean paste (*tauco)* are often added. Furthermore, there are various popular fish-based chili sauces, such as *sambal ikan roa* from Manado, as well as several fish-based chili sauces from Surabaya, including *sambal ebi*, *sambal jambal roti*, and *sambal lorjuk* (Asnani, 2022).

Fish is a highly perishable food commodity. Its high protein and moisture content make it susceptible to microbial contamination, which can lead to spoilage as microorganisms grow and multiply. Additionally, other factors such as temperature, pH, oxygen availability, storage duration, and handling facilities and equipment also affect shelf life (Hidayat, 2020).

Without proper handling, fish begin to show signs of spoilage around eight hours after being caught. To minimize losses, especially during periods of abundant catches, processing efforts are needed through diversification of fish products, one of which is fish chili sauce. This diversification aims not only to extend shelf life but also to increase the added value of fish by providing variations in taste, aroma, shape, and texture (Muchtar, 2022).

During storage, fish chili sauce tends to experience microbiological deterioration, as indicated by the growth of microorganisms, particularly bacteria. From a sensory perspective, spoilage is characterized by changes in aroma or smell, while chemically, it is characterized by an increase in the product's acidity. This deterioration reduces the shelf life of the chili sauce and can lead to consumer rejection, thus closely related to the food safety aspect of the product (Dian *et al*., 2020).

Packaging plays a crucial role in protecting and preventing food spoilage by preventing the entry of oxygen and air, which can carry contaminants. One commonly used method is vacuum packaging, a technique that removes gas and water vapor from the packaged product. This method is often combined with plastic materials due to their strength, flexibility, ease of molding, and resistance to moisture and air. Plastics with high density and low permeability to water vapor and gases, such as polypropylene (PP), polyethylene (PE), or a combination of aluminum and polypropylene (Al-PP), are often used as packaging materials. PP and PE plastics are among the most common types of packaging used in everyday life (Mulyawan *et al*., 2019).

The choice of packaging material is an important aspect to consider, as it is closely related to its permeability. Packaging materials such as polyethylene (PE), polypropylene (PP), and nylon are commonly used and are generally transparent, allowing the product to be clearly visible from the outside. Therefore, the purpose of this study is to examine the effect of packaging type on the quality and shelf life of fish chili sauce.

2. Methods

This research consisted of three stages: chili sauce production, product packaging, and fish chili sauce analysis. The ingredients used included skipjack tuna, milkfish, red chilies, shallots, garlic, salt, sugar, spices, sauce, soy sauce, and bay leaves. The equipment used included a frying pan, spatula, knife, cutting board, chopper, plastic tray, digital scale, oven, container, analytical balance, and a vacuum sealer.

Spicy Production

The production and packaging of chili sauce (skipjack tuna/milkfish) begins with cleaning the fish, followed by steaming the skipjack tuna until fully cooked. All spices are then ground and sautéed. Once the spice mixture boils, the shredded skipjack tuna chili sauce is added and cooked until the flavors are well absorbed. Cooking is carried out at 100°C for approximately 10 minutes. The cooked skipjack tuna chili sauce is then packaged into various types of packaging, including polyethylene (PE) packaging, pouch packaging, and vacuum packaging.

Analysis

Data obtained from water content measurements over 4 days were analyzed using descriptive statistics and presented as mean ± standard deviation, and organoleptic testing over 7 days.

3. Result and Discussion

Water Content

Water is a crucial component of fish chili sauce products, as it affects their appearance, taste, and texture. The amount of water contained in the product also plays a significant role in determining its shelf life. Therefore, a water content analysis was conducted to determine the amount of water present in the product. The results of the study on the water content of fish chili sauce are presented in Table 1.

The water content analysis results indicate that various packaging types affect the water content of fish

chili sauce. In the first treatment, low-quality plastic (polyethylene, PE) was used. In the second treatment, medium-quality plastic (pouch packaging) was used, while the third treatment used vacuum packaging. Based on the data obtained, the highest increase in water content was observed in the first treatment. Both samples, namely cakalang sambal (skipjack tuna chili sauce) and sambal bandeng (milkfish chili sauce), showed the highest water content when packaged using low-quality plastic.

Table 1. Moisture Content of Fish Chili Sauce

Packaging	Fish	
	Skipjack Tuna	Milkfish
LQP	52,22±0,46	54,67±0,79
MQP	48,56±0,06	50,26±3,78
HQP	50,83±2,16	53,53±4,02

Low Quality Plastic (LQP), Medium Quality Plastic (MQP), High Quality Plastic (HQP)

The type of plastic used for packaging significantly influences the moisture content of products, including skipjack tuna and milkfish sambal, as shown in the results. Different plastic types produce measurable variations in moisture content, with plastics with low water vapor permeability being more effective in maintaining moisture stability during storage. This is due to their ability to limit water vapor exchange between the product and its environment, thereby maintaining quality and extending the shelf life of food. Conversely, plastics with low water vapor resistance allow for greater fluctuations in moisture content, which can reduce product quality and even promote microbial growth during storage (Lapanga, 2020).

a b c

Fig 1. (a) Plastic PE (b) Plastic *pouch* (c) Plastic vacuum

High-quality plastic packaging is generally expected to have good barrier properties, but this study found that it actually had a higher water content than lower-quality plastic. This finding suggests that high-quality packaging is more efficient at preventing water vapor from escaping the packaging system, thus maintaining the product's water content for longer. This effectiveness is influenced by film thickness, polymer density, and the presence of composite layers in high-quality plastic packaging (Boban, 2024).

In this study, the type of fish used in chili sauce production significantly influenced the water content of the final product. Differences in chemical composition and muscle structure, particularly in water and natural protein content, result in distinct characteristics between skipjack tuna and milkfish. Skipjack tuna generally has a lower water content (Habi, 2021). Consequently, skipjack tuna chili sauce generally contains a lower water content than milkfish chili sauce, especially when the milkfish used is fresh and has a naturally higher water content (Abriana, 2020).

Shelf life

Shelf life refers to the period during which a food product maintains its physical, chemical, and microbiological qualities while remaining safe for consumption during storage. Shelf life, or product shelf life, represents the duration a food product can be stored under specific conditions before experiencing a certain level of quality decline. (Nurminabari *et al.,* 2022).

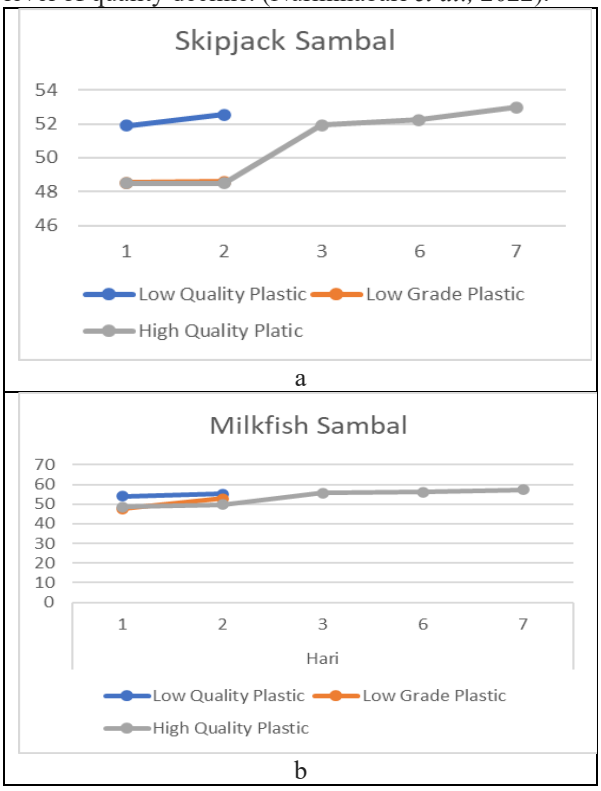

Fig 2. Shelf life graph of Skipjack Tuna chili sauce (a) and Milkfish (b).

Based on observations, the shelf life of fish chili sauce was determined by its moisture content, which reflects the degree of quality decline caused by changes in product humidity during storage. For both products,

skipjack tuna chili sauce and milkfish chili sauce, the use of low-quality plastic packaging resulted in a shorter shelf life, lasting only until the second day of storage. Conversely, packaging made from higher-quality plastic maintained a more stable moisture level, allowing the product to remain stable for up to seven days.

These findings indicate that the quality of the packaging material plays a crucial role in maintaining the physical and chemical stability of the product during storage. This shelf life is closely related to the product's moisture content. High moisture content in food products can facilitate the growth of microorganisms, thereby reducing the product's overall durability and stability (Pratiwi, 2018).

Sensory Evaluation

Based on sensory evaluation data for both types of fish chili sauce during the seven-day observation period, it was evident that the type of plastic packaging significantly affected sensory quality. Products packaged in low-quality plastic showed lower sensory scores. By the sixth day, fish chili sauce packaged in low- and medium-quality plastic showed signs of spoilage. In contrast, products packaged in high-quality (vacuum) packaging maintained their sensory qualities until the seventh day, as shown in Tables 2 and 3.

The off-odor that develops in chili sauce during storage is caused by increased microbial activity. The number of microorganisms in chili sauce gradually increases during storage, leading to more intensive microbial growth and intensifying the unpleasant odor. Furthermore, the storage-related odor in smoked stingray chili sauce can also be caused by oxidation reactions. According to Winarno (2008), oxidation is a series of processes involving the formation of free radicals that release hydrogen atoms and degrade fats, resulting in unpleasant odors and flavors. Fat oxidation not only produces undesirable odors and flavors but can also significantly reduce the nutritional value of food.

Table 2. Organoleptic test of Skipjack Tuna chili sauce

Packaging	Days				
	1	2	3	6	7
LQP	normal	pale and foul smelling	slimy	rotten	rotten
MQP	normal	pale and acid-smelling	slimy	rotten	rotten
HQP	normal	normal	normal	normal	normal

Table 3. Organoleptic test of Milkfish Chili Sauce

Packaging	Days				
	1	2	3	6	7
LQP	pale and acid-smelling	slimy	slimy	rotten	rotten
MQP	normal	pale and acid-smelling	Slimy and foul smelling	rotten	rotten
HQP	normal	normal	normal	normal	rotten

The use of vacuum packaging can suppress microbial growth because the increase in water content during storage is more controlled, thus slowing the oxidation process. This occurs because the vacuum process removes almost all water vapor and oxygen from the packaging. Consequently, vacuum packaging, by removing oxygen from the packaging environment, can slow the proliferation of microorganisms (*Angela et al*., 2015).

High-quality plastic packaging can maintain product freshness longer due to its ability to create stable and controlled internal conditions. This type of packaging generally has high resistance to oxygen and water vapor permeation and can be combined with technologies such as modified atmosphere packaging (MAP) or active packaging layers that function to suppress microbial growth. These characteristics are effective in slowing the growth of spoilage and slime-producing bacteria, while also reducing fat oxidation reactions that can lead to undesirable aromas and flavors (Hauzoukim, 2020).

4. Conclusion

The conclusion of this study indicates that water content is a major factor determining the quality, texture, and shelf life of fish chili sauce. The type of plastic packaging significantly affects the water content and product quality stability during storage. Low-quality plastic packaging, such as polyethylene (PE), causes an increase in water content and accelerates quality deterioration, while vacuum packaging can maintain moisture stability and slow product spoilage. Sensory evaluations showed that chili sauce packaged in low- and medium-quality plastic rapidly experienced changes in odor, taste, and texture, showing signs of spoilage after a few days of storage. In contrast, the vacuum-packed chili sauce were maintained freshness until the seventh day. The main causes of quality deterioration were microbial activity and lipid oxidation, which resulted in odor and decreased nutritional value. Therefore, selecting the right type of plastic packaging is crucial to maintain the physical,

chemical, and organoleptic qualities of fish chili sauce and to extend its shelf life.

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