International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 55 No. 1 January 2026, pp. 746-758

Application of Tuna Skin Gelatin Edible Film Packaging on Changes in the Quality of Asar Skipjack Tuna During Storage

Alfred Freddy Palyama[2], Raudhatul Jannah[2*], Niken Dharmayanti[2], Aef Permadi[1]

[1]Fisheries Processing Technology Study Program, Jakarta Technical University of Fisheries, AUP Street, Pasar Minggu, South Jakarta, Indonesia

[2]Fisheries Resources Utilization Study Program, Jakarta Technical University of Fisheries, Ragunan Street, Pasar Minggu, South Jakarta, Indonesia

*Corresponding author: raudhatuljannah.aup@gmail.com

Abstract - *Asar* skipjack tuna is a processed product of skipjack tuna through a processing process using a hot smoking system. This product is very popular and favored by various levels of society. In addition to being consumed by the people of Ambon city, this product has become a typical souvenir from Ambon. As a typical souvenir of Ambon city, this product has not been packaged with adequate packaging. Smoked skipjack tuna produced by processors in Hative Kecil Village generally has a shelf life of only 2 days at room temperature (27 – 30 °C). The purpose of this study was to study the changes in the quality of smoked skipjack tuna packaged with edible film tuna skin gelatin during storage at room temperature. The experimental design was a completely randomized factorial design (CRFD) with variables A1 (packaged with edible film), A2 (without packaging/as a control), and variables B1 (storage day 0), B2 (storage day 1), B3 (storage day 3), B4 (storage day 4). Each treatment was repeated 3 times. The variables observed were water content, TBA, and sensory values. The results showed that water content and TBA increased during storage. The rate of increase in water content and TBA was lower than that of smoked skipjack tuna that was not packaged. The sensory value of smoked skipjack tuna that was not packaged was rejected by the panelists on the third day, while the smoked skipjack tuna that was packaged with edible film was rejected on the fourth day.

Keywords: Edible film, Gelatin, Skipjack, Smoked fish, Tuna skin

I. INTRODUCTION

Edible film is defined as a thin layer of edible material that aims to inhibit oxygen, water vapor migration, carbon dioxide, aroma and lipids, as well as carrying food additives (e.g. flavors, antioxidants, antimicrobials), and improve the mechanical integrity or handling characteristics of food. In addition, other advantages of using edible film are, it is recyclable, biodegradable, improves the organoleptic properties of packaged food, as a nutritional supplement and source of antimicrobials and antioxidants, and can be used as individual packaging [1]

[2] stated that edible film made from protein (gelatin) is usually edible when used as food packaging. The main reason for using gelatin as a raw material for making edible film is the high glycine, proline, and hydroxyproline content in fish gelatin, making it more flexible and easier to apply to food ingredients [3]. [4] stated that in making edible film from gelatin, plasticizers must be added to obtain an elastic, non-rigid film and to prevent damage to the edible film during food packaging. Plasticizers commonly used in making edible film from protein are glycerol, sorbitol, triethylene glycol, sucrose, and polyethylene glycol [5]. The addition of plasticizers helps overcome brittle and easily broken films and increases elasticity.

Glycerol is a plasticizer that is often used because it is easy to obtain, cheap, renewable and environmentally friendly because it is easily degraded [6]. Based on research conducted [7], regarding the addition of glycerol to gelatin films from mackerel scales with the right concentration of gelatin and glycerol plasticizer can produce good mechanical properties.

Research on edible film has been widely conducted, however, research on the application of Edible Film from tuna skin gelatin and its application as a food packaging material is still rarely conducted, especially for packaging low-water content foods such as smoked skipjack tuna.

Smoked skipjack tuna is a processed product of skipjack tuna through a hot smoking process. The resulting product is golden brown in color with a delicious, smoky flavor. This product is very popular and favored by various levels of society. In addition to being consumed by the people of Ambon City, it has become a typical Ambon souvenir. As a typical Ambon souvenir, this product is not yet packaged adequately. According to [8], smoked skipjack tuna produced by processors in Hative Kecil Village generally has a shelf life of only 2 days at room temperature (27-30°C). This study aimed to determine the effect of tuna skin gelatin edible film on the storage of smoked skipjack tuna.

II. RESEARCH METHODS

This study used a laboratory experimental method, using a Factorial Completely Randomized Experimental Design (CRDF) with variables A1 (packaged in edible film), A2 (unpackaged), and variables C1 (storage day 0), C2 (storage day 1), C3 (storage day 3), C4 (day 4 of storage). Each treatment was repeated three times. The equipment and materials used in this study include:

2.1 Materials and Equipment:

a. Materials

The raw material is yellowfin tuna skin gelatin, while the smoked skipjack tuna is produced by a processor in Hative Kecil Village, Ambon City. Other ingredients used in the production of this edible film include: distilled water and glycerol.

b. Equipment

Equipment used in the application of tuna skin gelatin edible film as smoked fish packaging includes: analytical balance, digital balance, reaction tubes, measuring cylinders, Erlenmeyer flasks, glass beakers, thermometers, titration apparatus, distillation apparatus, digestion apparatus, desiccators, water baths, drying ovens (*Memmert*), homogenizers, UV spectrophotometers (Cecil 3021), stirring hot plates (*Thermo Scientific* CIMAREC Type 131320), digital thickness gauges, 20 x 20 cm printed glass, and sealers.

2.2 Research Time and Location

The research was conducted from March 2023 to April 2023. Edible film production and chemical composition testing of smoked tuna were conducted in the Chemistry Laboratory of the Jakarta Technical University of Fisheries. Sensory testing was conducted in the Microbiology Laboratory of the Jakarta Technical University of Fisheries.

2.3 Research Stages

The research consists of two stages and can be detailed as follows:

a. Edible Film Production

Edible film production refers to [9] with modifications. Gelatin powder was dissolved in 100 mL of distilled water with a gelatin content of 5% (w/v) and then heated at 60°C for 30 minutes with continuous stirring. Afterward, 10% (w/v) glycerol plasticizer was added. The gelatin solution with the added glycerol plasticizer was homogenized at 5000 rpm for 3 minutes using a homogenizer. The solution was then poured into 20 x 20 cm glass molds and dried in an oven at 40°C for 24 hours.

b. Application of Edible Film as Packaging for Smoked Fish Steaks

Packaging is crucial for any product, as its distinctive characteristics can reflect the brand image of the product being marketed. The packaging used in this study utilized edible film made from degradable tuna skin gelatin. The packaging application with edible film from tuna skin gelatin was carried out as follows: Smoked skipjack tuna steaks weighing 100 grams were packaged using two sheets of edible film measuring 20 cm x 20 cm. All four sides of the edible film were sealed using a hand sealer at a heating temperature of approximately 90°C. Place the area to be sealed on the heating element of the hand sealer. Next, press the lever or the top heating element down for 2-3 seconds to melt the edible film. The pressure of the lever caused the edible film to adhere and seal.

2.4 Analysis Method

The testing parameters in this study can be detailed as follows:

2.4.1 Proximate Analysis of Smoked Fish Raw Material

The proximate analysis of smoked fish raw material consists of:

a. Crude protein content analysis [10]

The crude protein content of tuna skin was analyzed using the semi-micro Kjeldahl method. Weigh a 0.51 g sample and transfer it to a 100 mL Kjeldahl flask. Add 2 g of the selenium mixture and 25 mL of concentrated H2SO4. Heat over an electric heater or burner until boiling and the solution becomes clear and greenish (approximately 2 hours). Allow to cool, then dilute and transfer to a 100 mL volumetric flask, making up to the mark. Pipette 5 mL of the solution into a distiller, add 5 mL of 30% NaOH and a few drops of pp indicator. Distill for approximately 10 minutes, using 10 mL of 2% boric acid solution mixed with indicator as a reservoir. Rinse the tip of the condenser with distilled water. Titrate with 0.01 N HCl solution. Perform a blank determination.

Calculation:

$$\text{Protein content} = \frac{(V_1 - V_2) \times N \times 0{,}014 \times fk \times fp}{W}$$

Note :

W = sample weight

V1 = volume of 0.01 N HCl used in the sample titration

V2 = volume of HCl used in the blank titration

fk = protein content of food, generally 6.25

fp = dilution factor

b. Fat Content Analysis [10]

Tuna skin fat content was analyzed using the Soxhlet method. The fat flask was dried in an oven at 105°C for 15 minutes, then cooled in a desiccator and weighed before use. A 1-2 gram sample of tuna skin was placed in a filter paper cartridge lined with cotton. The top of the paper cartridge containing the sample was plugged with cotton and then dried in an oven at a temperature not exceeding 80°C for approximately 1 hour. The paper cartridge was then placed in a Soxhlet apparatus connected to the fat flask. The fat from the tuna skin was extracted with hexane for approximately 6 hours. The hexane was then distilled to obtain the fat extract. The fat extract in the fat flask was then dried in an oven at 105°C for 12 hours. The flask containing the fish skin fat sample was then cooled in a desiccator and weighed. Drying is repeated until a constant weight is obtained. Fat content (%) is calculated using the following formula:

$$\% \text{ Fat content} = \frac{a - b}{c} \times 100\ \%$$

Note :

a = weight of the fat flask after the extraction process (g)

b = weight of the fat flask before the extraction process (g)

c = weight of the sample (g)

c. Moisture Content Analysis [10]

The moisture content of tuna skin samples was analyzed using the oven method. Condition the oven at the temperature to be used until it reaches a stable temperature. Place an empty dish in the oven for at least 2 hours. Transfer the empty dish to a desiccator for approximately 30 minutes to reach room temperature and weigh the empty weight (g). Weigh approximately 2 g of the ground tuna skin sample into the dish. Place the dish containing the tuna skin sample in an oven at 105°C for 3 hours. Cool in the desiccator for approximately 30 minutes, then weigh. Repeat heating until a constant weight is achieved. Moisture content is calculated using the following formula:

$$\% \text{ Water content} = \frac{w - (w_1 - w_2)}{w} \times 100\ \%$$

Note:

w = initial sample weight (g)

w1 = weight of the sample and the cup after drying (g)

w2 = weight of the empty cup (g)

d. Ash content analysis [10]

Accurately weigh approximately 2–3 g of tuna skin into a porcelain crucible of known weight. Char over a burner flame, then ash in an electric furnace at a maximum temperature of 550°C until complete ashing (occasionally open the furnace slightly to allow oxygen to enter).

Calculation:

$$\% \text{ Ash content} = \frac{W_1 - W_2}{W} \times 100\ \%$$

Note :

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 55 No. 1 January 2026, pp. 746-758

W is the weight of tuna skin before ashes (g)

W1 is the weight of tuna skin + cup after ashes (g)

W2 is the weight of the empty cup (g)

2.4.2 Quality Analysis of Smoked Skipjack Tuna During Storage

Quality analysis of smoked tuna during storage includes:

a. Moisture Content Analysis [10]

The moisture content of smoked skipjack tuna samples was analyzed using the oven method. Condition the oven at the temperature to be used until it reaches a stable condition. Place an empty dish in the oven for at least 2 hours. Transfer the empty dish to a desiccator for approximately 30 minutes until it reaches room temperature and weigh the empty weight (g). Weigh approximately 2 g of ground tuna skin into the dish. Place the dish containing the tuna skin sample in the oven at 105°C for 3 hours. Cool in a desiccator for approximately 30 minutes, then weigh. Repeat heating until a constant weight is obtained. The water content is calculated using the following formula:

$$\%\ \text{Water content} = \frac{w - (w_1 - w_2)}{w} \times 100\ \%$$

Note :

w = initial sample weight (g)

w1 = weight of the sample and the cup after drying (g)

w2 = weight of the empty cup (g)

b. TBA (*Thiobarbituric Acid*) Analysis

The TBA value is a method used to identify lipid oxidation in fish containing fatty acids with multiple double bonds, which can directly oxidize during storage in air at room temperature. The increase in the TBA value occurs during fatty acid degradation due to the breakdown of fatty acids. This means that the more double bonds in the fat used, the higher the oxidation rate [11].

The calculation of the determination of the TBA (thiobarbituric-acid) value was carried out by taking a sample of smoked fish weighing 3 g, then for the next stage the sample was dissolved using 50 mL of distilled water. Then the sample was put into a 1000 mL distillation flask while being washed with 48.5 mL of distilled water and adding 1.5 mL of 4 N HCl, then adding 3 boiling stones and putting cotton on the surface of the distillate flask lid. Install a set of distillation equipment and turn on the ON button and wait for the heating process for 10 minutes to obtain a result of 50 mL. Then the distillate was transferred into a test tube and added 5 mL of TBA reagent (0.02 M thiobarbituric-acid solution in 90% glacial acetic acid). The next stage the test tube was cooled with running water then the absorbance was measured at a wavelength of 528 nm with distilled water as the zero point. TBA number analysis is calculated in ppm units [12]. TBA calculation is according to the formula:

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 55 No. 1 January 2026, pp. 746-758

$$\text{TBA Value} = \frac{3xA528x7.8}{\text{Weight of the sample}} = \text{ppm}$$

Note :

$A528$ = Wave length

c. Sensory Analysis

To subjectively determine the quality of smoked fish, organoleptic testing was conducted. Organoleptic testing is a method of testing using the human senses as the primary tool for measuring food acceptability. The sensory organs target the meat, odor, and texture, with a panel of at least 15 semi-trained panelists. The organoleptic testing method for fresh fish uses a standard scoring test.

(scoring test) that is by using a scale of 1 (one) as the lowest value and 9 (nine) as the highest value. The rejection limit for the product is 7 (seven), meaning that if the product being tested gets a value equal to/less than 7 then the product is of poor quality/not fit for consumption [13]. The scale of numbers and specifications of smoked fish are listed in the organoleptic score sheet, which the panelists then directly provide an assessment on the score sheet. The score sheet includes the product specifications which are clear, concise and precise information containing instructions and response information.

To find the quality value, the average result of the panelists' assessments is determined at a 95% confidence level. To obtain the average quality value interval for each panelist, the following calculation is required:

$$\overline{X} = \frac{\sum_{i=1}^{n} Xi}{n}$$

$$S^2 = \frac{i \sum_{i=1}^{n}(x_1 - \bar{x})2}{n}$$

$$S = \sqrt{\frac{i \sum_{i=1}^{n}(x_1 - \bar{x})2}{n}}$$

$$P\ (\overline{X} - (1{,}96 \text{ x } \frac{s}{\sqrt{n}})) \leq \mu \leq (\overline{X} + (1{,}96 \text{ x } \frac{s}{\sqrt{n}}))$$

Note :

n = number of panelists;

S^2 = diversity of quality values;

1.96 = standard deviation coefficient at the 95% level;

x = average quality value;

xi = quality value of the i-th panelist, where i = 1,2,3......n;

s = standard deviation of the quality values;

P = sensory value

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 55 No. 1 January 2026, pp. 746-758

2.5 Data Analysis

This study used a completely randomized design (CRD) factorial design, with treatments of smoked skipjack tuna packaging with edible film (A1) and without packaging (A2), and observed for quality deterioration from day 0 to day 4. All treatments were replicated three times. The data obtained were analyzed using analysis of variance (ANOVA). If significant differences were found, Duncan's Multiple Range Test (DMRT) was used at a 95% confidence level.

III. Results and Discussion

Proximate analysis of smoked skipjack tuna *(Katsuwonus pelamis)*. In this study, smoked tuna was obtained from traditional traders at the Maluku souvenir center in Hative Kecil Village, Ambon City. Before being used in the tuna skin gelatin edible film application study, the smoked tuna was subjected to a proximate test to determine and ensure the quality of the raw material. The proximate analysis of smoked tuna included protein, fat, moisture, and ash content. The test was performed three times. The results of the proximate test of smoked skipjack tuna steak are presented in Figure 1.

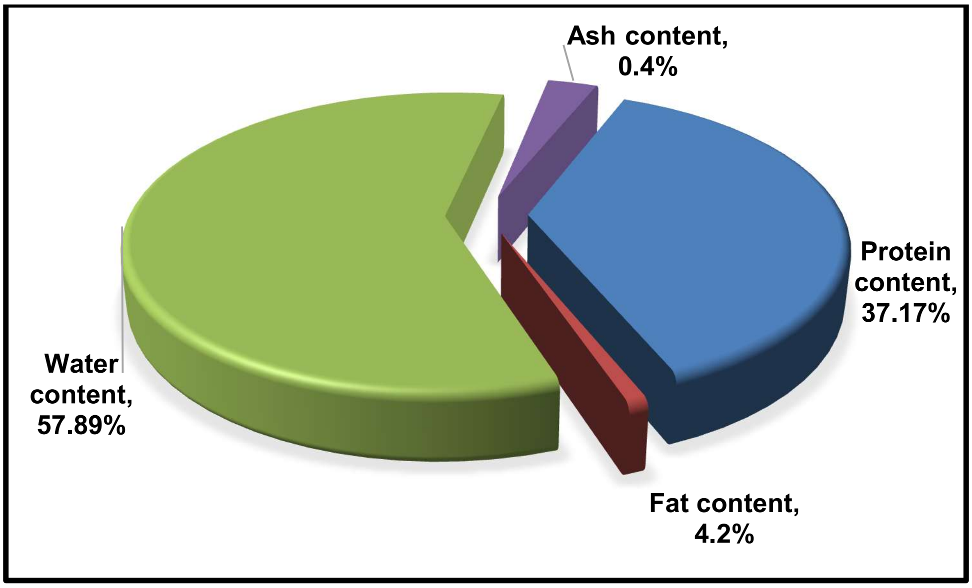

Figure 1. Proximate of Smoked Skipjack Tuna

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 55 No. 1 January 2026, pp. 746-758

Table 1. Proximate composition of smoked skipjack tuna

NO	Nutrition content	Value (%)1 Research Result	Value (%)2 Reference	Value (%)3 Reference
1	Protein content	36.83	35.96	-
2	Fat content	0.86	3.52	-
3	Water content	56.99	56.53	Maximum 60
4	Ash content	2.91	3.45	Maximum 1.5

Notes :

1. Research data;

2. Rieuwpassa et al. (2013);

3. SNI 02-2725-1992.

Table 1 shows that the proximate composition of smoked skipjack tuna differs from several reference sources. The protein content of smoked skipjack tuna can differ from that of other sources, possibly due to several factors. Factors influencing protein content include the processing process. Material preparation, smoking method, species differences, age, catch period, and habitat. According to [16], protein content can decrease due to processing, with protein denaturation occurring during heating. Denatured protein will coagulate when heated at 500°C or above.

The fat content of smoked skipjack tuna is lower than that of smoked skipjack tuna, according to comparative data. The low fat content of smoked skipjack tuna is likely due to several factors. Factors influencing fat content include fishing season, species, geography, age variation, and maturity within the same species [17]. Fish that migrate long distances before spawning will use their protein and fat for energy, thereby reducing their biological activity. Biota maturity is also related to the spawning period. During the spawning period, fish generally do not digest much food and therefore do not obtain sufficient energy. Protein and fat content return to normal after spawning because fish tend to migrate in search of food sources according to their dietary patterns [18]. [19] stated that hot smoking can affect changes in fat content, especially if the distance between the heat source and the fish on the stove is too close, indicating that the fish's fat has deteriorated.

The moisture content of smoked skipjack tuna is close to that of smoked fish in comparative literature. [19] stated that water is the largest component in smoked fish. Water provides a medium for microorganisms to thrive. Therefore, the smoking process aims to remove the water content from smoked fish and is expected to extend its shelf life.

During the smoking process, the water content decreases. This decrease is due to the salting and heating processes, which can reduce the water content in the fish. [20] state that salt has hygroscopic properties that absorb fluids in fish flesh through osmosis. Furthermore, during the smoking process, drying also occurs, resulting in a decrease in the weight of the fish as the water evaporates. On the one hand, reducing the water content can provide a preservative effect, but on the other hand, it can make the meat tough and reduce yield.

The water content analysis results were 56.99%. The standard water content for smoked fish according to the Indonesian National Standard (SNI) is a maximum of 60%. Therefore, the water content of smoked skipjack tuna still meets SNI standards. Smoked fish products produced using smoking cabinets and furnaces have water contents that largely exceed the standard limits set by [15]. According to [19], the decrease in water content during smoking is caused by the addition and concentration of salt, as well as the smoking process.

According to [21], the decrease in water content due to evaporation from the product due to the influence of air temperature and humidity of the surrounding environment causes evaporation in the product. High water content in processed smoked fish can affect the quality of the resulting smoked fish.

Ash content is a parameter of the nutritional value of a product ingredient produced by the inorganic components found in fish [19]. The ash content of smoked skipjack tuna is lower than that of smoked fish from comparative data sources. The difference in ash content is likely due to by the length of smoking time, smoking method, and the size of the fish used. The larger the size of the fish, the higher the ash content. This is supported by the results of research from [22], the ash content of fresh milkfish is 1.38% and after undergoing the smoking process it becomes 2.68%. Smoked tilapia has an ash content of 9.41% higher than the ash content of fresh tilapia of 7.60%. This increase can occur due to the precipitation of mineral elements contained in salt during the soaking process in the salt solution. The elements contained in minerals are phosphorus, calcium, potassium, sodium, magnesium, sulfur, and chlorine.

3.1 Quality Analysis of Smoked Skipjack Tuna *(Katsuwonus pelamis)*

a. Water Content

The water content test for smoked skipjack tuna *(Katsuwonus pelamis)* was conducted to determine the water content of smoked calakang fish packaged with edible tuna skin gelatin film and without packaging, stored at room temperature (27°C – 30°C) from day 0 to day 4. The results of the smoked calakang fish analysis are described in Table 2.

Table 2. Water content value of smoked skipjack tuna

Treatment	Repeat (%)			Total	Mean	STDEV
	I	II	III			
A1C1	49.20	49.20	54.00	152.40	50.80	2.77
A1C2	50.39	51.93	48.72	151.04	50.35	1.61
A1C3	47.91	52.31	51.10	151.32	50.44	2.27
A1C4	58.15	49.06	50.14	157.35	52.45	4.97
A2C1	52.18	51.87	50.26	154.31	51.44	1.03
A2C2	40.65	40.33	41.87	122.85	40.95	0.81
A2C3	42.21	41.27	42.32	125.80	41.93	0.58
A2C4	50.56	52.36	49.74	152.66	50.89	1.34

Note:

A1 = Edible film packaging

A2 = without edible film packaging

C1 = storage day 1

C2 = storage day 2

C3 = storage day 3

C4 = storage day 4

Water content value of smoked fish samples packed with edible film tuna skin gelatin experienced an increase in water content with a slow and stable change pattern where on day 0 the average water content value was 50.08% while on the 4th day of storage it was 52.45%. Meanwhile, the smoked skipjack tuna that was not packaged on day 0 had an average water content of 51.44% and experienced a decrease in average water content on day 1, namely 40.95% and experienced a rapid increase in water content on days 2 to 4. Where on the 4th day of observation, an average water content of 50.89% was obtained. From these data, a relationship can be made between storage time and water content of smoked fish that were packaged and without packaging.

The increase in water content in the product is likely due to the absorption of water vapor in the surrounding environment even though it has been packaged with edible film packaging, considering that edible film tuna skin gelatin has permeable

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 55 No. 1 January 2026, pp. 746-758

properties to water vapor with a water vapor transmission rate of 3.5012 gr/m^2/hour. For smoked skipjack tuna samples that were not packaged experienced a pattern of decreasing water content on the 1st day of storage and experienced a rapid increase on the 2nd to 4th day of storage. This decrease in water content and increase in water content is likely due to evaporation from the product on the 1st day of storage due to the influence of the surrounding temperature and high humidity. While on the following day, it experienced absorption of water vapor from the environment due to the surrounding conditions having low humidity. [21] stated that the water content of a product is influenced by the humidity of the surrounding air. If the humidity of the room is higher, the product will absorb water, and if the humidity of the storage room is low, the product will evaporate its water. The increase in water content of smoked skipjack tuna during storage is caused by the activity of microorganisms (*suspected to be anaerobic bacteria*). Reference [23] stated that microorganisms (*bacteria*) break down proteins and carbohydrates in fish tissue to meet their growth needs. This breakdown produces energy, other simpler compounds, and some water. The analysis of variance data revealed significant differences between the edible film packaging treatments (A1) and those without packaging (A2). There was a significant interaction between treatments A and C (sig. ≤ 0.05). Factor A differed significantly between treatments. There was a significant difference between treatments Factor C.

The standard moisture content for smoked fish according to [24] is a maximum of 60–65%. The results showed that smoked fish products packaged with edible film and without packaging during 4 days of storage had moisture content within the standard limits determined by [24].

b. TBA levels

The TBA value is one way to determine the rancidity of a food product containing fat. The use of the TBA value is to analyze aldehydes which are known to be the main cause of rancidity in fat. One advantage of using this parameter is that the TBA acid reagent can be directly used on the fat of the material being tested without prior extraction. Rancidity is the result of fat oxidation which will reduce the quality of smoked fish. In the TBA analysis of smoked skipjack tuna *(Katsuwonus pelamis)* was carried out to obtain the water content value of smoked skipjack tuna which was treated with edible film tuna skin gelatin and without packaging which was stored at room temperature (27°C – 30°C) during storage from day 0 to day 4. The results of the analysis of the levels of smoked skipjack tuna can be described in Table 3.

Table 3. TBA content values of smoked skipjack tuna

Treatment	Repeat *(ppm)*			Total	Mean	STDEV
	I	II	III			
A1C1	0.8709	0.6806	0.5234	2.0749	0.6916	0.1740
A1C2	1.2439	1.5574	0.3022	3.1035	1.0345	0.6533
A1C3	2.3013	1.4856	0.4066	4.1935	1.3978	0.9504
A1C4	2.2782	0.8804	1.2707	4.4293	1.4764	0.7213
A2C1	1.5805	0.7928	1.5524	3.9256	1.3085	0.4468
A2C2	2.3324	2.1712	0.5698	5.0734	1.6911	0.9744
A2C3	2.8403	1.5807	1.6792	6.1002	2.0334	0.7006
A2C4	4.0969	2.4570	3.4752	10.0292	3.3431	0.8279

Note:

A1 = Edible film packaging

A2 = without edible film packaging

C1 = storage day 1

C2 = storage day 2

International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 55 No. 1 January 2026, pp. 746-758

C3 = storage day 3

C4 = storage day 4

The TBA value of smoked skipjack tuna packaged with tuna skin gelatin edible film was 0.6916 ppm on the first day of storage. This TBA value continued to increase on subsequent storage days. On the fourth day of storage, the TBA value of smoked skipjack tuna packaged with tuna skin gelatin edible film was 1.4764 ppm. The TBA value of smoked skipjack tuna unpackaged on the first day of storage was 1.3085 ppm. This TBA value continued to increase on subsequent storage days. On the fourth day of storage, the TBA value of smoked skipjack tuna unpackaged was 3.3431 ppm. This value is significantly higher than the TBA level of smoked skipjack tuna packaged with edible film, which was 1.4764 ppm. The higher the TBA content, the lower the quality of smoked skipjack tuna.

The results of the TBA value analysis of smoked skipjack tuna based on storage duration indicate that the TBA value increased up to the fourth day of storage. The longer the smoked skipjack tuna was stored, the higher the peroxide value. This increase is thought to be due to the accumulation of peroxide compounds oxidized during storage. Although the increase occurred during storage, the increase was relatively small. The TBA value obtained in this study still meets standards. The maximum tolerable limit for food consumption is 18 ppm.

b. Sensory Analysis

Appearance

The average appearance score for smoked skipjack tuna packed and unpackaged with tuna skin gelatin edible film was 8.73 at the beginning of storage. The appearance score for smoked skipjack tuna packed and unpackaged with tuna skin gelatin edible film decreased with increasing storage time. The decline in appearance score for smoked skipjack tuna unpackaged was rather slow from day 0 to day 2, but decreased drastically on days 3 to 4. On day 3, the panelists rejected the appearance of unpackaged smoked skipjack tuna (score <7). The decline in appearance of smoked skipjack tuna packaged with tuna skin gelatin edible film was relatively slow from day 0 to day 3, but decreased drastically from day 3 to day 4. By day 4, the panelist rejected the appearance of packaged smoked skipjack tuna (score <7).

The color of the fish flesh after salting changes from golden yellow to brownish. This color is produced by a chemical reaction between phenol and oxygen (O_2) from the air. The surface of salted fish flesh is usually shiny. This is due to the chemical reaction of the formaldehyde compound from phenol, which creates a layer of artificial resin on the surface of the fish flesh [25] As storage time increases, the appearance of smoked skipjack tuna becomes dull and unattractive. The appearance value of smoked skipjack tuna packaged with edible fish skin gelatin film is higher than that of smoked skipjack tuna that is not packaged. This causes the rate of decline in the appearance value of smoked skipjack tuna that is not packaged is faster than that of smoked skipjack tuna that is packaged with edible film.

Odor

The average odor value for smoked skipjack tuna packed and unpackaged with tuna skin gelatin edible film was 8.42 at the start of storage. The odor value for smoked skipjack tuna packed and unpackaged with tuna skin gelatin edible film decreased with increasing storage time. The odor value for smoked skipjack tuna packed and unpackaged with tuna skin gelatin edible film decreased slowly from day 0 to day 2, but decreased drastically on days 3 to 4. By day 3, the odor value for smoked skipjack tuna packed with tuna skin gelatin edible film decreased slowly from day 0 to day 3, but decreased drastically on day 4. By day 4, the odor value for smoked skipjack tuna packed and unpackaged was rejected by panelists (value <7). [25] stated that the decrease in odor value for smoked skipjack tuna was correlated with an increase in microorganisms and their activity, which causes product deterioration and a foul odor. A foul odor is formed due to the decomposition of protein in food by the activity of microorganisms that produce hydrogen sulfide, ammonia, methyl sulfide, amines and other compounds. The odor score of smoked skipjack tuna packaged with edible film and fish skin gelatin was higher than that of unpackaged smoked skipjack tuna. This caused the odor score to decline more rapidly in unpackaged smoked skipjack tuna compared to that packaged with edible film.

Flavor

The average flavor score of smoked skipjack tuna packaged and unpackaged with edible film and tuna skin gelatin was 8.82 at the beginning of storage. The flavor score of smoked skipjack tuna packaged and unpackaged with edible film and tuna skin gelatin decreased with increasing storage time. The flavor score of smoked skipjack tuna packaged and unpackaged with edible film and tuna skin gelatin decreased with increasing storage time. The flavor score of smoked skipjack tuna packaged and unpackaged with edible film and tuna skin gelatin decreased relatively slowly from day 0 to day 2, but decreased drastically on days 3 to 4. By day 3, the flavor score of smoked skipjack tuna packaged and unpackaged was already rejected by panelists (score <7). The decline in flavor value of smoked skipjack tuna packed with tuna skin gelatin edible film was relatively slow from day 0 to day 3, but decreased drastically on day 4. By day 4, the flavor value of the packaged smoked skipjack tuna was already rejected by the panelists (value <7). [25] stated that smoking also produces a distinctive (smoky) flavor in the product. This flavor is formed by the presence of acids and phenols from fuel smoke that adhere to the product. The increase in the number and activity of microorganisms in smoked skipjack tuna during storage causes a deviation in the flavor of smoked skipjack tuna.

The flavor rating of smoked skipjack tuna packaged with edible film and fish skin gelatin is higher than that of unpackaged smoked skipjack tuna. This causes the rate of flavor decline in smoked skipjack tuna packaged with edible film to be faster than that of unpackaged smoked skipjack tuna.

Texture

The average texture rating of smoked skipjack tuna packaged with edible film and tuna skin gelatin at the beginning of storage was 8.73. The texture rating of smoked skipjack tuna packaged with edible film and tuna skin gelatin decreased with increasing storage time. The decline in texture rating of smoked skipjack tuna packaged with edible film and tuna skin gelatin decreased relatively slowly from day 0 to day 2, but decreased drastically on days 3 to 4. By day 3, the texture rating of smoked skipjack tuna packaged with edible film and tuna skin gelatin was already rejected by panelists (score <7). The decline in the texture value of smoked skipjack tuna packed with tuna skin gelatin edible film was relatively slow from day 0 to day 3, but decreased drastically on day 4. By day 4, the texture value of the packaged smoked skipjack tuna was already rejected by the panelists (value <7).

The texture of smoked skipjack tuna was slightly firm at the beginning of storage, but as storage time increased, it became softer and somewhat brittle. This was due to the increased water content resulting from the activity of microorganisms in the product.

IV. CONCLUSION

1. Edible tuna skin gelatin film has good characteristics as a packaging material for smoked skipjack tuna steaks.
2. Smoked skipjack tuna steaks packaged with edible tuna skin gelatin film can extend the shelf life of smoked tuna at room temperature.

REFERENCES

[1] Handito, D, "Pengaruh Konsentrasi Karagenan Terhadap Sifat Fisik Dan Mekanik Edible Film (the Effect of Carrageenan Concentrations on Mechanical and Physical Properties of Edible Films)," Agroteksos, 21(2–3), pp. 151–157, 2011.

[2] Tyuftin, A. A., & Kerry, J. P, "Gelatin films: Study review of barrier properties and implications for future studies employing biopolymer films," Food Packaging and Shelf Life, 29(June), 100688, 2021, https://doi.org/10.1016/j.fpsl.2021.100688.

[3] Wang, H., Ding, F., Ma, L., & Zhang, Y, "Edible films from chitosan-gelatin: Physical properties and food packaging application," Food Bioscience, 40(January), 100871, 2021, https://doi.org/10.1016/j.fbio.2020.100871.

[4] Sanyang, M. L., Sapuan, S. M., Jawaid, M., Ishak, M. R., & Sahari, J, "Effect of Plasticizer Type and Concentration on Dynamic Mechanical Properties of Sugar Palm Starch–Based Films," International Journal of Polymer Analysis and Characterization, 20(7), pp. 627–636, 2015, https://doi.org/10.1080/1023666X.2015.1054107.

[5] Krochta, J. M., "Proteins as raw materials for films and coatings: definitions, current status, and opportunities," *Protein-Based Films and Coatings*, Elsevier, 2015.

[6] Rudyardjo, D. I,"Pengaruh Penambahan Plasticier Gliserol Terhadap Karakteristik Hidrogel Kitosan-Glutaraldehid Untuk Aplikasi Penutup Luka," Jurnal Ilmiah Sains, 14(1), 18, 2014, https://doi.org/10.35799/jis.14.1.2014.4883.

[7] Thuy, Maki, H., Takahashi, K., Okazaki, E., & Osako, K, "Properties of Gelatin Film from Horse Mackerel (Trachurus japonicus) Scale. Journal of Food Science, 80(4), E734–E741, 2015, https://doi.org/10.1111/1750-3841.12806.

[8] Savitri, I. K. E., and Y. M. T. N. Apituley, "Packaging Applications and Consumer Demand for Smoked Fish Products (After Packaging) (In Indonesia)," Research Report by Young Lecturers, Pattimura University, Ambon, 2006.

[9] Yanwong, S., and P. Threepopnatkul. "Effect of Peppermint and Citronella Essential Oils on Properties of Fish Skin Gelatin Edible Films." *IOP Conference Series: Materials Science and Engineering*, vol. 87, no. 1, 2015. doi:10.1088/1757-899X/87/1/012064.

[10] Indonesian National Standard, "SNI 01-2891-1992: How to Test Food and Beverages" BSN, Jakarta, 1992.

[11] Park, S. Y., N. Han, S. Y. Kim, M. Y. Yoo, H. D. Paik, and S. D. Lim. "Evaluation of Natural Food Preservatives in Domestic and Imported Cheese." *Korean Journal for Food Science of Animal Resources*, vol. 36, no. 4, pp. 531–538, 2016.

[12] Sudarmadji, S., B. Haryono, and Suhardi, "*Food and Agricultural Analysis*," Liberty, Yogyakarta, 1997.

[13] Indonesian National Standard, "SNI 01-2346-2006: Organoleptic or Sensory Testing Instructions," BSN, Jakarta, 2006.

[14] Rieuwpassa, F. J., J. Santoso, and W. Trilaksani. "Characterization of Functional Properties of Fish Protein Concentrate of Skipjack Roe *(Katsuwonus pelamis)*." *Jurnal Ilmu dan Teknologi Kelautan Tropis*, vol. 5, no. 2, pp. 299–309, 2013.

[15] Indonesian National Standard, "SNI 02-2725-1992: Ikan Asap." BSN, Jakarta, 1992.

[16] Ghozali, Thomas, D. Muchtadi, and Yaroh. "Improving the Shelf Life of Milkfish Satay (Chanos chanos) through Cold Storage and Freezing," *Jurnal Infotek*, vol. 6, no. 1, 2004.

[17] Piggot, G. M., and B. Tucker., "*Effects of Technology on Nutrition,*" CRC Press, Boca Raton, FL, USA, 1990.

[18] AOAC, "*Official Methods of Analysis*," Association of Official Analytical Chemists, Washington, DC, USA, 1995.

[19] Swastawati, F., B. Cahyono, and I. Wijayanti. "Changes in the Quality Characteristics of Skipjack Tuna (*Euthynnus affinis*) Using Traditional Smoking Methods and the Application of Liquid Smoke (In Indonesia),"*Info*, vol. 19, no. 2, pp. 55–64, 2018.

[20] Afrianto, E., and E. Liviawaty. *Budidaya Rumput Laut dan Cara Pengolahannya*. Bhratara, Jakarta, 1993.

[21] Winarno, F. G., and S. Fardiaz. *"Introduction to Food Technology*," Scholastic, Jakarta, 1980.

[22] Saleh, M., P. Rochiati, Z. Saptijah, Z. Winarti, and I. Muljanah. "The Shelf Life of Smoked Milkfish under Various Storage Conditions," *Jurnal Penanganan Pasca Panen Perikanan*, vol. 77, pp. 11–24, 1994.

[23] Buckle, K. A. *Ilmu Pangan*. Cetakan ke-2, Universitas Indonesia Press, Jakarta, 1987.

[24] Indonesian National Standard, "SNI 2725:2013: Smoked Fish Specifications," BSN, Jakarta, 2013.

[25] Moeljanto R, "*Preservation on processing of fishery product* (Jakarta: Penebar Swadaya) (in Indonesian)," 2001.