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Development of Fish-Based Halal Gelatin as an Edible Film Coating Material

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ABSTRACT

This study focuses on food products innovation by employing animal-derived material as a basis ingredient for making gelatin. Increasing halal lifestyle provides an opportunity to innovate and answer challenges in meeting consumer needs. The manufacture of animal-based gelatin in the production of edible packaging is a promising solution to reduce plastic waste, but it needs to meet halal requirements. This review analyzes gelatin usage, the application of animal-based food resources, and the potential of edible films as packaging materials in halal product development for Muslim consumers. Edible packaging has great capability to decrease plastic waste and meet the demands of an increasingly conscious market for halal and safety in food products. The results showed that fish gelatin-based edible film is biodegradable, safe for consumption, and able to protect food products from oxidation and microbial contamination because it has a thin layer that can inhibit oxygen. Various studies have also shown that the mechanical and physicochemical characteristics of edible films depend on the fish source and the additives utilized Edible films derived from fish gelatin with halal certification represent a key innovation in supporting halal food industries, minimizing plastic packaging, and improving product preservation time.

1. INTRODUCTION

Indonesia is a country where 86.83% of the population is Muslim (Triyasari *et al*., 2025). Every Muslim has an obligation to consume halal products. The current rise in the halal lifestyle is not limited to countries with a Muslim majority. This trend is driven by growing global awareness of the need for halal food, which has expanded rapidly over time (Akbar *et al*., 2023). Beyond religious obligations, health and safety considerations play a crucial role in the selection of food products. Based on Law No. 18 of 2012 on Food, food safety is defined as the conditions and efforts required to prevent food from potential biological, chemical, and other contaminants that may disrupt, harm, or endanger human health, and that do not conflict with the religion, beliefs, and culture of society, thereby ensuring it is safe for consumption. When discussing halal and safety, these two aspects are fundamentally inseparable and are often referred to as *halalan thayyiban*.

Halal is an Arabic term meaning permissible, not prohibited, and in accordance with Islamic law or sharia (Abdul Hamid *et al*., 2022). Meanwhile, *thayyib* is defined as good, safe, and of high quality (Dewi, 2021). The principles of halal and thayyib in Islamic teachings serve not only as religious guidelines but also as standards for meeting food needs and consumption. In this context, halal pertains to food that complies with Islamic law, while *thayyib* refers to production processes conducted in a hygienic manner (Istiasih, 2022). For Muslims, the concept of halal and *thayyib* involves consuming food that is religiously permissible and possesses good nutrition and quality. The progression of time in the era of globalization has significantly impacted technological advancements and the emergence of various types of food and beverages by industry players (Sahib & Ifna, 2024). The need for certainty regarding the halal status and safety of food products is crucial for consumer well-being and health. Halal issues in Indonesia are often related to the use of animal-derived raw materials in the production process (Aris *et al*., 2020). This situation has prompted industry players

to develop animal-derived materials into processed products that are not only high-quality but also ensure halal compliance. In recent years, one animal-based processed product that has begun to be developed and is related to halal issues is gelatin (Prasetyo *et al*., 2025).

Gelatin protein biopolymer formed through partial hydrolysis of collagen extracted from animal skin, bones, and connective tissue. Collagen is the most dominant protein found in animals, representing about 25% of total protein content (Shenoy *et al*., 2022). The hydrolysis of collagen transforms its structure into water-soluble polypeptide chains capable of forming gels, making it suitable for use in various food products (Rather *et al*., 2022). Research by Hatsa *et al*. (2024) reports that 41% of the world's gelatin is produced from pig skin, 28.5% from cowhide, and 29.5% from cow bones. Animal products such as pigs and their derivatives are considered haram for Muslims, so industry players have begun innovating by utilizing other animal-based foods to produce fish-based gelatin. In addition to halal considerations, fish gelatin also possesses characteristics that allow it to function as a food additive, such as a thickener or stabilizer. With the passage of time, fish gelatin plays a role in addressing environmental issues, as it can be utilized as a biodegradable edible packaging material. Product packaging materials, currently dominated by plastic packaging, contribute to environmental pollution. This is due to the nature of plastic, which cannot be broken down by micro-organisms, making environmentally friendly packaging materials such as edible films are necessary (Cheng *et al*., 2023).

Research on the development of fish-based gelatin has not been extensively examined from a halal perspective, particularly regarding the selection of raw materials, production processes, and product safety for consumption, especially by Muslims. The novelty of this literature review lies in its emphasis on halal aspects in the use of animal-based raw materials. Based on this, this literature review aims to provide information on the utilization of various types of fish in developing gelatin that not only meets halal standards but is also environmentally friendly.

2. MATERIALS AND METHODS

The review paper was conducted through a literature review covering the past 5–10 years. Data sources used include ResearchGate, ScienceDirect, Scholar, MDPI, Springer, and Atlantis Press, as well as national journals accessible online and government regulations or laws that are open-access. This literature review includes information on the sources and characteristics of gelatin, the process of forming gelatin into edible films, applications of edible films, halal aspects and food safety, as well as environmental impacts and opportunities for the halal industry.

3. RESULTS AND DISCUSSION

3.1. Halal Certified Gelatin

Gelatin is one of the key ingredients in industry, particularly in the food sector, due to its easily digestible nature, as it consists of partially hydrolyzed collagen protein (Syandri *et al*., 2025). According to Nitsuwat *et al*. (2021), gelatin is produced through the denaturation of collagen found in animal tissues. Skin, bones, scales, and connective tissue are the parts of animal bodies that are generally used as sources of collagen. According to Fauzan *et al*. (2023), gelatin is a denatured protein, giving it water-soluble properties. In the food industry, gelatin is often used as a stabilizer, thickener, water-binding agent, or coating for food products. This is due to gelatin's ability to form an elastic gel in food products (Mikhailov, 2023). Gelatin's characteristics, which add value to products, significantly contribute to increasing consumer appeal and demand. Industry players must therefore ensure the availability of raw materials in the gelatin production process to meet consumer needs.

According to Hanif & Afifah (2024), wild-caught fish can be used as a source of gelatin due to their widespread availability. Fish habitats can generally be classified into freshwater, marine, and brackish water. Fish body parts such as skin, bones, and swim bladders contain high levels of collagen (Nurilmala *et al*., 2022). Fish gelatin has advantages over mammalian gelatin. Based on research by Syandri *et al*. (2025), fish gelatin offers superior properties in terms of solubility, gel strength, viscosity, and stability at specific temperatures and pH levels. Research by Fazial *et al*. (2024) found that red tilapia gelatin produces gel strength and physicochemical properties that closely resemble those of bovine gelatin. The use of fish as a gelatin source can expand food product diversification as a thickening agent, stabilizer, or texturizer, thereby increasing added value. From a halal perspective, fish gelatin can serve as a safe gelatin base because

it complies with Islamic sharia requirements. The appealing properties of fish gelatin make it a viable alternative to mammalian gelatin, making it more readily accepted by consumers. The differences in characteristics between gelatin derived from fish and other animal sources are presented in Table 1.

Table 1. Differences in the characteristics of fish gelatin and pork gelatin

Aspect	Fish Gelatin	Pork Gelatin
Raw materials	Fish skin, bones, and scales (Windayani *et al*., 2020)	Pig skin and bones (Hatsa *et al*., 2024)
Halal status / consumer acceptance	Halal and acceptable to Muslim consumers (Astri *et al.,* 2022)	Limited and not acceptable to all consumers, especially those of the Islamic faith (Hanif & Afifah, 2024)
Sustainability of raw materials	Environmentally friendly, made from fish waste (Wijayani *et al*., 2021)	The availability of raw materials is relatively high (Hatsa *et al*., 2024)
Characteristics of the film	Flexible and not rigid (Radipta Lailatussifa *et al*., 2025)	Stronger and stiffer (Chandra & Shamasundar, 2015)
Applications of edible film	Halal based and biodegradable film (Sharif, 2019)	The movie is very appealing (Yang *et al*., 2025)

Commercial gelatin is generally produced from pork, which raises concerns for some individuals because of social, cultural, and halal considerations (Azizah *et al*., 2023). The main raw materials for gelatin production are currently undergoing continuous innovation through the use of various types of mammals. The halal status of gelatin derived from mammals, such as cows, goats, and other mammals, is heavily influenced by the slaughtering process. Gelatin derived from mammals must be obtained through slaughter in accordance with Islamic law to be considered halal. This limitation has driven the development of safer and more reliable alternative gelatins. Fish gelatin is one such alternative that is more readily accepted from a halal perspective and holds significant potential in the halal food industry. In terms of production, the halal status of fish gelatin is easier to verify since it does not require a slaughtering process. This view is also supported by the Companions of the Prophet, such as Abu Bakr, Ibn Abbas, and others, may Allah be pleased with them, who, based on the verse in Surah Al-Maidah (5:96), opined that fish—being marine animals—are safe for consumption or use as a gelatin source, even in a state of carcass (Astri *et al*. 2022).

3.2. Halal Gelatin Applications

Fish-derived halal gelatin has the potential to be developed as a basic material for food packaging. This type of packaging takes the form of an edible film that protects products from the external environment. Halal gelatin-based edible films are safe and environmentally friendly (biodegradable), allowing products to be stored for extended periods (Ratna *et al*., 2022). Edible films made from fish gelatin have the potential to serve as an alternative packaging material in the halal food industry. Various studies on the use of halal gelatin as a fish-based edible film are presented in Table 2.

Based on various studies, it is evident that halal gelatin extracted from fish skin, bones, or waste has great potential as a raw material for edible films. The application of halal gelatin derived from various fish species yields quite diverse characteristics. The type of fish and the additives used influence the characteristics of the resulting edible film. However, fish gelatin-based edible films are biodegradable and safe for consumption because they do not contain pork or its derivatives, which are prohibited for Muslims. Overall, the use of halal gelatin from fish shows great potential as an alternative to plastic packaging for food products such as meat, fish, and similar products. Edible films not only reduce plastic waste, but they also protect products from oxidation and microbial contamination and possess antioxidant activity.

3.3. The Process of Turning Gelatin into an Edible Film

The use of packaging is crucial for protecting products and minimizing the risk of external contamination. Other benefits of packaging are quite diverse, relating to both shelf life and food safety. Edible film packaging consists of a thin layer that serves as primary packaging for food. The mechanism of edible film is related to its permeability (Li *et al*., 2024). This property enables edible film to prevent the transfer of substances—such as oxygen, light, water vapor, and fats—rom outside the packaging. Edible film generally has both advantages and disadvantages. The advantage of edible film

Table 2. Applications of halal gelatin as an edible film on various types of fish

References	Raw Materials and/or Additives	Applications and Characteristics of Edible Films
Nasution & Wahyuni (2023)	Fresh catfish skin (*Pangasius hypophthalmus*) with astaxanthin and ascorbic acid	The edible gelatin film derived from catfish exhibits antioxidant activity with an IC50 value of 251.06 × 10^3 mcg/ml for 0.5% astaxanthin and 133.11 mcg/ml for ascorbic acid.
Nurdiani *et al*. (2022)	The skin of the starry goby (*Abalistes stellaris*) with added extracts from the leaves of two mangrove species (*Bruguiera gymnorrhiza* and *Sonneratia alba*)	Film packaging made from starfish skin gelatin with added mangrove leaf extract contributes to film properties such as elongation (16.89-19.38%), water vapor transmission (13.31-13.59%), and antioxidant activity in active packaging (12.36%-60.98%).
Wijayani *et al*. (2021)	Waste from catfish (*Pangasius* sp.), milkfish (*C. chanos*), and barracuda (*S. picuda*)	Barracuda fish skin has a positive effect on the properties of edible films, including protein content, gel strength, tensile strength, elongation percentage, and water vapor transmission rate.
Windayani *et al*. (2020)	Tilapia bones (*O. niloticus*)	The edible film produced from tilapia fish bones has a thickness of 0.05 mm, a tensile strength of 3.07 MPa, and an elongation of 64.34%.
Nurdiani *et al*. (2019)	Red snapper skin (*Lutjanus argentimaculatus*) with pectin	An edible film made from red snapper skin with 0.6% pectin had a thickness of 159.66 µm, a tensile strength of 9.35 MPa, a moisture content of 9.3%, an elongation of 30.5%, and a water vapor transmission rate of 29.52 g/m².
Salimah *et al*. (2016)	White snapper (*Lates calcarifer*) skin treated with transglutaminase	Edible films produced from white snapper skin and added transglutaminase exhibit low permeability to water vapor, high tensile strength, and low moisture content

as packaging is that it can mitigate environmental damage because it degrades naturally (Ratna *et al*., 2024). Meanwhile, the hydrophilic nature of edible film poses a challenge in producing a final product with water vapor or moisture barrier properties, thus requiring appropriate methods in the manufacturing process.

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Fish-based gelatin accounts for 1.5% of total global gelatin production (Abedinia *et al*., 2020). According to Fauzan *et al*. (2023), the concentration of fish gelatin in the production of edible films ranges from 2.5% to 10% w/w. The production of edible films made from fish gelatin is a complex process consisting of several key stages. The fish-based gelatin production process focuses not only on the extraction stage but encompasses the entire process from start to finish to produce edible films of high quality. Each stage of this process plays a crucial role in determining the quality of the gelatin in the edible film. According to research by Reza & Annissa (2023), the gelatin extraction process from fish involves several stages, including pre-treatment, acid or alkaline treatment, extraction and filtration, concentration and purification, as well as drying and grinding. The explanation of these stages is as follows:

3.4.1. Pre-treatment

Pre-treatment is the initial stage in fish gelatin extraction, which involves collecting skin or bones from fish species

selected according to specific requirements. The fish species used are selected based on criteria such as religious halal status, high collagen content, safety, and wide availability. The raw materials used are ensured to be fresh and free from contaminants. This pre-treatment stage involves removing scales, fat, and other impurities from the fish to produce high-quality gelatin.

3.4.2. Acid or Alkaline Treatment

Acid or alkaline treatment is the second step in extracting gelatin from fish skin or bones. The purpose of acid or alkaline treatment is to remove non-collagenous contaminants and prepare the collagen for further extraction (Joy *et al*., 2024). The choice between acid and alkaline is applied according to the desired properties and characteristics of the gelatin.

3.4.2.1. Acid Treatment

Acid treatment in fish gelatin production involves soaking fish skin or bones in a dilute acid solution. The acid solution is typically hydrochloric acid or sulfuric acid. This acid treatment serves to break down connective tissue and release collagen from the fish. The mixture is subsequently heated at a specific temperature and for a specific duration to facilitate collagen extraction. Another study (Masirah *et al*., 2025) characterized gelatin extracted from milkfish (*Chanos chanos*) bones treated with 4.65% hydrochloric acid (HCl) and heated for 27 hours at 89.92 ℃. The result of this acid treatment was type A gelatin with an isoelectric point between pH 7.5 and 9.0 (Suryati *et al*., 2017).

3.4.2.2. Alkaline Treatment

The alkaline treatment in the fish gelatin production process involves soaking fish skin or bones in an alkaline solution. The alkaline solutions used are calcium chloride ($CaCl_2$) or sodium hydroxide (NaOH). These alkaline solutions remove minerals and non-collagenous proteins from the fish. The mixture is then heated at a controlled temperature to extract collagen from the fish tissue. Another study (Susanti *et al*., 2024) involved soaking milkfish scales in a 0.1 M NaOH solution and heating them at 65–70 ℃ for 6–7 hours. The alkaline solution treatment produced type B gelatin. A study (Aljaber *et al*., 2023) found that type B gelatin obtained through alkaline treatment has a pH of approximately 12–13 with an isoelectric point at pH 5–6.

3.4.2.3. Extraction and Filtration

The acid- or base-treated mixture is then extracted to produce gelatin. Extraction is carried out using two methods: continuous and batch. Continuous extraction involves passing the mixture through a series of extraction vessels. These vessels are gradually filled with fresh solution to achieve optimal results. Batch extraction is performed by heating and stirring the mixture in a single container. The extraction yield is a collagen solution that is filtered to separate impurities, solid particles, and non-collagen residues, resulting in a purer gelatin solution. The extracted collagen solution is then filtered. Filtration is the process of separating solid or colloidal particles from water using a filter (Pratiwi, 2023). The extracted collagen solution is filtered to remove impurities and reduce particle size.

The extraction process can be influenced by several factors, such as temperature, extraction time, and pH. High temperatures can break collagen hydrogen bonds, thereby accelerating the hydrolysis process into gelatin. High extraction temperatures tend to increase gel strength (Gerungan *et al*., 2019). According to a study (Suliasih *et al*., 2020), tilapia bones treated with 4% hydrochloric acid, 3% acetic acid, and 6% citric acid showed an increase in gelatin gel strength as extraction time increased. Heating and the addition of water cause gelatin to transition into the sol phase. Meanwhile, cooling and water reduction cause the formation of a gel phase in the gelatin (Aris *et al*., 2020). Another study (Rao *et al*., 2025) found that gelatin extraction from skipjack tuna bones at temperatures of 80 °C, 90 °C, and 100 °C showed an increase in gel strength and viscosity.

3.4.3. Concentration and Purification

The extracted collagen solution is then concentrated to increase the collagen content and reduce the water content. This results in gelatin of higher quality compared to the unconcentrated solution. This increase in concentration can provide gelatin with a more compact and stable structural character (Nguyen *et al*., 2026). The concentration process can be carried out through various methods, such as ultrafiltration and vacuum evaporation. Ultrafiltration is a membrane-based

separation method that is economical and effective for increasing concentration and purifying collagen protein (Scutariu *et al*., 2019). Vacuum evaporation is performed to reduce water content under low pressure. Vacuum evaporation is used to improve shelf life, reduce the risk of spoilage, and increase economic value (Syakdani *et al*., 2019). The concentrated solution is then purified to enhance the quality and clarity of the gelatin. Filtration is applied during this purification process to remove residual impurities. Research (Han *et al*., 2023) found that collagen peptides from marlin skin purified using ultrafiltration produced clearer, more stable, and higher-quality gelatin. These results align with those of Khedri *et al*. (2021), who stated that collagen peptides within the gelatin matrix can improve the mechanical properties and stability of edible films by increasing tensile strength and elongation while reducing water vapor permeability. The concentration of the collagen solution via ultrafiltration is performed at low temperatures, thereby preventing denaturation of the collagen protein structure. This results in superior gelatin quality with improved gel strength and purity (Bretanha *et al*., 2020).

3.4.4. Drying and Milling

The purified collagen solution is then dried and ground. This process aims to remove residual water and serves as the final stage in gelatin formation. The drying methods used are spray drying and freeze drying. Spray drying is a process that involves spraying the solution using a hot drying spray to convert it into dry particles (Usda *et al*., 2023). According to research (Voroshilin *et al*., 2022), spray drying can reduce protein degradation and preserve many α-chains that contribute to gelatin quality. Freeze drying is a type of non-thermal drying that uses low temperatures (Habibi *et al*., 2019). Research (Kanwate *et al*., 2019) found that freeze-drying yields a recovery rate of 54.51 g/100 g dry weight. This method also better preserves the physicochemical and functional properties of gelatin. The dried gelatin is then ground into a fine powder, making the product easier to store and use in the production of edible films. In addition to freeze-drying, spray drying is a method that can be used for industrial-scale gelatin drying. The use of spray drying for production can yield high-quality gelatin powder through a fast and efficient process. This is supported by Mad-Ali (2017), which produced gelatin powder from goat skin using spray drying at 160-180 ℃, resulting in higher gel strength compared to commercial bovine gelatin.

3.5. The Use of Edible Film as Halal Packaging

In general, the packaging currently used for food products is made from plastic. According to Najahi *et al*. (2025), since 2022, global plastic production has increased by 1.6% compared to the previous year. Global plastic production exceeds 400 million tons per year, with only 9% is recycled, 50% is disposed of directly in landfills, and the remainder is not properly managed. The continuing tradition of plastic use is projected to result in plastic production reaching 26 billion tons by 2050. Plastic waste has become one of the major challenges facing the world today (Dokl *et al*., 2024; Geyer *et al*., 2017). Waste pollution will affect the sustainability of human life in the future, both environmentally and in terms of health (Macena *et al*., 2021; Adam *et al*., 2021). Packaging for food and beverages, such as bottles, cups, and single-use wrappers, constitutes industrial plastic waste that significantly contributes to environmental issues in Indonesia. Recognizing the detrimental effects of continuous plastic use, the food industry has begun innovating to develop packaging that is safe for consumption and environmentally friendly (Ghasemlou *et al*., 2024; Lambert & Wagner, 2017).

Packaging essentially offers many benefits and conveniences for people in managing food products. Edible film is a thin sheet characterized by being clear, transparent, odorless, and tasteless. The primary function of edible film is to control the moisture content in food, thereby extending the product's shelf life (Nurjanah *et al*., 2023). Raj *et al*. 2024 found that fish gelatin edible film mixed with 5% cassava starch and 10% cinnamon essential oil provides antibacterial and antioxidant effects that can extend the shelf life of fish fillets by up to 10 days. Research (Niera *et al*., 2019) also found that fish gelatin-based edible films with added carvacrol exhibited stable physicochemical, antibacterial, and antioxidant properties during storage for up to 15 days. Gelatin can serve as a raw material for edible films due to its excellent ability to form thin layers or films. Research (Santoso & Atma 2020) found that an edible film made from catfish bone gelatin was capable of forming a film thickness of 0.084–0.123 mm, a tensile strength of 0.245–1.186 MPa, and an elongation of 70–87.14%.

The production of edible films from animal gelatin as halal packaging can help address environmental issues (Windayani *et al*., 2020). The use of fish gelatin for edible film production is an important innovation to support the

innovation of the halal food industry in meeting consumer needs, particularly those of Muslims. Fish-based gelatin is a highly promising alternative in the halal food industry. Fish gelatin possesses functional characteristics comparable to conventional gelatin and complies with halal standards (Reza & Annissa 2023). Research (Derkach *et al*., 2020) found that fish gelatin from warm waters has characteristics that are nearly comparable to mammalian gelatin, with a gel strength reaching 200 g Bloom, compared to 320 g Bloom for mammalian gelatin (Chung, 2020).

The main challenge in the food sector is the decline in product quality during storage, such as in the case of perishable items like meat or fruits. Edible films can serve as a potential alternative for packaging because they can block moisture and oxygen (Azizah *et al*., 2023). Gelatin-based edible films derived from tilapia skin exhibit good barrier properties against oxygen, with low oxygen permeability values ranging from 5.07–5.88×10^{-18} mol·m^{-1}·s^{-1}·Pa^{-1}, thereby potentially inhibiting oxidation and moisture loss in food products (Nilsuwan *et al*., 2018). Edible film packaging derived from halal animal sources also plays a crucial role in protecting food products from oxidation, microbial contamination, and moisture loss (Silva *et al*., 2023). Gelatin-based films or coatings possess barrier properties against oxygen and carbon dioxide (Sezer *et al*., 2026). These properties of gelatin can minimize oxidation by blocking oxygen from entering the food product. Low oxygen availability can inhibit the growth of aerobic microbes. According to Liu *et al*. (2021), gelatin-based films with added curcumin were able to reduce the growth of both Gram-positive bacteria (*E. coli*) and Gram-negative bacteria (*S. aureus*). Gelatin's antimicrobial properties and its ability to inhibit oxidation support the development of edible films that can maintain product quality during storage. Research findings (Otero-Tuárez *et al*., 2020) indicate that edible films made from fish gelatin exhibit antimicrobial activity against *Listeria innocua*, *Pseudomonas fluorescens*, and *Shewanella putrefaciens*, thereby extending the shelf life of fresh fish products.

A thin layer on edible film can extend shelf life by delaying microbial spoilage and helping to maintain product quality, safety, and freshness. Gelatin-based packaging materials are considered superior in terms of their characteristics. The properties of the packaging in this context are greatly influenced by the source of the gelatin, its amino acid composition, and the extraction method. According to Rather (2022), gelatin films and coatings can preserve food quality during storage by acting as a barrier against gases, oxygen, light, and moisture. Research (Fauzan *et al*., 2023) found that an edible film based on fish gelatin with *Ficus carica* leaf extract has a tensile strength of 2.74 MPa, an elongation of 372.82%, and a water vapor permeability of 3.96 × 10-11 g/msPa. Gelatin is known to form a thin layer on the surface of food materials, thereby acting as a barrier against the transfer of gases and moisture. This can slow down the rates of respiration, oxidation, and water loss in food products. Research by Said & Sarbon (2022) reported that gelatin-based edible film packaging can extend the shelf life of fruits and vegetables. The thin layer on the edible film reduces the transfer of oxygen gas into the tissue of fruits and vegetables. It can be concluded that through this packaging, potential food spoilage can be prevented, the rate of oxidation is inhibited, and product quality is maintained against various forms of quality degradation.

4. CONCLUSIONS AND RECOMMENDATIONS

Fish caught in the ocean can serve as the primary raw material for gelatin production because it is more widely accepted from a halal perspective and is widely available in aquatic environments. Gelatin derived from animal products for the production of edible films as halal packaging can be utilized in food products to address environmental issues. A recommendation from this literature review is the need for further development regarding the production of edible films from fish gelatin, taking halal regulations into account. Clear regulations from halal certification bodies are expected to increase consumer confidence in using fish gelatin as edible packaging.

AUTHOR CONTRIBUTION STATEMENT

Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
JAO	✓		✓	✓		✓	✓		✓	✓	✓		✓	✓
ERASG	✓	✓		✓	✓			✓	✓	✓	✓		✓	✓

C: Conceptualization
M: Methodology
So: Software
Va: Validation
Fo: Formal Analysis
I: Investigation
D: Data Curation
R: Resources
O: Writing - Original Draft
E: Writing - Review & Editing
Vi: Visualization
Su: Supervision
Fu: Funding Acquisition
P: Project Administration

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