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Aluminium Foil as a Packaging Material for Fishery Products: A Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Aluminium foil is a thin material made of aluminum metal used for packaging. Aluminium foil has good properties for packaging food products, including hermetic, flexible, opaque, impervious to moisture and water, non-flammable, and does not absorb other materials or substances. Widely, aluminium foil is used as a coating, especially for packaging food which must be protected from gas, moisture, odors, and light so that it can better maintain the durability of the packaged product. Fishery products need to be packaged to extend shelf life and maintain product quality. Several studies have shown that the use of aluminium foil packaging can extend the shelf life compared to other packaging.

Keywords: Aluminium foil; fishery products; packaging; shelf life.

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1. INTRODUCTION

Aluminium foil is a thin material made of aluminum metal which is used as packaging with a thickness of less than 0.15 mm [1]. Aluminium foil has a smooth surface and is easy to clean, does not produce toxic residues or react with most chemicals [2]. Widely, aluminium foil is used as a coating, especially for packaging food which must be protected from gas, moisture, odors, and light so that it can better maintain the durability of the packaged product [3]. In general, aluminium foil is used as a coating material (laminate) which is placed on the inside (inner layer) or the middle layer of the package which aims to be a reinforcement to protect the package. Food products packaged using aluminium can last up to one year.

Packaging is important to maintain the quality of a product. In general, packaging can be interpreted as the outermost part that wraps a product with a function as a protector from external and internal influences, such as excess sunlight and humidity [4]. Packaging can be interpreted as packing or wrapping a product and is included in one of the product preservation efforts, because packaging can extend shelf life [5]. At present, the scope of packaging varies greatly, starting from packaging equipment, packaging forms, and packaging materials which used to use natural materials, but now have developed into materials that can be produced commercially, such as plastic, paper, metal and glass.

Fish is a commodity that has high potential, and until now it is still believed to be the main source of animal protein for humans. Fishery products are any form of food product in the form of whole fish or products containing fish parts, including products that have been processed in any way which has the main raw material in the form of fish [6]. Processing of fishery products is an activity carried out with the aim of increasing added value to fishery products and serves to preserve fish, because fish are easily damaged and rotten. Regular consumption of fish and fishery products has many advantages, including boosting the immune system, preventing atherosclerosis or coronary heart disease, due to the presence of unsaturated fatty acids such as Omega-3 fatty acids, taurine, vitamins A, B and D in high amounts [7].

At this time, fish processing products experienced many developments. The development of various processed fish products or those containing fish is one of the efforts to improve community nutrition through diversification, fortification or fish protein substitution [8]. Processed fishery products are usually carried out using traditional or modern processing techniques. Processing is done traditionally, namely by drying, salting, fermentation, smoking and roasting, while modern processing, for example, is freezing fishery products, extracting collagen, and processing chitin and chitosan from shrimp waste.

A food product will experience a change in quality, as well as fishery products. Aluminium foil has good properties for packaging food products, including hermetic, flexible, opaque, impervious to moisture and water, non-flammable, and non-absorbing of other materials or substances [4]. Based on this information it appears that aluminium foil packaging can be used as a packaging material for fishery products thereby extending the shelf life and maintaining product quality when packaged.

2. CHARACTERISTICS OF ALUMINIUM FOIL PACKAGING

Aluminium foil is packaging in the form of dense and thin aluminium metal sheets with a thickness of <0.15 mm [9]. Even though it is included in a metal packaging, aluminium foil does not contain a magnet, which makes it easier to separate aluminium foil from cans when recycling. This packaging has a level of hardness ranging from very soft to hard. Based on the type of material, packaging is divided into two, namely metal and non-metal packaging. Aluminium foil which is included in the metal packaging group has several advantages, including: having good defense against water vapor, gas, dust, dirt and microorganisms; low level of toxicity; resistant to temperature changes; and has an ideal surface. Aluminium foil is also admired because from an aesthetic point of view it has odorless, tasteless, harmless, hygienic properties and is not easily overgrown by bacteria and fungi [1]. Differences in the properties of metal and non-metallic packaging can be seen in Table 1.

Table 1. Differences in the properties of metal and non-metallic packaging

Metal	Non Metal
Good conductor of heat and electricity	Bad conductor, good insulator
Can be malleable or bent in the solid state	Fragile and not malleable
Has a metallic flash	Non metallic luster
Not see-through	Some types are translucent
High density	Low density
Solids (except mercury)	Solid, liquid or gas form

Source: Sulaiman [10]

Table 2. Correlation between the thickness of aluminium foil with the presence of pinholes and water vapor permeability

Aluminium foil thickness (inch)	The number of sheets containing small holes	The number of sheets that do not contain pinholes	Permeability average value (g/m^2/24 hours)
0,00035	100	0	0,29
0,00050	100	0	0,12
0,00070	15	85	0,043
0,00010	8	92	0,007

Source: Sucipta et al. [4]

2.1 Flexibility

Currently the types of packaging variations used to package food products are growing. Generally, product packaging that is now widely circulating in the market is a type of packaging that uses flexible packaging materials. This is because flexible packaging has a cheaper price compared to rigid packaging, besides that flexible packaging is also lighter so that it has an impact on lower transportation costs [4].

Aluminium foil is a packaging that is flexible or easy to shape. Flexible packaging is a revolution in packaging technology, this packaging is easily flexible without breaking or being damaged, and its shape can change if it is given pressure or touch [11]. Flexible packaging can be produced in rolls or bags, and is usually in the form of thin sheets. For flexible packaging, aluminium foil usually used has a thickness of 0.025 mm [12]. Aluminium foil used as packaging is usually in the form of rolls and some are in the form of pouches. In the market, aluminium foil can be found in various forms such as pouches or standing pouches [13].

2.2 Water and Air Tight

One of the functions of packaging is the function of protection, where effective packaging must be able to protect its contents from causes of damage such as water, moisture, gas, odors, dust, and so on. Especially for products that easily react with oxygen, such as dry food, packaging that cannot be penetrated by oxygen is needed [14]. The permeability of aluminium foil packaging to gas and water vapor is the lowest and the density is also the highest when compared to other packages so that it can protect food products from oxidative damage and maintain crispness.

The higher the water content in a product, the faster the quality of the product will decrease, because the water content is the main factor for microorganisms to reduce product quality [15]. Water vapor will be used by microbes to live, grow and reproduce which will eventually damage fishery products and cause decay in these products [16]. The increase in water content in a product is caused by the absorption of moisture from the air. Therefore, to be able to maintain moisture content, a package must be made of water- and air-tight packaging materials so that water vapor and air cannot freely enter and exit the package [4].

The thickness of aluminium foil affects the possibility of permeability of water vapor entering through small holes on the surface of the packaging. The lower the permeability value to light, water vapor, oxygen and microbes, the lower the diffusion rate so that it can maintain product quality and extend the shelf life of food products [17]. The relationship between aluminium foil thickness and the presence of small holes and water vapor permeability is shown in Table 2.

As long as it can withstand water vapor and gas (hermetic), products packaged using aluminium foil cannot be passed by bacteria, mold, yeast and dust. With its characteristic that is impermeable to oxygen, aluminium foil is an ideal packaging besides being non-corrosive, easy to form even though it is easily wrinkled. Some examples of fishery products that can be packaged in water- and air-tight containers are fish crackers, fish meal and fish floss.

2.3 Heat Resistant

Aluminium foil is a heat carrier and is reflective, so it can protect the product it is covered in [18]. Aluminium foil packaging is suitable for food ingredients and products that have a high fat and vitamin content, as well as fermented foods, because protecting from light can activate chemical reactions and enzyme activity [19]. Even though it can hold fat, aluminium foil's resistance to acids and bases is still lacking, so it requires an additional layer of wax or other chemical coatings.

Aluminium foil has properties that are not easy to absorb other materials or substances, does not show changes in size, is not affected by sunlight, and cannot be burned [13]. Its resistance to the sun's heat makes aluminium foil widely used to package health materials. The heat resistance of aluminium foil can reach up to 550°C [20].

3. THE USE OF ALUMINIUM FOIL PACKAGING IN FISHERY PRODUCTS

Fishery products need to be packaged in order to maintain quality and extend shelf life. The diversity of types of fishery products is currently increasing. The use of aluminium foil packaging for fishery products can extend their shelf life. The following are some examples of fishery products that can be packaged using aluminium foil.

3.1 Shredded Fish

Shredded fish is a processed fish food that is processed by boiling and frying which is then seasoned, has soft characteristics, tastes good and has a relatively long shelf life [21]. Shredded fish is a processed fishery product made from fish meat, through a combination of grinding, frying, and adding additional ingredients and flavoring ingredients to fish meat. Making shredded fish is an alternative way of processing fish to anticipate the abundance of raw materials or to diversify fishery products [22]. Almost all types of fish can be processed into floss, both freshwater and seawater fish. Some examples of the types of fish used in making shredded fish are catfish, catfish, and tuna.

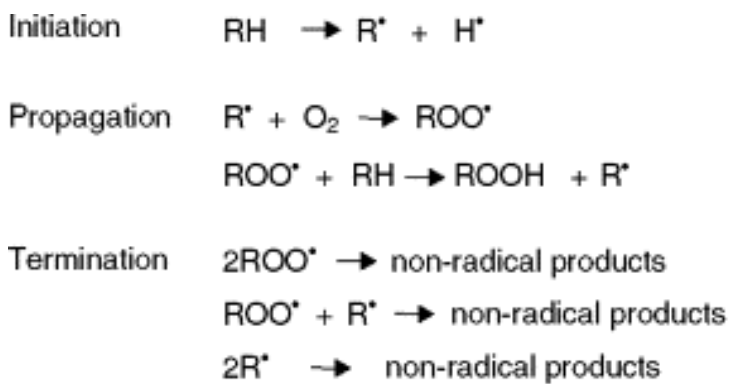
One of the supporting factors in the processing of fish floss is packaging. Packaging is very influential on the quality and shelf life of shredded fish, so it is necessary to do good packaging including the type and packaging process. This type of aluminium foil packaging is widely used by home industries because it has several advantages, including being hermetic, flexible and opaque. Shredded fish packaged in aluminium foil can last up to 116 days at 30°C [21].

3.2 Smoked fish

Smoked fish is fish that is preserved by smoking, the fish is smoked until the color is brown with a distinctive and special aroma. Types of fish that are easy to use to be processed into smoked fish are fish that do not have scales. This is because fish without scales has a thick layer of fat on the skin, so it is very suitable for smoking. The drawbacks of using fish that have scales are that they have to be cleaned first and the skin is thin [23].

Unpackaged smoked fish products have a shelf life of up to 14 days at room temperature. During storage, damage occurs in the form of changes in the sensory flavor of smoked fish, namely the appearance of rancidity caused by fat oxidation [24]. The components present in the product will affect the fat oxidation process during storage which is also triggered by environmental conditions such as the presence of oxygen, humidity and the influence of light, which in turn can reduce product quality [25].

One alternative way to prevent oxidation or contamination of smoked fish is to use packaging that limits the permeability of light, water vapor, oxygen and microbes so as to extend the product's shelf life. Jam fish packaging using aluminium foil has the longest shelf life compared to jam fish packaged with HDPE plastic. The shelf life of jam fish at 30°C with aluminium foil packaging for 25.72 days and aluminium foil vacuum packaging for 32.56 days [24].



Source: Rohman and Sumantri 2018 [26]

Fig. 1. The initiation, propagation, and termination reaction steps in fat oxidation which then produce a rancid odor

3.3 Fish Jerky

Fish jerky is a processed fish product that has a flat shape (plate) made from sliced fish or whole fish which is seasoned and dried. Fish jerky has a water content of around 15-50%, is plastic and does not taste dry [27]. In principle, all types of fish can be used to make jerky, but the types of fish commonly used include tilapia, mujair and tawes. Fish that contain high fat content require a longer drying time so that the types of fish with high fat content are less preferred. Jerky is a product that is easily subjected to the spoilage process, because it has a high protein content that makes it easier for bacteria to multiply and chemical changes easily occur that cause spoilage. Jerky packaged in aluminium foil has a shelf life of up to 19 days at room temperature (27°C) and 16 days at cold temperature (5°C).

3.4 Fish Crackers or Fish Chips

Crackers are food products made from tapioca flour and sago flour with or without the addition of food and other permitted additives [28]. Crackers are prepared by frying or baking before serving. Fish cracker is defined as a processed product from a mixture consisting of fresh fish, tapioca flour and other ingredients which have been subjected to the processing of kneading, molding, steaming, airing, slicing and drying [29]. There are also some who add monosodium glutamate as a condiment or flavoring for crackers. All types of fresh fish can be made or processed into fish crackers. Types of fresh fish that are generally used as raw materials for fish crackers are mackerel, snakehead fish, snapper, gouramy, and tilapia.

Crackers need to be packaged in airtight packaging in order to maintain their crunchy texture. The use of aluminium foil in packing crackers can maintain their crispness so that they are not easily rancid and rancid [30]. Coupled with the innovation of standing pouch type aluminium foil which is currently being developed, it can beautify the packaging. The use of aluminium foil packaging is able to maintain a longer shelf life compared to other packages so it is better for use in packaging chips [31].

3.5 Nori

Nori in Japanese is a food ingredient in the form of dried seaweed sheets, which is a product that has high nutritional value, where the nori protein content reaches 41.49%, 0.44% fat, 4.99% ash content; water content of 13.4% and contains 10 types of amino acids namely threonine, arginine, tyrosine, meteonine, lysine, valine, glutamic acid, glycine, phenylalanine, and alanine [32]. Nori is usually used in soups or to wrap food such as sushi and onigiri, nori can also be found in the form of snacks.

Nori is a product with a low water content because it is made through a drying or roasting process so that it has a dry and crunchy texture. Roasting causes most of the water to come out of the food product to form air bubbles and then break to form pores on the surface of the product. Nori has hygroscopic properties (easily absorbs water) so that when it experiences a decrease in quality, the texture will become moist [33]. Therefore, nori needs to be packaged in airtight packaging. The use of aluminium foil in packing nori can maintain the quality of the nori and avoid increasing the water content in the product.

3.6 Shrimp Paste

Shrimp paste is a fermented product of shrimp or fish with the addition of salt and other additives in a solid form, usually used as a food flavoring agent with a distinctive aroma [34]. The length of time used for fermentation determines the aroma and taste produced by shrimp paste. In general, instant shrimp paste is packaged using plastic or aluminium foil.

4. CONCLUSION

Aluminium foil is a thin material made of aluminum metal used for packaging. Aluminium foil can be used as an alternative to plastic packaging which is widely used today. The advantages of aluminium foil include being flexible, waterproof and airtight, heat resistant and non-toxic. The use of aluminium foil as a packaging material for fishery products can extend shelf life and maintain product quality when packaged.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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