Review Article

POTENTIAL EDIBLE FILM BIOCOMPOSITE (GELATIN, NANOCHITOSAN, AND BEESWAX) FOR EXTEND SHELF LIFE PANGASIUS FILLETS BASED ON ORGANOLEPTIC CHARACTERISTICS, ROTTENNESS, AND PH: A REVIEW

ABSTRACT

Pangasius fillets have a shelf life of 6 days at cold temperatures because fish is a perishable food. Application of biocomposite edible films made from gelatin, nanochitosan, and beeswax can extend the shelf life of pangasius fillets due to their ability to improve mechanical and physical properties which will affect the product. The effect of using biocomposite edible films on pangasius fillets can be analyzed through pH, organoleptic, and rottenness parameters.

Keywords: Pangasius Fillet; biocomposite edible films; gelatin; nanochitosan; beeswax

1. INTRODUCTION

Pangasius is one of the fishery products commodities which has large market share this is because pangasius have delicious taste, white flesh color and also the price is relatively cheap Suryaningrum [1]. Pangasius can be produced as a whole, but mostly pangasius are marketed in the form of frozen fillets and other processed products because the quality of the fish is easily degraded, so by freezing it can be distributed to various markets Suryaningrum [1]. In general, pangasius fillet has a shelf life of up to 6 days at cold temperatures (5-10℃) Agustin et al. [2]. Various efforts to extend the shelf life of fishery products are by adding antimicrobial agents, low temperature storage, and packaging.

Edible coating/film is a coating made from materials containing natural antimicrobials that can maintain the quality and shelf life of products Malhotra et al. [3] in Ningtyas and Ramadhanti [4]. Component edible film consists of hydrocolloids, lipids, and composites (a mix of hydrocolloids and lipids) Rochima et al. [5]. Chitosan is a chitin-derived polysaccharide which one of the edible components Mustapa et al. [6]. Chitosan can be resized into nanoparticles which have the potential to be used as fillers so that they will improve functional properties in antibacterial activity. The use of nanochitosan has been widely used as a material for making biodegradable films that are resistant to microbe Rochima et al. [5].

Another component of edible is protein, one of the protein components is gelatin. Gelatin can protect food from external contamination either in the form of oxygen or microbe, so gelatin can be used as an edible film and coating Lasmi et al. [7]. Beside chitosan and gelatin, beeswax can also be used as a component of edibles because beeswax has hydrophobic properties that can improve the transmission rate of water vapor that diffuses through the film Mudaffar [8]. Water vapor transmission rate indicates the film's ability to withstand the movement of water vapor so that it can protect the product it is packaged with, so the use of beeswax in film making will affect the shelf life and quality of the product it is packaged in. Safitri et al. [9].

The combination of gelatin, nanochitosan, and beeswax can improve the properties of edible films. This is in accordance with the statement of Velikcova et al. [10] that film made of polysaccharides and proteins have the advantage of good mechanical properties but low permeability, while film made of lipids have high permeability but poor mechanical properties, so combining beeswax as lipids and chitosan as polysaccharides can correct these deficiencies. Based on this information, it can be seen that biocomposite edible films made from nanochitosan, gelatin, and beeswax can improve physical properties, especially the rate of water vapor transmission so that they have the effect of extending the shelf life and improving the quality of the products they are packaged with.

2. BIOCOMPOSITE EDIBLE FILM

Composite is an edible film formed from a combination of lipids and hydrocolloid biopolymers Santoso et al. [11] Composites are materials formed from a combination of hydrocolloids and lipids. Composites are formed from two or more materials that have strong properties. Edibles made from composite materials can improve the film or coating of hydrocolloids and lipids and reduce their weakness. Edible composite can improve the deficiencies of the film which is only made of hydrocolloids and lipids Rohim et al. [12] in Mudaffar [8]. Beeswax from fatty acids also includes composites that are usually used in making edibles because of its hydrophobic nature so that it can inhibit moisture from passing through the film/coating Mudaffar [8].

Table 1. Research results on the use of biocomposite edible films in various products

Ingredient	Types of products	Parameter	Observations	Source
Chitosan-beeswax	Strawberries	Organoleptics	7 days at 20℃	Velickcova et al. [10]
Collagen-nanochitosan	Red sea bream fillets	TVB, TPC, pH, Organoleptic	14 days at 4 ℃	Zhao et al. [13]
Gelatin- chitosan	Grass crap fillets	TVB, TPC, pH	12 days at 4℃	Wu et al. [14]

3. GELATIN

Gelatin is a polypeptide bond resulting from the hydrolysis of bone collagen, a skin protein derived from the denaturation of Agustin's collagen [2]. Pangasius gelatin is the result of collagen hydrolysis and can be used in various food and non-food industries because of its multifunctional nature Nurilmala et al. [15].

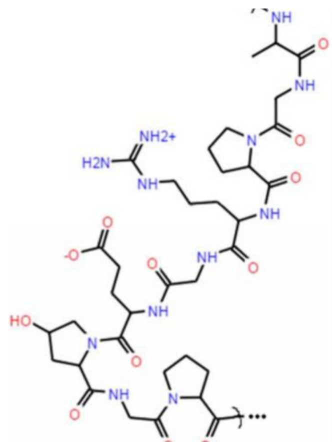

Figure 1. The structure of gelatin based on amino acid composition
Source: Ramos et al. [16]

Gelatin is generally made from cow and pork, but this raises doubts for some religion. Nurilmala et al. [15]. Fish waste products such as bones, skin, heads, and fish scales can be used as gelatin. According to Agustin [2] almost 90% of imported gelatin raw materials come from pig skin, cow hide and cow bone. Gelatin has a chemical structure $C_{102}H_{151}N_{31}$ in which it contains amino acids such as 14% Hydroxyproline, 16% Proline, 26% Glysine, the content varies because it depends on the raw material Ockerman and Hansen [17] in Agustin [2]. Research on the manufacture of gelatin from fish waste has been carried out because gelatin has various benefits. Characteristics of gelatin from various types of fish can be seen in Table 2.

Table 2. Characteristics of Gelatin from Various Types of Fish

Characteristics	Gelatin			SNI	GMA
	Pangasius	Tilapia	Tuna	(1995)	(2019)
Yield (%)	18.11±0.38	19.6±0.86	16.95±0.38	-	-
Moisture content 95)	6.43±1.03	7.04±0.47	3.96±0.52	≤16	-
Ash content (%)	0.39 ±0.05	0.46±0.05	0.13±0.05	≤3.25	≤2
Viscosity (mps)	61.66±4.50	66.33±3.51	65±2.00	-	15-75
pH	5.56±0.15	5.67±0.06	5.65±0.02	-	3.8-7.5

Characteristics	Gelatin			SNI (1995)	GMA (2019)
	Pangasius	Tilapia	Tuna		
Gel strength (bloom)	204.01±10.8	59.73±3.66	59.43±3.72	-	50-300
Setting point (0C)	18.5±0.5	17.5±0.5	16.33±1.04	-	-

Source: Nurilmala et al. [15]

4. NANOCHITOSAN

Based on research Rochima [18] chitosan is chitin whose acetyl group is removed but leaves a free amine group, namely Beta-(1,4)-N-acetyl-D-glucosamine and Beta-91,4)-D-glucosamine. Chitosan has three reactive functional groups in the form of an amino group on the 2nd carbon bond and a hydroxyl group on the 3rd and 6th carbon bonds which make it polycationic. The structure of chitosan can be seen in Figure 2. These properties make chitosan utilized in the food sector, biomedicine, cosmetics, environment and agriculture.

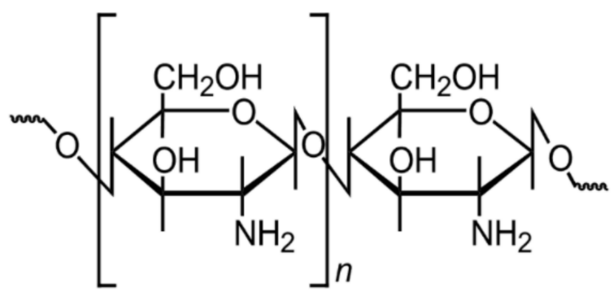

Figure 1. Chitosan Polymer Structure
Source: Sugita et al. [19]

Utilization of chitin and chitosan is presented in Table 3 according to Suhartono [20] in Rochima [18].

Table1. Utilization of chitin and chitosan

Field	Utilization
Nutrition	Nutritional Supplements, Sea Fiber Supplements
Food	Nutraceuticals, fat absorbing compounds, flavours, emulsifiers, texturizers, beverage clarifiers
Biomedical	Treat wound, Square lens, Blood dialysis membrane, Antitumor

Field	Utilization
Cosmetics	Moisturizing cream, Hair care products
Environment and agriculture	Water purifier, Saving seeds, Fertilizers and fungicides
Etc	The final process of making paper, Absorbing color in paint, Feed additives, Chromatography

Method modification of nano-chitosan continues to grow, the variety of methods in the manufacture of nano-chitosan makes it produce particles of different particle sizes or molecular structures Rumengan et al. [21]. The formation of chitosan with the commonly used method usually obtains particle sizes ranging from 300-500 nm, but in fact the sizes vary, some are only 50 nm in size. Rumengan et al. [21]. Modification of chitosan into nano chitosan can use the ionic gelation method. According to Suptijah et al. [22] in Rumengan et al. [21] stated that ionic gelation is a polylecrolite complexation method between positively charged chitosan and tripolyphosphate.

5. BEESWAX

Beeswax is the product of beehive which has like a waxy texture Dewi et al. [23]. The main components of beeswax are palmitate, palmitoleate, and esters with a chain length of 30 to 32 carbons consisting of aliphatic alcohol compounds Dewi et al. [23]. The use of beeswax in edible films is able to improve the physical properties in resisting the transmission rate of water vapor also affecting the thickness, tensile strength and elongation percentage Hastuti [24] in Kanani et al. [25]. Wax can also increase the moisture barrier properties of edible films because they are hydrophobic, this hydrophobic property can produce better edible films Manab [26] in Kanani et al. [25]. Beeswax can be used as a component in the manufacture of edible coatings/films as lipids or fatty acids. Beeswax comes from beeswax containing 50% resin compounds (flavonoids and phenolic acids), 30% beeswax, 10% aromatic oils, 5% pollen and 5% functions as aromatic compounds Pietta et al. [27] in Hermayasari et al. [28]. Flavonoid compounds in beeswax are useful as antimicrobials which can inhibit the pathogenic microorganism Manoi [29] in Dewi et al [23]. The active compound in beeswax plays a role in inhibiting the growth of pathogenic microbes, namely the hydroxyl group which causes a toxic effect on pathogenic microbes. Dewi et al. [23]. Flavonoid compounds in beeswax are useful as antimicrobials which can inhibit the pathogenic microorganism of Manoi [29] in Dewi et al [23]. The active compound in beeswax plays a role in inhibiting the growth of pathogenic microbes, namely the hydroxyl group which causes a toxic effect on pathogenic microbes. Dewi et al. [23]. Flavonoid compounds in beeswax are useful as antimicrobials which can inhibit the pathogenic microorganism of Manoi [29] in Dewi et al [23].

6. PANGASIUS FILLETS

Fish fillets are an intermediate product that is popular because of its easy handling and can be processed into various other products Damayanti et al. [30]. Fish fillets are fishery products that have been separated from spines, skin, viscera, and other parts Suryaningrum et al. [31], Pangasius fillets are popular with the public because they are easy to process and serve as a daily menu and also have high nutritional value, so there is no need to clean the scales during the filleting process, relatively few spines, has a reddish-white flesh color, and is easily skinned so it is relatively easy to make good fillets Susanto and Amri [32].The advantages of using fish fillets as processed raw materials according to Peraginangin et al. [33] in Suryaningrum et al. [31]. is :

1. It can be directly used for processing food products
2. It does not have a fishy smell, is free of bones and thorns so that processed products are easily consumed by people of all ages
3. The supply and price are relatively stable because fillets can be stored for a long time and this will facilitate processing planning
4. Have a short time to handling
5. Free from waste because it does not contain other body parts

Fillets is a fishery product that is easily damaged Afrianto and Liviawati [34]. Quality of fillet can be maintained by the addition of natural antimicrobials, packaging, and low temperature or frozen storage. Changes in quality generally occur due to improper handling, poor sanitation, and inadequate hygiene so that the fish will experience a rapid process of decay Afrianto and Liviawati [34]. Fish has a fairly high water content, which is 80%, so it is easily digested by autolysis enzymes causing fish meat to be susceptible to rapid deterioration in quality. Lestari et al. [35]. Quality changes in fish meat is caused by microorganisms, enzyme activity and fat oxidation in the body of Adawyah fish [36]. The following are the characteristics of fresh and not fresh fish fillets.

Table 4. Characteristics of fresh and non-fresh fish fillets

Parameter	***Fillets*Fresh fish**	***Fillets*Fish Not Fresh**
Appearance	Bright white flesh, neatly clean, the lines formed from the spine and the lateral line are bright red and not split	The flesh is green throughout, very dull, the dorsal line and linea literalis brown and riven
Smell	Smells very fresh, kind specific	Strong ammonia smell and bad smell
Texture	Elastic, dense and compact	Very inelastic, the meat tissue is not compact

Source: SNI 01-2346-2006[37]

7. POTENTIAL EDIBLE FILM BIOCOMPOSITE FOR SHELF LIFE PANGASIUS FILLET

7.1 ORGANOLEPTICS

Organoleptic testing is a subjective method because it uses the senses as a measuring tool Permadi et al. [38]. Organoleptic tests have been widely used to assess quality in the food industry. Quoting from Wagiyono [39] sensing used as an organoleptic test tool is defined as a physio-psychological process, namely sensitivity to the properties of objects due to stimuli received by sensory organs. The impression of the stimulus from the object that is felt is psychological so that this organoleptic test is subjective, assessing the product of what is felt so it is not recommended to exaggerate or reduce product ratings. Each product assessed has a different SNI reference. Organoleptic assessment generally consists of taste, aroma, texture, and appearance. According to SNI 01-2346-2006 [37] the acceptance limit for organoleptic assessment products is 7. The person conducting the organoleptic test is a panelist. Panelists must have the ability:

1. Understand the principles and factors that influence sensing
2. Able to perform sensing correctly and be able to interpret sensing results
3. Able to maintain and increase sensitivity in sensing

4. Capable of being a panelist in a preference or hedonic test

7.2 pH

The degree of acidity or better known as pH is the acidity value of a compound or the hydrogen value of that compound. Determination of the pH value is an indicator for measuring the level of freshness in fish and other food products. Vatria et al. [40]. Fish meat that has entered the post-rigor mortis phase can be identified from its pH. Fish that have entered the post-rigor mortis phase have a pH value of 6.29 Liviawaty and Afrianto [41]. The decrease in pH value in postmortem muscle is determined by the rate of glycolysis and muscle glycogen reserves from meat Roswandono et al. [42].

A decrease in the pH value indicates that the product is undergoing a glycolysis process, for example in fish fillets. Quoting from Vatria et al. [40] Fish fillets that have a decreased pH value are caused by the glycolysis process which continues after the fish dies because the enzymes in the fish are still active. There is no oxygen supply in the fish body, so the formation of glycogen cannot occur, instead glycogen is decomposed into lactic acid under anaerobic conditions so that lactic acid accumulates in the fish flesh. The acid formed in the fish meat causes the pH value to drop and gases from the breakdown are formed which results in an bad smell and taste. Utami et al. [43]. The tool for analyzing pH is a pH meter.

7.3 ROTTENNESS

Decay in fish meat is caused by the activity of putrefactive bacteria which causes the degradation of meat protein into amino acids so that the meat cells become rotten Usmiati and Marwati [44]. Rottenness can change the color of the product, this is caused by damage to the cell wall due to softening of the tissue and then break of fat and change the color product Roswandono et al. [42]. Rottenness product is indicated by the formation of foul-smelling compounds such as ammonia and H_2S. Decomposition also means that there is an intensive bacterial decomposition of organic materials, resulting in the formation of smelly gas which causes a decrease in the nutritional value and product value of a product. Es et al. [45]. Rottenness is characterized by the appearance of white vapor (NH_4Cl) which is formed from the reaction of HCl with NH_3 from microbial activity in the meat. The faster the appearance of white dew on the tube wall indicates that the product has been contaminated. Some types of rottenness bacteria that are commonly found in fresh meat are Aeromonas, Enterococcus, Acinobacter, Moraxella, Chomobacterium, and Pseudomonas Aymerich et al. [46].

8. CONCLUSION

Patin fish has a tasty meat taste and a low price so it has a large market share. Pangasius fish are marketed in the form of frozen fillets due to their easy deterioration in quality. Quality of fish can be prevented by adding natural antimicrobials, packaging, and low temperature or freezing storage. Edible film is a packaging technique that can maintain quality. Edible films are composed of hydrocolloid, lipid, and composite (a mixture of hydrocolloid and lipid) components. Nanochitosan, gelatin, and beeswax can be used as ingredients for edible films because they can improve the properties of edible films. Film made of polysaccharides and proteins have the advantage of good mechanical properties but low permeability, while film made of lipids have high permeability but poor mechanical properties. then by combining beeswax as a lipid and chitosan as a polysaccharide can improve the deficiencies of each. In general, pangasius fillets can survive in cold temperatures (5-10℃) for 6 days. The use of biocomposite edible films on pangasius fillets can extend the shelf life up to 14 days at cold temperatures. Quality deterioration can be tested through pH, organoleptic, and rottenness parameters.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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