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REVIEW ARTICLE: POTENTIAL *EDIBLE* COATING OF CHITOSAN

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ABSTRACT

Processed and food products from fisheries, agriculture, and animal husbandry are generally susceptible to quality degradation due to environmental, chemical, biochemical, and microbiological factors. The decline in quality can be accelerated in the presence of oxygen, water, light, and temperature. One way to prevent or slow down this phenomenon is with proper packaging. Packaging is a food packaging process and is very important to protect the quality of food. Alternatives to the use of packaging plastic one that is packaging Edible coatings. One of the edible coating materials is chitosan. This material was chosen because it has almost complete characteristics and is following the needs of biodegradable packaging, namely odorless, tasteless, flexible, and transparent In addition, chitosan is an alternative material because of its hydrophobic nature, plus its availability in nature is very abundant and is the second-largest number after cellulose. Chitosan can be used as an edible coating, which is a thin layer that can be eaten and formed to coat food. The article review method used is the literature review method. This method examines, summarizes, and interprets all problem findings on a research topic and answers research questions that have been previously determined. The literature review is carried out through electronic-based journals, namely database ProQuest, scholar, science direct, and Ebsco. The results of the review showed that chitosan edible coating with a mass of 5 grams was better in maintaining the quality of wet crackers for two days of storage than starch-chitosan edible coating and starch edible coating against wet crackers. Based on the results of research that has been carried out, it can be concluded that Edible coating is capable of packaging many products ranging from agricultural, livestock, and processed fishery products, such as tuna fish balls, pempek, kurisi fish sausage, green grapes, tofu, beef, chicken meat, Mango fruit, sticky rice dodol, Betawi dodol, wet crackers, beef meatballs, nuggets, red snapper fillet, catfish meat. Sources of chitosan are widely available in nature such as shrimp and crab waste, gold snails, and other alternatives that are still underutilized, namely the Black Soldier Fly (BSF) pupa shell. Edible coatings made from chitosan can be modified by adding additional ingredients to make it more optimal in protecting the packaging inside, such as garlic, casein, ZnO nanoparticles, acetic acid, and starch from fruits or tubers. The edible coating of chitosan affects the shelf life of the product.

INTRODUCTION

Processed and food products from fisheries, agriculture, and animal husbandry are generally susceptible to quality degradation due to environmental, chemical, biochemical, and microbiological factors. The decline in quality can be accelerated in the presence of oxygen, water, light, and temperature. One way to prevent or slow down this phenomenon is with proper packaging. Packaging is a food packaging process and is very important to protect the quality of food. Until now, the product packaging that is still often used is plastic. Plastic packaging includes synthetic polymers that cause contamination through the transmission of monomers to the packaged material and has been proven to cause problems to the environment (Dwimayasanti and Kumayanjati 2019).

Alternatives to the use of packaging plastic one that is packaging Edible coatings. This packaging is biodegradable which also acts as a protector or barrier to control the transfer of water vapor, oxygen, and lipids. Edible coatings can also be used to coat products that function as protection from mechanical damage and are safe for consumption. According to Nur Moulia et al. (2019) Edible Coating serves to extend shelf life, as a carrier for food components including preservatives, antioxidants, vitamins, minerals, antimicrobials, ingredients to improve the taste and color of packaged products.

Edible coatings can come from renewable raw materials and are grouped into three, namely hydrocolloids (such as proteins and polysaccharides), lipids (such as waxes and paraffin, acetoglycerides, and resins) and composites. According to Guarav and Neha (2018), Edible coatings can come from easily renewable raw materials such as a mixture of lipids, polysaccharides, and proteins, which function as a barrier to water vapor, gases, and other dissolved substances and function as a carrier for various kinds of food. ingredients such as emulsifiers, antimicrobials, and antioxidants. According to Wulandari et al. (2015), Edible coatings can be made from a variety of materials including polysaccharides, proteins, and lipids. Coatings can be applied directly to food ingredients or made into edible films which are then used to coat the food surface.

Generally, the main ingredient in the manufacture of edible coatings is starch, because it contains additive compounds that function as gelling agents. The raw material that can be a source of starch is fruit peels, where so far it can be seen that the skins from fruits are just thrown away so that they are still underutilized. Starch-based edible coatings can act as oxygen buffers and can improve the physical properties of food to become slightly harder, but starch-based edible coatings have weaknesses, namely low water resistance and low water vapor barrier properties because the hydrophilic nature of starch can affect stability and mechanical properties. Garcia et al. 2011). One way to improve the physical and functional characteristics of edible coatings is to use other sources of hydrophobic materials and materials that have antimicrobial and preservative properties.

One of the edible coating materials is chitosan. This material was chosen because it has almost complete characteristics and is following the needs of biodegradable packaging, which is odorless, tasteless, flexible, and transparent. In addition, chitosan is an alternative material because of its hydrophobic nature, plus its availability in nature is very abundant and is the second-largest number after cellulose. Chitosan is a compound resulting from chitin deacetylation, which consists of N-acetylglucosamine and N-glucosamine units (Pola et al. 2020). Chitosan has very wide uses in everyday life. The presence of reactive amino groups and hydroxyl groups in chitosan is useful in its wide application, namely as a preservative for fishery products and color stabilizers for food products, water purification, additives for agrochemical products, and seed preservatives (Lalenoh and Cahyono, 2018). Chitosan is a chitin derivative that is widely found in fishery commodities such as shrimp and small crabs (Apriyanti and Mahatmanti, 2013).

In addition to being hydrophobic, chitosan is a natural and safe preservative that has antimicrobial properties with a broad spectrum, both against bacteria, fungi and molds so that it can be used to extend the shelf life of food products because it is antimicrobial or antibacterial (Pitayati et al. 2021). As an antibacterial, chitosan has an inhibitory mechanism, where chitosan will bind to cell membrane proteins, namely glutamate which is a component of cell membranes. Chitosan also binds to membrane phospholipids, especially phosphatidylcholine (PC), thereby increasing the permeability of the inner membrane (IM). Chitosan can be used as an edible coating, which is a thin layer that can be eaten and formed to coat food. This thin layer can be applied to the product by soaking or spraying. Chitosan has an amine functional group (NH_2) which is positively charged so that it can bind to the bacterial cell wall which is negatively charged and can inhibit spoilage bacteria containing pathogens (Hafdani, 2011).

Therefore, from the existing potential, a literature review is needed regarding edible coatings derived from chitosan. The results of this literature review are expected to present further experimental research so that it has a good impact on reducing the use of non-biodegradable plastics and increasing the use of natural environmentally friendly plastics that have potential and contain antimicrobial ingredients.

Method

The article review method used is the literature review method. This method examines, summarizes, and interprets all problem findings on a research topic and answers research questions that have been previously determined. The literature review is carried out through electronic-based journals, namely database ProQuest, scholar, science direct, and Ebsco. The article used is following the keywords, namely the potential of edible coating from chitosan, with a limitation of 2011-2021. The type of research is from descriptive to RCT. The number of articles found was 997 and 28 articles were taken according to the topic.

Results and Discussion

Edible coatings can be packaging for many products ranging from agricultural products to processed fishery products, based on the results of previous research products that can be packaged with edible coatings made from chitosan, such as tuna fish balls (Wulandari et al. 2015), pempek (Nur Moulia et al. 2019; Pitayati et al. 2021), green grapes (Hilma et al. 2018), tofu (Rohim et al. 2015), Meat (Hanafiah et al. 2018), Mango fruit (Romadhan and Pujilestari 2018), dodol (Pola et al. 2020), and many more. These products can be seen in Table 1.

Table 1. Some products have been packaged with edible coatings based on the results of previous studies.

No.	Processed Fishery Products	Agricultural Products	Livestock Products
1.	Tuna fish balls (Wulandari et al. 2015)	Sticky Dodol (Yahya et al., 2015)	Beef (Hanafiah et al. 2018)
2.	Pempek (Nur Moulia et al. 2019; Pitayati et al. 2021)	Green Grapes (Hilma et al. 2018)	Chicken meat (Amalia et al. 2020)
3.	Vannamei Peeled Shrimp (Hastarini et al., 2014)	Tofu (Rohim et al. 2015)	Broiler Chicken Carcass (Alhuur et al. 2020)
4.	Red Snapper Fillet (Tambunana & Chamidaha 2021)	Mango fruit (Romadhan and Pujilestari 2018)	*Nugget* (Harianingsih et al. 2019)
5.	Catfish Meat (Triwibowo & Sumarni, 2017)	Dodol (Pattern et al. 2020)	Beef Meatballs (Sri Hadi et al. 2014)
6.	Kite Fish (Rizqiyah et al., 2017)	Wet Crackers Typical of Kapuas Hulu (Misni et al., 2017)	

Source of Chitosan for Edible Coating

Edible from chitosan can be obtained from fishery waste such as shrimp and crab shells. In previous research, namely Hanafiah et al. (2018) used edible coatings made from commercial chitosan derived from shrimp shells (Kitosan Pharmaceutical Medical Grade, CV. ChiMultiguna) on beef. In his research, it was concluded that liquid smoke edible coating from palm shells modified with chitosan could be an alternative to beef preservatives. The higher the concentration of chitosan in the liquid smoke, the longer the durability of the meat. Beef preserved with edible coating with 1% chitosan concentration can last up to 6 days. In this condition, the meat is still suitable for consumption because the aroma, taste, and texture are still good. Meanwhile, on day 8 the condition of the meat was not good for consumption. Chitosan from vaname shrimp shell has been applied in the research of Wulandari et al. (2015) using fishery products, namely tuna fish balls. From his research, it was concluded that chitosan coating could increase the inhibitory ability of bacteria growth in tuna fish balls so that it could last up to 2 days. In addition, chitosan-coated tuna fish balls can reduce the rate of bacterial growth compared to chitosan-coated tuna fish balls.

The edible coating is made from chitosan, which is sourced from crabs. Based on the research of Pola et al. (2020) using chitosan sourced from crabs CV. Chimultiguna against Dodol Betawi showed positive results, namely the coating of Dodol Betawi with an edible coating made from chitosan from crabs gave a good influence on the appearance, texture, and aroma that could be maintained without affecting the taste. The use of 4% chitosan is better as a recommended use for edible coating mixtures because it can maintain the appearance and texture values until the 12th day and the aroma until the 16th day.

The manufacture of chitosan is not only sourced from shrimp or crab but can also come from snail shells. As in the research of Harianingsih et al. (2019) the use of chitosan from the shell of mulberry snail (Pomacea canaliculate L.) or golden snail as an ingredient for edible coating on Nugget products. According to him, mulberry snails or better known as golden snails can be used as raw materials for the manufacture of chitosan. Chitosan from mulberry snail shells can inhibit microbial growth, inhibit water evaporation, and the degree of deacetylation which reaches 79.54% can be used as an edible coating on beef nuggets. The storage time for beef nuggets, which usually only lasts 24 hours at room temperature, can be extended for up to 4 days. The concentration of added chitosan also affects the storage time of beef nuggets. The higher the concentration of chitosan, the longer the storage time.

From the source of the chitosan material that has been used in previous studies, it is necessary to compare each of the characteristics of the chitosan content, so that its use is optimal. Some of the chitosan content includes parameters such as water content, ash content, degree of deacetylation, protein, nitrogen, color, particle size and shape, and viscosity making it very potential as an edible coating. In table 2. There are characteristics contained in each chitosan, both from crabs, shrimps, to commercial products.

Table 2. Characteristics of chitosan-based on previous research

Parameter	Characteristics of chitosan (Protan Laboratories 1987)	Chitosan Characteristics (Wulandari et al. 2015)	Commercial	Characteristics of chitosan (Yahya et al., 2015)	Chitosan from mubai snail shells (Harianingsih et al., 2019)
Water content	<10 %	6.0%	10%	8.5%	9%
Ash content	< 1%	1.1%	2%	1%	0.54%
Degree of deacetylation	< 70%	< 1.05%	70%	73.54%.	79.54%
Protein	-	-	-	-	19%
Nitrogen	7 – 8%	4.20%		-	1.42%
Viscosity					
- Low	200	-	< 200 cps	-	-
- Currently	200 – 799	400	200-799 cps	-	-
- Tall	800 – 2000	-	800-2000 cps	1000 cps	-
- The tallest	> 2000	-	>2000 cps	-	-
Color	White to pale yellow	Pale yellow	Clear	Clear	Brownish yellow
Particle size and shape	-	-	Flakes to powder	-	Powder (5 mesh)

In addition to chitosan from shrimp, crabs, and golden snails, there is an alternative source of chitosan that has not been widely utilized, namely from the pupa shell of the Black Soldier Fly (BSF). In the cultivation of BSF (Black Soldier Fly, BSF) it produces waste in the form of BSF sleeves (exuviae) which have not been widely utilized, about 2/5 of the total production, or about 400 kg/day. Exuviae are produced when the pupae molt to the next instar stage (Wahyuni et al. 2020). Based on the results of Ranti's research (2020) showed that chitosan can be produced from waste BSF sleeves with a chitosan yield of 4.8% and a degree of deacetylation of 91.88%. The resulting chitosan can be applied as an edible coating on red grapes using either the dip method or the spray method. The dip method and the spray method on the chitosan edible coating treatment were able to inhibit the shrinkage of fruit weight and were able to maintain the physical appearance of the fruit compared to the control. The best variation of chitosan concentration as an edible coating was obtained at a concentration of 2.5% and the best immersion time was obtained at 10 minutes of immersion.

Addition of Ingredients to Chitosan Edible Coating Packaging

Chitosan is widely used as a bacterial inhibitor that can protect food from damage, but chitosan still has several weaknesses. The weakness of chitosan is that it has not produced antioxidants optimally. Even in various applications, chitosan tends to be fragile and break easily. This can be overcome by adding materials and modifying chitosan. The right modification will get optimal results in protecting the packaged product.

In previous research, namely Apriliyani et al. (2020) added casein material due to the nature of casein which is difficult to break down by high heat and the addition is to add active components. He continued to Apriliyani et al. (2020) concluded that the ability of casein and chitosan materials in edible coatings using chicken has an effect on product stability for 1-10 days seen from their effect on peroxide number, iodine number, antioxidant activity, number of bacteria, S. aureus, E. coli, and Salmonella sp. The research of Hastarini et al. (2014) used vannamei peeled shrimp products packaged with an edible coating made from chitosan and then added lindur extract (*Bruguiera gymnorrhiza*). According to him, Lindur (*Bruguiera gymnorrhiza*) is an alternative as an edible coating material that can be added to the product because it has a preservative effect and has antibacterial properties. Based on his research, the color change in peeled shrimp during storage could be inhibited by a mixture of chitosan and lindur extract compared to no treatment. Lindur extract can be used as raw material for edible coatings and has the potential as a material that can maintain the chemical, microbiological, and color quality of peeled shrimp so that lindur fruit extract can be used as an alternative antibacterial and natural preservative in peeled vannamei shrimp.

The addition of materials to edible coatings made from chitosan has also been carried out using starch as in the research of Misni et al. (2017) used starch derived from taro (*Colacasia esculenta* (L.) Schoot). Mixing chitosan with starch is because starch-based edibles have weaknesses, namely low water resistance and low water vapor barrier properties due to the hydrophilic nature of starch. Therefore, it is necessary to have hydrophobic biopolymer materials such as chitosan so that their properties are complementary.
In fishery products such as tuna fish balls based on the research of Sri Hadi et al. (2014), his research used the addition of garlic extract to edible coatings made from chitosan which aims to increase the effectiveness of chitosan in inhibiting microbial growth and the compound content of garlic does not affect the physical properties of edible coatings because there is no interaction between garlic

compounds and chitosan functional group. Then in the study of Tambunan and Chamidaha (2021) using red snapper fillets added additional ingredients such as cinnamon essential oil with the results of their research concluded that the addition of cinnamon essential oil to the chitosan edible coating has an effect on the quality of red snapper fillets during the storage period seen from the TPC parameters, TVB and pH.

Effect of Edible Coating of chitosan on product shelf life

The use of edible coatings has a goal, one of which is to reduce the obstacles faced by foodstuffs that have a relatively short product life. Several products that have been given additional edible coating using chitosan material, namely sticky rice dodol, in the research of Yahya et al. (2015) revealed that the use of edible coating using 2% chitosan was able to maintain the aroma and taste for up to 10 days of storage. According to him, Chitosan can maintain the color quality of dodol so that dodol coated with an edible coating at the end of storage (15 days) gives a distinctive brown color to dodol. Other dodol products such as Betawi dodol coated with an edible coating made from chitosan showed positive results. According to Pattern ST Panjaitan et al. (2020), The use of edible coatings as coatings for semi-wet food and fruits by mixing 4% chitosan (K3) can maintain the appearance and texture values until the 12th day and the aroma until the 16th day. Thus, coating Dodol Betawi with an edible coating provides a Good influence on appearance, texture, and aroma can be maintained without affecting the taste. The use of 4% chitosan is better as a recommended use for a mixture of edible coatings. Other food products from agriculture are fruits. As in the research of Romadhan and Pujilestari (2018) using mangoes coated with an edible coating of chitosan material with the addition of incorporated ZnO nanoparticles, according to him, ZnO nanoparticles are one of the materials that can be used to improve the mechanical and functional properties of chitosan-based edible coatings. NP-ZnO is known to actively inhibit the growth of B. cereus, E. coli, and Penicillium sp. The application of chitosan-based edible coating incorporating ZnO nanoparticles on mango fruit showed a delay in increasing weight loss and preventing damage. The extension of the shelf life of mangoes treated with chitosan + NP-ZnO edible coating was 2-3 days longer than without treatment (Romadhan & Pujilestari 2018).

In processed fishery products that have a fairly high water content, edible coating packaging from chitosan has been applied in previous studies and has resulted in a shelf life that has a positive impact. based on the research of Wulandari et al. (2015) To get meatballs that have a longer shelf life and quality that can be maintained and safe for consumption, it is recommended to use harmless types of packaging, one of which is the use of chitosan as an edible coating. In his research, it was revealed that tuna fish balls using an edible coating of chitosan can last up to 2 days. In addition, chitosan-coated tuna fish balls can reduce the rate of bacterial growth compared to tuna fish balls without chitosan coating. Then the research of Triwibowo and Sumarni (2017) concluded that catfish meat coated with a 1% solution of chitosan and acetic acid was able to survive up to day 4 at cold temperature storage and still meet the limits set by BSN, where the limits of microbial contamination determined by BSN of 5x105 CFU/g. The greater the concentration and the longer immersion time of chitosan, the greater the inhibition of microbes (Triwibowo and Sumarni 2017). In addition to the freshwater fish use of an edible coating of chitosan have also been carried out on seawater fish such as snapper fillet with additives, cinnamon essential oil, its influence on fillets are coated with an edible coating of chitosan with the addition of cinnamon essential oil that is still suitable for consumption up to storage day 9 with a TPC Log value of 5.7; TVB 30.33 mgN/100g and pH 6.53 (Tambunan & Chamidaha, 2021).

Edible coating with materials from chitosan has also been applied to livestock products such as beef meatballs in the research of Sri Hadi et al. (2014) by providing additional ingredients in the form of garlic extract. Based on research (Sri Hadi et al., 2014) The antimicrobial activity of 1% chitosan solution was able to inhibit the growth of Pseudomonas aureuginosa and Bacillus cereus . The addition of 2% garlic extract with 1% chitosan was able to increase the inhibition of the growth of the tested microbes compared to using only one type of antibacterial (1% chitosan solution). The application of 1% chitosan solution and the addition of garlic extract to the meatball dough increased the shelf life for 12 hours, while the application as an edible coating was able to increase the shelf life for 24 hours compared to the control at room temperature storage. Observations using Scanning Electron Microscopy showed that there was a difference in microstructure between the product and the coating where the chitosan-coated product had a compact and smooth surface and could inhibit microbial growth on the surface of the food product. The results of this study prove that the application of chitosan as an edible coating is more effective than its application as a preservative (mixed in the dough).

Table 3. Effect of edible coating on product shelf life

No.	Food products	Edible Coating Material	Long storage with chitosan	Long shelf life without treatment
1.	Sticky Dodol (Yahya et al. 2015)	Chitosan	10 days (maintain aroma and taste) and 15 days (maintain color and texture parameters)	4-5 days
2.	Tuna Fish Meatballs (Wulandari et al. 2015)	Chitosan	2 days	1 day

3.	Catfish Meat (Triwibowo and Sumarni 2017)	Chitosan and 1% acetic acid	4 days	1-2 days
4.	Red snapper fillet (Tambunan & Chamidaha, 2021)	Chitosan and cinnamon essential oil	9 days	0-1 days
5.	Beef meatballs (Sri Hadi et al., 2014)	Chitosan and garlic	24 hours	
6.	Mango fruit (Romadhan & Pujilestari 2018)	edible coating chitosan+NP-ZnO	2 – 3 days	
7.	Dodol Betawi (Pattern ST Panjaitan et al., 2020)	Chitosan 4%	maintain the value of appearance and texture until the 12th day and aroma until the 16th day	
8.	Wet crackers (Misni et al., 2017)	Chitosan	2 days	
9.	Green grapes (Hilma et al., 2018)	Chitosan 2%	7 days	
10.	Nugget (Harianingsih et al., 2019)	Chitosan from mulberry snail shell	4 days	24 hours
11.	Beef (Hanafiah et al., 2018)	Chitosan 1%	6 days	
12.	Chicken meat (Apriliyani et al., 2020)	casein and chitosan	1-10 days	

Conclusion

Based on the results of research that has been carried out, it can be concluded that Edible coating is capable of packaging many products ranging from agricultural, livestock, and processed fishery products, such as tuna fish balls, pempek, kurisi fish sausage, green grapes, tofu, beef, chicken meat. , Mango fruit, sticky rice dodol, Betawi dodol, wet crackers, beef meatballs, nuggets, red snapper fillet, catfish meat. Sources of chitosan are widely available in nature such as shrimp and crab waste, gold snails, and other alternatives that are still underutilized, namely the Black Soldier Fly (BSF) pupa shell. Edible coatings made from chitosan can be modified by adding additional ingredients to make it more optimal in protecting the packaging inside, such as garlic, casein, ZnO nanoparticles, acetic acid, and starch from fruits or tubers. The edible coating of chitosan affects the shelf life of the product.

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