Crustacean and Shellfish Waste: Source, Processing and Utilization (A Review)

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ABSTRACT

Indonesia is one of the exporting countries for processed fishery products, including processed products from the crustacean and shellfish groups. Demand for this commodity can be in the form of fresh, frozen, or canned products. But half of the body cannot be consumed, so the waste from processing is relatively high. The purpose of this study was to analyze the utilization of crustacean, crab and shellfish processing waste so that it has added value. Waste causes odors and pollutes the environment, but this waste can also be seen as a potential or environmental asset that can be used as a selling point. Crustacean and shellfish waste is usually not utilized and immediately disposed of by fishermen resulting in accumulation on the beach which eventually causes a foul smell mixed with fishy. Can be used as an abrasive product in toothpaste, as a source of flavor, as an environmentally friendly bioplastic material, as an adsorbent, as a filter for silver waste contained in radiographic film fixer waste, and can be used as a health drink with chitosan ingredients. .

Keyword: - *Waste, crustacean, shellfish, waste management, waste utilization*

1. INTRODUCTION

Crustaceans are a food source of animal protein which has high nutritional value. Crustaceans are shrimp, crab and blue swimming crab are products of Indonesian waters, some of which are marketed and consumed domestically, while others are exported in the form of frozen raw materials. In general, frozen shrimp in the form without the head and skin. The waste that comes from freezing shrimp varies. Solid waste originating from shrimp processing ranges from 60-70% or 65-85%. Thus the amount of wasted parts originating from the shrimp freezing business is quite high. The waste is in the form of shells, shrimp heads and tails, and shells. In developed countries such as America and Japan, shrimp waste is used in industry as a raw material for making chitin and chitosan. Chitin and chitosan are widely used in modern industry. Chitin compounds and chitosan derivatives have been produced for commercial purposes. In general, the people who consume shrimp are obtained or purchased on the market in the form of meat only, while the scalp and tail have been separated, so traders in the market only accumulate the waste produced. This can interfere with the comfort, smell and aesthetics of the environment around the market.

Chitin and chitosan with all their derivatives can be used in the health sector and wastewater treatment. Shrimp waste is still a problem that needs to be sought for its utilization. This will provide added value to the shrimp processing business, and can also overcome the environmental pollution problems it causes. Chitosan from shrimp shells has been widely applied to the maintenance of seafood products such as oysters, salmon because it is non-toxic, antimicrobial and has antifungal activity and biodegradability. Due to its film forming properties and antimicrobial character, chitosan is a potential material for packaging coatings.

Crustaceans are a large group of arthropods or members of the segmented body class of animals that have an external skeleton to support and protect the animal's body. Examples are crabs, lobsters, crabs and shrimp. Crustacean exoskeletons are generally rich in pigment, which is a good potential source for the improvement of farmed red and yellow skin pigment. Products from shrimp and crab may contain carotenoids 34-147 mg/Kg. Based

on the many benefits of shrimp shells, it is necessary to do research on the manufacture of chitin and chitosan contained in shrimp shells, especially the use of chitosan and to obtain pure chitosan. In general, chitosan can be found from the shells of shrimp, oysters, cuttlefish, fish, squid, crabs and others. This polysaccharide is a renewable source which can be explored intensively for its applications in pharmaceutical, cosmetic, biomedical, biotechnology, agriculture, food and non-food industries as water treatment, paper and textiles.

Waste from crustaceans is the largest source of chitin or its deacetylated chitin derivative, namely chitosan, where the process of isolating this compound includes deproteination, demineralization, and bleaching. Chitosan has been extensively studied for its various industrial applications and recently also for its antioxidant, antimicrobial, and film forming properties. Chitin is a waste material from the head and exoskeleton is also rich in compounds that have high nutritional value, namely having primary protein, which is more than 40% of the total waste weight, either as fat soluble, carotenoid pigments, such as for colored crustaceans orange-pink. Aside from shrimp shells, insects, mushrooms, crabs. The purpose of this study was to analyze the utilization of crustacean, crab and shellfish processing waste so that it has added value.

2. WASTE SOURCES OF CRUSTACEANS AND SHELLFISH

Indonesia has a large sea area of around 3,446,488 km2 with potential natural wealth including biological creatures as fishery products [1]. Fishery products such as shrimp, clams, crabs and shellfish leave waste in their processing [2]. According to [1], crustacean solid waste (skin, head, feet and tail) is one of the problems faced by shellfish processing factories, as well as the packaging industry. These materials have not been utilized optimally which will pollute the environment [3].

Indonesian waters are also a source of crustacean shells which contain abundant chitin. The chitin contained in crustaceans is in quite high levels, ranging from 20-60% depending on the species. At present, around 56,200 tons of chitin-containing waste is produced in Indonesia per year [4].

The development of fisheries that is being promoted at this time not only produces products that can be used to meet food needs, but also produces waste in the form of solid, liquid and gaseous waste. Until now these wastes generally have not been properly managed and utilized. This condition, if it continues continuously, will disrupt the sustainability of fishery development in the future [5].

Indonesia is one of the exporting countries for processed fishery products. One of them is processed from blue swimming crab (*Portunus pelagicus*). In general, crabs are exported in the form of pasteurized meat [4]. According to the Indonesian Crab Management Association, Indonesia's total crab production reaches 30,000 tons/year, and most of this product is for export needs in the form of canned packaging which leaves crab shell waste [6].

Demand for this commodity can be in the form of fresh, frozen, or canned products. However, half of the body parts cannot be consumed, so the waste from crab processing is relatively high. Considering that the economic value of small crab waste is almost non-existent, the processing of small crab waste into food products is an alternative way to increase the economic value of small crab waste [7].

Small crab waste is generally produced from crab meat processing industries or from coastal fishing activities such as Fishermen Farmers in Banjar Sari Village, Sumberasih District, Probolinggo Regency [6], crab shell waste (*Portunus* sp.) obtained from PT. Medan Tropical Canning and Frozen Industries [7]. Crab shells are also the main waste generated from the pasteurization or crab canning industry [8].

Apart from crustacean shell waste and crab waste, there is also shell waste which is usually produced from coastal fishing activities, shell shells which have become trash around the beach, or can also be produced from restaurants selling seafood menus.

3. WASTE HANDLING OF CRUSTACEAN AND SHELLFISH

Shrimp cultivation is growing rapidly because shrimp is a reliable export commodity and has high economic value. Shrimp is generally used as a food ingredient that has high nutritional value. In general, shrimp in Indonesia are exported in raw materials whose heads, tails and skin have been peeled. This shrimp waste then becomes waste

whose utilization is not optimal, causing environmental pollution, especially odors and bad environmental aesthetics [9].

These wastes are usually handled by directly disposing of them to the waste disposal area in the form of rivers or trash cans in the environment around the industry. In addition to being immediately disposed of, shrimp shell waste is used by drying it as feed or fertilizer with low value. Leftover processed shrimp in the form of shrimp heads and tails are also commonly sold by home industries to traditional markets at low prices [10].

Blue swimming crab is a fishery commodity that has high economic value. Apart from meeting domestic nutritional needs, it is also an export commodity in the form of frozen crab or canned meat. In the process of taking the meat, quite a lot of waste in the form of skin (shell) is produced, around 40-60 percent of the total weight of the crab. This waste has not been utilized properly and perfectly and most of it is waste that also pollutes the environment [11].

Much crab waste is disposed of directly into the disposal area around the industry in the form of rivers or nearby landfills. Apart from being disposed of immediately, crab waste is also commonly reprocessed, for example in the subah miniplan of the household industry assisted by the crab meat canning industry in Cirebon. The waste is also dried and immediately packaged and sold at the local market. The waste sold is in the form of shells and large pincers which are sold for IDR 1,800 and IDR 1,500 per kilogram respectively [11].

Mussels as one of the fishermen's commodities, for example in Nambangan-Cumpat Village, Surabaya, are very abundant. The majority of fishermen only use clam meat to be traded, while most of it becomes shell waste that piles up on the coast of the village. Shellfish waste causes odor and is not clean, but this waste can also be seen as a community environmental potential/asset that can be a selling point. Waste in the form of clam shells is usually not utilized and immediately thrown away by fishermen resulting in accumulation on the beach which eventually creates a foul smell mixed with fishy. Shellfish waste is also often directly used as a substitute for cement in concrete blocks and can also be made into shell flour [12].

4. ALTERNATIVE WASTE HANDLING

Preservatives are needed in food processing, but we must still consider their safety. Until now, the use of inappropriate preservatives is still common and has become more widespread, regardless of the impact on consumer health. Preservatives may not be used to deceive consumers by changing the appearance of food from what it should be. For example, preservatives containing sulfites are prohibited from being used on meat because these substances can cause a red color in the meat so that it cannot be known with certainty whether the meat is fresh meat or is no longer fresh.

Crustacean and shellfish waste can have high economic value if it is used to make chitosan compounds. Chitosan from shrimp waste can be used as a natural preservative. Chitosan is a derivative product of chitin polymer, which is a by-product (waste) from the processing of the fishery industry, especially shrimp and crab. Manufacture of chitin from shrimp waste as a natural preservative in food. The manufacture of chitin consists of 2 main stages, namely deproteination and demineralization.

5. PRODUCTS FROM WASTE PROCESSING OF CRUSTACEA AND SHELLFISH

5.1 Utilization of clam shell waste as an abrasive in toothpaste [13]

Toothpaste contains Calcium carbonate (CaCO3) which functions as an abrasive which is generally in powder form which can remove stains and plaque, also helps to increase the thickness of the toothpaste. Using large amounts of calcium carbonate (CaCO3) over a period of time can cause side effects. The side effect that arises is enamel fluorosis, namely tooth enamel with spots. Tooth enamel becomes brittle with an irreversible blackish brown color because it has hit the hard tooth tissue. Therefore, natural ingredients are used to minimize side effects, namely using clam shells. According to [14], shell waste contains high calcium carbonate, which is 98%, which has the potential to be utilized.

5.2 Utilization of Shrimp Shell Waste as Flavor

This flavored is used as a flavoring for high protein dishes made from natural ingredients which are expected to replace Mono Sodium Glutamate, which is a synthetic flavor.

5.3 Products based on chitin and chitosan

The process of making chitosan from crab shell waste goes through 4 stages, namely deproteination, demineralization, decolorization and deacetylation.

1) Deproteination

Deproteination is the stage of protein removal. With this treatment, the protein which is one of the constituents of the crab shell which is covalently bound to chitin will be released and form soluble sodium proteinate. For different material sources, the deproteination process can be carried out differently. The deproteination of the crab shell itself can be done through various treatments

In principle, deproteination is carried out by providing alkaline conditions followed by heating for a certain period of time. As a base, many choose NaOH, because, apart from being more effective, this material is also relatively cheap and easy to obtain. The provision of base is intended to denature the protein into its primary form which will precipitate. Then filtered to separate the precipitate from the supernatant. The filtrate is then further processed.

2) Demineralization

The main mineral contained in the shell is calcium carbonate which is physically bound to chitin. The crab shell contains minerals weighing up to 40-60% dry weight. Thus, in the process of refining chitin, demineralization is important. Demineralization can be carried out easily by treating it with dilute hydrochloric acid at room temperature, while demineralization of crab shells is generally carried out with hydrochloric acid at a concentration certain.

3) Decolorization

Decolorization is the stage of removing fat and dyes which have actually begun to disappear in washing after the deproteination and demineralization processes. This process was carried out by adding acetone and soxhleting for 7 hours with a sample weight ratio of 1:10 (w/v). Acetone can remove the orange color from chitin. Bleaching can also be carried out using a bleaching agent in the form of sodium hypochlorite or peroxide.

4) Deasetilization

Chitin deacetylation is a process of removing acetyl groups from chitin to form chitosan. The treatment given is administration of high concentration sodium hydroxide solution at high temperature, which can produce a product that is almost entirely deacetylated. Chitosan is commercially produced chemically by dissolving chitin in 40-45% sodium hydroxide solution.

a) Manufacture of health drinks with chitosan ingredients

The form of functional food is like ordinary food or drink but actually has functional properties that are important for health. Thus consumers do not feel sick due to consumption of neutraceuticals such as drugs, but like normal people who consume ordinary food/drinks. One of the instant functional drink formulations made from chitosan and tea offered has been made in one package containing 3 grams of chitosan [11].

b) Bioplastics

Bioplastics are plastics that can be naturally decomposed by microorganisms into environmentally friendly compounds. One of the natural materials that has been widely used as a constituent of bioplastics is chitosan [15].

5.4 Functions and Applications of Crustacean Waste Treatment

a. Utilization of shrimp shells as an edible coating material

Chitosan not only provides added value to the shrimp processing business, but can also overcome the problems of environmental pollution caused, especially the odor issues that are emitted and the unfavorable environmental aesthetics. Research to utilize shrimp shell waste into chitosan as an "Edible Coating" has been carried out through the following processes: drying, crushing, demineralization, neutralization, deproteination, neutralization, deacetylation, neutralization and drying. The yield of chitosan produced was 15% with a water content of 5.56%;

ash content 0.86%; degree of deacetylation 90%. Chitosan was applied to pindang fish using concentrations: 0% and 0.25% [16].

b. Utilization of chitosan as an effective adsorbent in reducing pH, turbidity, and cyanide levels in wastewater
The use of chitosan is effective at a solution concentration of 1,000 ppm through the coagulation–flocculation process using the jartest method. Chitosan treatment modified swelling crosslink GA with slow stirring contact time can reduce cyanide content in wastewater by 90.38%.

c. Chitosan membrane application as a means of filtering silver waste contained in radiographic film fixer waste.
The membrane is used as a filter to filter out the silver waste by filtration techniques. Chitosan membrane that has been made and characterized as a filter tool for silver waste, in the form of salt compounds, which are pollutant substances that are very dangerous, especially for human health problems, which are found in radiographic film fixer waste.

d. Utilization as Livestock Feed
According to [17], found that the manufacture of flour and protein concentrate from frozen shrimp industrial waste by means of protein hydrolyzate, can increase the protein content of approximately 30%. This concentrated protein flour can be used for animal feed mixtures as a source of nitrogen for growth.

5.5 Application of Chitosan

The application of chitosan in human life has been widely used in various fields. Chitosan is a biopolymer that is widely used in various chemical industries, including as a coagulant in wastewater treatment, a moisturizer, a coating for seeds to be planted, an adsorbent for metal ions, the pharmaceutical field, a fat solvent and a food preservative [18]. Unlike polysaccharides, the presence of positively charged amino groups along the piler bonds causes the molecule to bind to negative surface charges through ionic or hydrogen bonds, so chitosan has the linear chemical properties of plyamine (poly D-glucosamine), reactive amino groups, and reactive hydroxy groups. One of the areas of utilization of chitosan is in the medical aspect. In the medical aspect, chitosan which is a biopolymer has biocompatible properties with the body, so that this chitosan can be applied by synthesizing chitosan and bioceramics which are capable of creating good abilities as bone regeneration. The ceramic material that is often used in the field of bone tissue reconstruction is synthetic hydroxyapatite.
Hydroxyapatite is a material that has similarities with natural bone material [19]. The combination of chitosan and hydroxyapatite can be reacted to produce scaffold [20]. Ideally the mixture should have high porosity, large spaces (porous), to provide sufficient space for the development of new tissue and vascularization. This fusion is in the form of a porous pellet thus providing a network for cell migration which allows tissue growth [21]. In addition to the use of chitosan in the medical field, chitosan can now be applied in the environmental field. With these new applications, chitosan has brought significant benefits. One of the uses of chitosan in the environmental field is as an adsorbent or adsorbent for heavy metal atoms, such as lead (Pb), chromium (Cr) and mercury (Hg) which are found in polluted water [22].

Chitosan is also known as a scavenger of toxic metals. Chitosan powder or solution can remove or reduce metals or metal ions contained in river water, sea water and waste water. Chitosan is a natural biopolymer which is a cationic polyelectrolyte with high potential for absorbing metals, easily biodegradable and non-toxic. According to [22], conducted a study on the application of chitosan as an adsorbent to reduce Cu metal levels by synthesizing chitosan from shrimp shells with deproteination steps using 3.5% NaOH, demineralization stages using 1.5 M HCl and deacetylation stages with 60% NaOH. Furthermore, the resulting chitosan was characterized and determined its adsorption capacity to Cu metal, a mass of 0.1 gram of chitosan was able to reduce Cu metal content to a concentration of 100 ppm with a percentage of 90.37%.

6. CONCLUSIONS

Based on the discussion of waste originating from crustaceans and shellfish, it can be reduced by reprocessing it into a product that is more useful and also has more economic value. The product including toothpaste contains Calcium carbonate ($CaCO_3$) which functions as an abrasive which is generally in powder form which can polish and remove stains and plaque, also helps to increase the thickness of the toothpaste. Flavor sources used as a flavoring for high protein dishes from natural ingredients which are expected to replace Mono Sodium Glutamate, namely synthetic flavors. Manufacture of health drinks with chitosan ingredients, form of functional food is like ordinary food or

drink but actually has functional properties that are important for health. Bioplastics are plastics that can be naturally decomposed by microorganisms into environmentally friendly compounds.

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