Literature Study on Small Crab Shell (*Portunus pelagicus*) Waste Management in Mertasinga Village to Produce Valuable Economic Product

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Abstract. Majority of Mertasinga citizens work as fishermen who most often catch crabs. Then the crabs are marketed in the traditional market and the meat is collected to be sent to factories. The factories then make variety of processes food from the crab meat. However, the process of collecting meat leaves a heap of crab shells that becomes fishy-smelling waste and pollutes environment because biological oxygen demand (BOD) and chemical oxygen demand (COD) increase. To solve the environmental problem caused by the crab waste, a waste management is needed. The objective of this study is to examine the literature study of various research results concerning the processing of small crab shell waste into something that has economic value. The result of the study found out that the crab shell waste contains (a) protein (b) crude fiber, (c) calcium, and (d) phosphorus. As the waste is rich in content, several studies have processed the waste into: (a) breeding animal feed, (b) making crackers, (c) making natural food flavors, and (d) chitosan. Branding and copyright of the product are obtained to make the product more valuable. In addition, high quality product is maintained according to the quality assurance standard with affordable price so that it can increase the living standards of the citizens.

Keywords: Environmental pollution, Crab Shell Waste Management, Economic value of the product, Increasing the Living Standards of the Citizens

1 Introduction

Mertasinga village is a coastal area which has crabs as its major potency. The crab is a group of crabs from the family of Portunidae which is known as a blue swimmer crab and it is classified as a species of Scylla serrate [1]. As the crab potential is evident, the citizens of Mertasinga village take the advantage of it as a source of their income by being fishermen or laborers who skin the crab and take the meat to be sent to factories. From the skinning process in figure 1.1, it can be seen that the process leaves meat and a heap of crab shells in figure 1.2 and 1.3. The effect of the activity is environmental pollution which is indicated by the increasing amount of biological oxygen demand (BOD) and chemical oxygen demand (COD) that is higher than the standard allowed as happened in the Turag river Dhaka, Bangladesh [2]. BOD and COD is a measure of rainfall, temperature, and waste composition [3].

ICE 2019, September 28-30, Purwokerto, Indonesia

DOI 10.4108/eai.28-9-2019.2290995

Fig. 1.1 Crab skinning process

Fig. 1.2 Crab's meat

Fig. 1.3 Shell waste from skinning process

Determining the value of BOD is done by seeing at the difference in the value of dissolved oxygen (Dissolved Oxygen) in the sample before and after storage in an incubator at 20ºC for 5 days using a DO meter. Measurements were done by refluxing the sample for 2 hours in acidic media, with potassium dichromate as an oxidizing agent. Total Suspended Solids (TSS) are separated by filtering the sample water through a pre-weighted membrane filter with a pore size of 0,45 µm, then dried in an oven at 103-105ºC, then weigh again. The results of the filtering sample then analyzed by using colorimetric method, the solution is measured by spectrophotometer with Shimazhu 1601 model [4].

Tabel 1. Correlation coefficient and level of significant between water quality parameters for COD, BOD and DO [5]

Parameters	pH	TDS ppm	Turbidity	Conductivity	Salinity %	Temperature ºC	COD mg/L	BOD mg/L
COD mg/L	-0,76	-0,29	0,64	-0,29	-0,58	0,92**	1	
BOD mg/L	0,30	0,92**	-0,82*	0,92**	1,00***	-0,54	-0,61	1
DO mg/L	-0,11	0,87*	-0,44	0,88**	0,76	-0,07	-0,11	0,75

The data shows a significant correlation between water quality parameters, this strongly supports the formation of healthy ecosystems. Healthy ecosystems provide "the benefits of nature to households, communities, and economies" [6]. A healthy ecosystem is formed by healthy enviroment through a good waste treatment system. Therefore, it must be avoided that the accumulation of crab shell waste in the mertasinga village needs to be done with the right steps in the waste treatment system.

Waste treatment is carried out through processing waste something useful and economic value. This is supported by research data showing that the content of crab shell contains: (a) protein (32,95%), (b) crude fiber (10,89%), (c) calcium (22,93%) and (d) phosporus (0,78%) [7]. So the waste can be proceesed into several products that have high selling value. The aim of this study is to give a recomendation for (1) crab shell waste management based on the study literature of several research that have transformed the crab shells becoming flour to be: (a) animal feed, (b) natural food flavor and (c) chitosan. (2) Increasing the quality of the product so that it has high economic value to increase Mertasinga citizens' living standard.

2 Methods

The object of this study is Mertasinga village. The method of this study is study literature. Study literature is a type of study that analyzes, critically evaluates and synthesizes

existing knowledge and is relevant to the research problems [8]. In this research we examine study from various study that concerning in the processing of crab shell waste from flour into something that has economic value. The waste treatment process that will be assessed are: (a) making animal feed, (b) making natural food flavoring, and (c) chitosan.

2.1 Making Animals Feed

Small crab waste that has percentage of calcium by 22,93% [7], is needed in the process of egg formation. Eggs are one of the energy with the lowest nutrient density of any food, the quality of the protein possessed by eggs is higher when compared to beef steaks, which have almost the same content as milk [9]. Based on the calcium content is that waste, the researchers Purnamasari et all, state that small crab shell waste can be turned into laying ducks. The research method is divided into two stages, namely: (a) Phase 1 which is Stage of Duck Maintenance, (b) Stage 2 which is Phase of Observation of Egg Quality and External Egg Quality. In Phase I, The duck rearing stage is carried out using 60 local ducks aged ± 10 months allocated randomly according to a complete random design into 3 feed treatments namely P1, P2 and P3 by providing treatments consisting of 5 repetitions, each repetition consisting of 4 ducks. Phase II is Observation of Egg Quality that is carried out through observing the external and internal egg quality and egg weight [7].

2.2 Making Natural Food Flavors

Making natural food flavorings is done through the process of making small crab flour and adding flavor dextrin with a percentage of 0%, 1%, 2% and 3%. The study was divided into stages 2 namely preliminary research, and primary research. Preliminary research was in the form of making flour, and the main research was in the form of selection of flavoring powder and addition of dextrin. Meanwhile, the process of making small crab shell flour is done through the process of hydrolysis and non-hydrolysis. Dextrin is chosen based on its high solubility, water binding ability, and relatively low viscosity. The research was conducted by observations through hedonic scale organoleptic tests, and analysis of water content, and% calcium [10].

2.3 Producing Chitosan

Chitosan is formed by polymer naturally, chitin is the most abundant polysaccharide and cellulose [11]. Chitin can be extracted and used commercially as a plastic film [12]. Chitin is an N-acetyl-D-glucosamine with a β-1,4 bond which is abundant in nature, especially in the crustacean shell [13]. The process of producing chitosan is done by drying the crab shell in the sun, then grinding and sifting until the crab shell powder is obtained in the preparation process. After obtaining the powder, chitosan will be made in three stages, namely: (a) Deproteination, the addition of small crab shell with NaOH 3,5%, (b) Demineralization, deproteination's result is added with 1 M HCl solution to get chitin, (c) Deacetylation, chitin which is obtained from demineralization is added with 50% NaOH solution to get chitosan [12]. The degree of deacetylation (DD) determines the molecular weight of chitosan, if the DD value is lower, then the molecular weight, chemical stability and mechanical strength produced are higher [14].

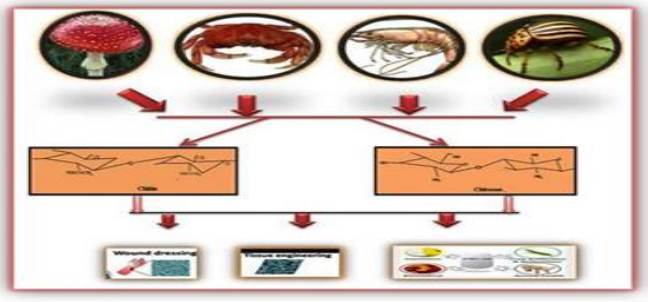

Fig. 2. Different sources of chitin in nature and applications [15]

3 Result and Discussion

3.1 Result and Discussion for the Study of Laying Duck Feed Production

The quality of laying duck feed showed in the test is indicated by (a) the egg weight, (b) the eggshell , (c) the interior quality of the egg, (d) the yolk index, (e) the egg white index, and (f) the Haugh Unit (HU).

3.1.1 The egg weight

The average weight of the egg from the lowest to the highest are P2 = 64.05 ±3.88; P = 66.28 ±3.02 and P1 = 66.61 ±3.06 respectively. The analysis of the statistics indicates that there is no significant difference between the treatments (P>0.05) that influence the egg weight, the protein in the feed is approximately 17.52 – 17.69 % to fulfill protein needs of the laying duck in a laying phase which is between 17–19%. Furthermore, the result of the study is supported by the result that the crab waste contains protein 15-50%, mineral 30-50% and chitin 15 – 30 % [16].

3.1.2 The eggshell

The average thickness of the eggshell increases significantly because the laying ducks were given the crab waste from the lowest point P1 (0.45 ± 0.02 mm), P2 (0.48 ± 0.01mm) and the highest is P3 (0.49 ± 0.01mm), thus, the quality of the eggshell is good [7].

3.1.3 The interior quality of the egg

The average scores of yolk color from the lowest to the highest is P1 (12.40 ± 0.65); P2 (12.60 ± 0.22) and P3 (13.30 ± 0.45) respectively. By adding the crab waste into the feed, the score of the yolk color increases as of 8% which is significant. The result shows that crab waste increases the yolk color because of its carotenoids. The yolk color is formed by protein through the process of yolk formation known as vitellogenesis. Vitellogenesis is a synthesis of lipoprotein in a liver that is controlled by estrogen. Vitellogenesis that is formed then is collected by blood in follicles to become egg yolk [17].

3.1.4 The yolk index

The scores of yolk from the lowest to the highest are P3 (0.37 ± 0.02); P2 (0.37 ± 0.02), and P1 (0.43 ± 0.03) respectively which means the score decreases as the crab waste is given. The score is normal because according to Romanoff and Romanoff (1963) a normal score for the fresh yolk index is between 0.30 – 0.50 [7].

3.1.5 The egg white index

The scores of egg white from the lowest to the highest are P3 (0.15 ± 0.03), P1 (0.16 ± 0.02) and P2 (0.16 ± 0.02) respectively which is meaningless to the egg white index because the feed is composed of iso-protein. The index of the white egg in this study is normal because according to Romanoff and Romanoff (1963) the standard of the egg white index is between 0.05 – 0.17 which depends on its storage [7].

3.1.6 Haugh Unit (HU)

HU is measured based on the height of the egg white and the egg weight. It was measured by weighing, breaking and laying the egg onto a flat surface. Caliper was used to measure the thickness of the white egg by choosing the part between the edge of the yolk and the egg white [15]. The average score of Haugh Unit from the lowest to the highest is P2 (106.22 ± 4. 26), P3 (105.21 ± 5.04), and P1 (104.75 ± 4.81) respectively. Based on the HU score, the grade for the egg white in this study is AA quality because the mean score of HU is more than 72 [7].

3.2 Result and discussion for the Test of Natural Flavoring

The flavor is chosen based on the sensory test that measures the aroma, the taste, the color, and the moisture content.

3.2.1 The aroma

The aroma is a chemical compound that is easily vapored so that it is smelled by smell sensory in the nose when the food is inside of the mouth [19]. In the food industry, the aroma test is important because it determines the food processing quality [20]. From the statistics result, by adding dextrin of 1% concentration the average value is obtained 4,65 and the lowest score is in 2% dextrin concentration of 4,3 which shows an insignificant difference of the aroma. The result indicates that there is no change in the aroma after dextrin is added so that the panelists like the aroma in the food flavor [10].

3.2.2 The Taste

The taste is an important indicator of whether the food is acceptable by the panelists. The taste test can be done by a hedonist test, which is done by tasting the food using the tongue and receiving it by the papillae [18]. The test was done by adding 1% dextrin concentration as of 4,65 and 3% dextrin concentration as of 4,4 in the flavor of the crab waste. The data shows that there is an insignificant difference, thus the use of dextrin (1%, 2%, and 3%) has no influence on the taste of food flavoring [10].

3.2.3 The Color

The statistics result of color measurement is obtained by adding 0% and 1% dextrin concentration of 4,7 and 2% dextrin concentration of 4,25. The result shows that the treatment without using dextrin and with dextrin for the food color is different but insignificantly. Thus, the addition of dextrin does not influence the food color. The color is white brownish. The process of a non-enzymatic Maillard makes the brown color. The color of the food flavor without and with 1% dextrin is more likable because the color is attractive [10].

3.2.4 The Likability Test

From the statistics result, by adding insignificantly different dextrin on the aroma, the color and the taste (1%, 2%, 3%) and without dextrin (0%) does not influence the aroma, the taste and the color of the food flavor so that the respondents like them. [10].

3.2.5 The Moisture Content

The moisture content influences the physical properties or organoleptic, chemical substances, and shelf life of the food by microorganism attack [21]. From the statistics test of moisture content, it is obtained with 0% dextrin concentration of 4.05% and the

lowest level of dextrin, 2% of 3.48%. The high level of moisture content without dextrin is a result of adding seasoning and salt. Meanwhile, the low level of moisture content 1%, 2% and 3% of dextrin concentration was added because the water content is tied by the dextrin. The data shows a large amount of the moisture content in the food flavor which is not influenced by the dextrin concentration [10].

3.3 Chitosan Test Results and Discussion

Chitosan is produced from waste of crab shell through encapsulation method, they are three stages: demineralization, deproteinase and deacetylation. The demineralization process is carried out to remove mineral content, there are $CaCO_3$ and $Ca_3(PO_4)_2$. Giving HCl is done separate minerals that are marked by the formation of CO2 gas, HCl is given orderly in order to not evaporate [14]. Deproteinase aims to remove proteins that are covalently bound to chitin and which bind physically. At the deproteinase stage NaOH solution is used with a concentration of 50%. The use of NaOH solution with high concentrations and temperature is increasingly effective in removing proteins and leading to deacetylation process [22]. Chitosan is obtained from chitin through deacetylation process. In the process of deacetylase, acetyl group is removed ($-COCH_3$) from chitin using 50% NaOH at temperature 100^oC for 1 hour, then turn into an amine group ($-NH_2$). The result of chitosan synthesis is 66,64% with the degree deacetylation 76,69%. Chitosan with a degree of deacetylase between 60-100% meet the standard of making chitosan used, the higher the degree of deacetylation indicates the more pure chitosan [23]. In the pharmaceutical, food and health industries.Chitosan has several beneficial properties that are antimicrobial as wound healing, non toxic, cheap,biocompatible, biodegradable and water-soluble [24].

3.4 Product Marketing Process To Improve Community Economy

All the products from the results of the research i.e. by taking the raw material of the crab shell waste flour will not have a good effect if it only reaches the manufacturing process. However, to improve the standard of living of the community, it is necessary to do the marketing process so that the products are economically valuable. One way to create advantages from the market competition is to apply a differentiation strategy, brand image, product quality and the right price so that it can influence customer purchasing decisions. The initial process that can be done is to register a copyright, to keep the product name from being imitated by others, then to register the product to the health department, National Agency of Drug and Food Control, and Indonesian Ulema Council. Next, several processes need to be carried out in following Ong and Sugiharto's research on the *Cincau Station Grand City* brand in the following steps:

a. Adding a tagline to improve consumers' recalling of the brand. The tagline that can be chosen is: "Mertasinga Small Crab Waste Processed Products". The existence of this tag line will make it easier for customers to remember the existence of Mertasinga Village.
b. Giving a banner which contains the benefits of the product to make sure the product is safe. If the product is in the form of food then there should be a stage of product promotion by bringing in a nutritionist or doctor to be trusted by consumers.
c. Selling the product at reasonable prices according to the product quality. For this reason, the products should include data from the National Agency of Drug and Food Control regarding the product content, to be more confident in front of customers about product quality.

d. Making comparison with other variety of products through several events such as events held by Mertasinga village, Sub-districts event such as "Cirebon Festival" so that the distinction can be explained in comparison with other products [25].

If the four processes are carried out, it is expected that the product has a high selling price which can be decided from the calculation of the total capital by accumulating expenses such as transportation, rental costs, electricity, gas stoves, purchasing materials, tools, and services in the manufacturing process and compare them with market price. The recommended price is decided after reducing the market price slightly. For example, for chitosan with the results of the FTIR standard degree of deacetylation of 70%, we can sell at a price of 50gram with only Rp. 100,000. However, if we look at the standard price from the internet, and we can sell for Rp. 80,000, - 90,000, to attract buyers.

4 Conclusion

Based on the results of several studies on the processing of crab shell waste into something of economic value, the following conclusions are:

1. Provision of small crab waste can increase the external quality of the egg, the thickness of the eggshell and the internal quality of the egg, which is the color of the yolk, so that it is appropriate to be used as a material for duck feed, thus the feed product can produce economic value.
2. Based on the level of panelists' acceptance of crab shell waste flavorings as natural food flavorers, the average panelist likes flavor products based on their aroma and taste, it means that the product is accepted by the public and suitable for marketing.
3. Synthesis of chitosan made from crab shell waste produces a value of 66,64% with a degree of deacetylation 76,69%. The results of the degree of deacetylase indicate that chitosan products are worth selling in the market.
4. Increasing and decreasing in consumer assessment of: (a) brand image, (b) quality of product, (c) price and (d) differentiation affect customer purchasing decisions.

Acknowledgments

The author would like to thank the Ristekdikti for the assistance of KKN-PPM Community Service Grants and our thanks to Mr. Badawi as the chairperson of LPPM Muhammadiyah University of Cirebon and Mr. Budi as Secretary of the LPPM Muhammadiyah University of Cirebon for their support of KKN-PPM Community service activities so that we can write this article well.

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