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Biogas Production from Crab Picking (*Portunus Pelagius*) Wastes

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Abstract: Crab picking waste is a product by process with low economic value. Waste in the form of solid wastes (shell, offal) and waste water (remnants water of crab stew). The amount of waste was generated by one of the fisheries industry Putra Mandiri Mini Plant which causes environmental pollution that has a negative impact on the community. Therefore, good and efficient waste management is needed to be effective and eco-friendly. The waste can be fermented to make gas for the picking product of the biological breakdown of organic waste under oxygen free conditions. This study aims to determine the raw material content of crab waste and the best formula in making biogas. The process of making biogas using different formulation, there are wastes; wastes + cow *rumen* and wastes + cow *rumen* + molasses. Then the samples were fermented in aerobic digester for 21 days to produces methane gas. Methane gas is best obtained from anaerobic fermentation processes with crab picking; *rumen* and molasses waste formulas with ration of 1:1:1 (w/v/v) can produce methane gas of 2.42%.

1. Introduction

Petroleum-based materials that are depleted give rise to the potential for contamination, to cause damage to nature; it can be replaced with biogas which has a content methane and carbon dioxide gas. Adityawarman *et al.* [1], he elements contained in biogas are methane gas (CH_4), carbon dioxide gas (CO_2), oxygen gas (O_2), hydrogen sulfide gas (H_2S), hydrogen gas (H_2), and carbon monoxide gas (CO), of all these elements, play a role in determining the quality of biogas, namely methane gas (CH_4) and carbon dioxide (CO_2) gas.

The characteristics of biogas can potentially be an alternative to renewable biogas. BIGAS is specifically designed to process waste into biogas which can be utilized again by the miniplan. Agustina *et al.* [2], biogas is any fuel either solids, liquids or gases produced directly from organic materials. Biogas can be produced directly from plants or indirectly from industrial, commercial, domestic or agricultural waste. In the biogas production process, methane gas is a gas that has the largest percentage in biogas, in addition to other gases such as carbon dioxide, nitrogen, and oxygen. The composition of biogas which is dominated by methane gas is what makes biogas referred to as an alternative energy source. BIGAS is expected to be able to be utilized in the Miniplan Putra Mandiri industry as the main ingredient for LPG gas replacement in the process of boiling the crabs before undergoing the stripping process. So that the innovation and technology of BIGAS that is effective, can reduce expenditure in purchasing LPG gas, and be able to be applied sustainably by Miniplan Putra Mandiri.

Blue swimming crab (*fortunes Pelagius*) is a type of crab family that have striking blue body characteristics. This crab has very high economic value. Indonesia is a crab exporting countryto various countries such as Singapore, Malaysia, China, Japan, and several countries in Europe, especially the United States. Every year nearly 90% of Indonesian crab meat production goes to the American market [3]. The handling process is carried out in a mini crab plan including washing of raw materials, boiling and picking. In the process of removing its shell, one crab produced waste that consists of 57% shells, 3% reject weight and 20% boiled water. The increase of crab waste will have an impact on environmental pollution if it is not handled [5].

Shell and offal waste is a by-process product with low economic value. This causes environmental pollution which affects the citizen. Therefore, good and efficient waste management is needed to be effective and eco-friendly. The waste can be fermented to make gas which allows the picking industry to be used as an alternative fuel to replace government-subsidized LPG gas. Salam *et al*. [9], biogas is produced from anaerobic digestion of fish waste and also from anaerobic co-digestion of fish waste and cow dung. This study aims to determine the raw material content of crab waste and the best formula in making biogas.

2. Research Methods

2.1. Collection of raw materials

The crab waste in the form of shell, *lemi* and gill were tested for water content using the gravimetric method [11] and protein content tested by Kjeldahl method [4] to determine the raw material content before the fermentation process was carried out at the Analysis Laboratory, Faculty of Fisheries and Marine Science, Diponegoro University.

The crab picking waste in this study was obtained from the Putra Mandiri Mini plan in the village of Gedongmulyo, Lasem, Rembang. Waste taken the form of solid waste (shells, *lemi* and gills) and liquid waste (leftover boiling crabs), cow *rumen* and molasses obtained from animal slaughterhouses in the Rembang area.

2.2. Biogas production

To produce natural biogas from crab picking waste, solid waste (shell, *lemi*, gill), liquid waste (remaining crab cooking water), cow *rumen* and molasses were mixed thoroughly in a ratio of 1: 1: 1 (w/v/v). carried out with three treatments namely solid and liquid waste; waste + cow *rumen* and waste + cow *rumen* + molasses which were tested in a laboratory scale using 2 L. Each volume was 300 ml with a fermentation process for 21 days and then the methane gas content was tested using Gas Chromatography Mass Spectroscopy (Shimadzu, GCMS QP2010 Plus) in the Integrated Laboratory, Diponegoro University.

Bio digester for producing biogas was made using closed drum (capacity of 300 L) and connected using PVC pipes (Fig. 1). The mechanism of working of the bio digester is an anaerobic fermentation or airtight fermentation device to obtain gas content. Bio digester is equipped with two holes namely the input hole and the outer hole. The input hole is made of 2.5 inch PVC pipe which is connected to the body of the drum with a distance of ½ of the total height of the drum facing upwards making it easier for the owner to enter the sample to make bio digester. This is intended to dispose of anaerobic fermentation by-products that can be reprocessed into fertilizer. So that if the gas pressure on the drum has filled the space it can be channeled through a pipe that is connected directly to the gas stove for the boiling process of the crab.

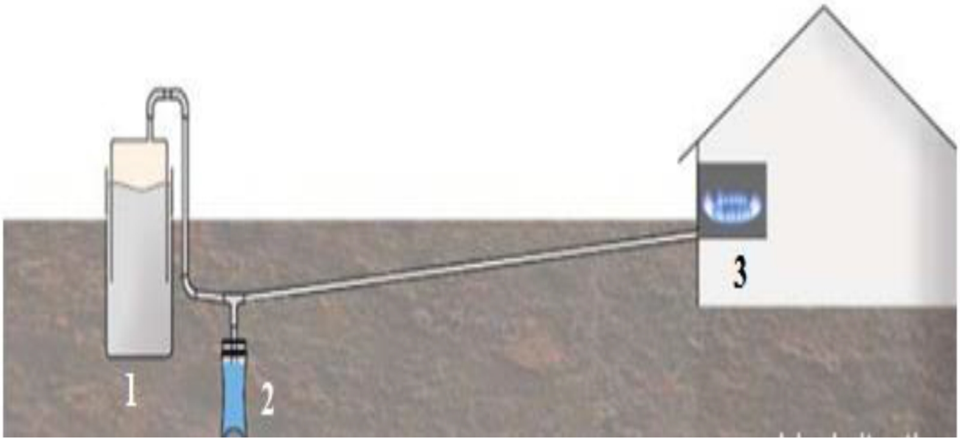

Figure 1. Tool Design : 1) Digester, 2) Water trap 3) Boiling Furnance

3. Results and Discussion

3.1. Moisture and protein content of raw materials

Water content testing is intended to determine the hydro scope content of a raw material as to produce a fast fermentation process and produce methane gas content.

Table 1. Moisture and Protein Content of Crab Picking Waste

No.	Sample	Moisture Content (%)	Protein Content (%)
1.	*Lemi*	73.025	13.380
2.	Shell	15.950	11.124
3.	Gill	85.647	7.043

The highest water content obtained by the gills was 86.033%, while the shells had the lowest water content value of 15.424%. These numbers was in accordance to the research by Sarower *et al.* [9] where the crab gills have humidity around 83.59% higher than the water content of the crab's *lemi* which is around 47.35%.

Protein content is used to determine the nitrogen content contained in ingredients that function as bacterial food to produce the right gas. The results of testing the protein content of the remaining crab picking waste can be seen in Table 1. The highest protein content obtained by *lemi* was 13.38%, while the gills had the lowest protein content of 7.043%. Sarower *et al*. [10] crab's gills have a protein content of 8.10% lower than the protein content in crab's lemi 34.67%. High protein levels capable of producing amino acids will be overhauled as a producer of methane gas. Marwah *et al*. [11], research shows that methanogenetic bacteria utilize H_2, CO_2, amino acids and other NH_4 nitrogen compounds that are capable of forming methane gas content.

3.2. Biogas profile

Methane gas is a gas that can be used for alternative fuels. In general, methane can be produced from solid waste, liquid waste, and starter, while the fermentation process can be carried out in three treatments, they are solid fermentation, the mixture of solid-liquid-molasses, and the mixture of solid-liquid-molasses-*rumen*. In our preliminary studies, it was shown that the mixture of solid-liquid-molasses-*rumen* could produce flames in biogas fermentation testing for 21 days. Methane gas content can be obtained through the fermentation process of residual crab picking with the addition of cow *rumen* and molasses. This can be obtained because the *rumen* of the cow is bacterial. Bacteria found in the *rumen* of the cow will consume the nutrients obtained by residual crabs and molasses. Bacteria will produce secondary metabolism in the form of C / N. The carbon content (C) is obtained from molasses while nitrogen (N) obtained from the remaining crab picking waste containing protein and nitrogen is the result of protein remodeling. Gas profile data are presented in Table 2.

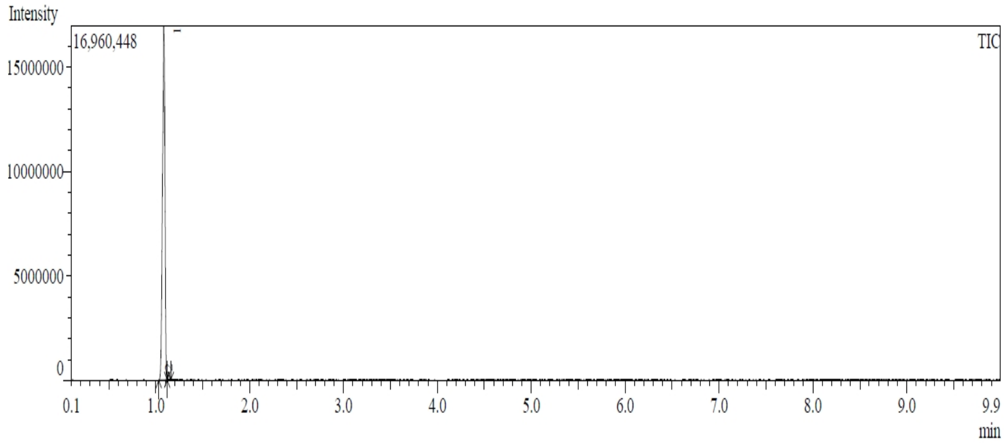

Figure 2. The Test Result of Fermented Solid and Liquid Wastes

Table 2. Gas Profile on Fermented Solid and Liquid Wastes

Name	Concentration (%)
Methanamine, N-methyl- (CAS)	98.75
Ammonium bicarbonate (pyrolysis)	1.25

Based on data from biogas fermentation with solid and liquid waste samples do not produce methane gas (Fig. 2). This is because in the fermentation process the nitrogen content produced is very high so that bacteria are poisoned by nitrogen. Mujdalipah *et al.* [8] showed that the source of C and N needed by microbes which play anaerobic process as a source of nutrients for the growth and development of these microbes. If the N content in the substrate is small, the bacteria cannot produce the enzymes needed to synthesize carbon-containing compounds. While the substrate that contains a lot of N will increase the content of ammonia which inhibits bacterial growth.

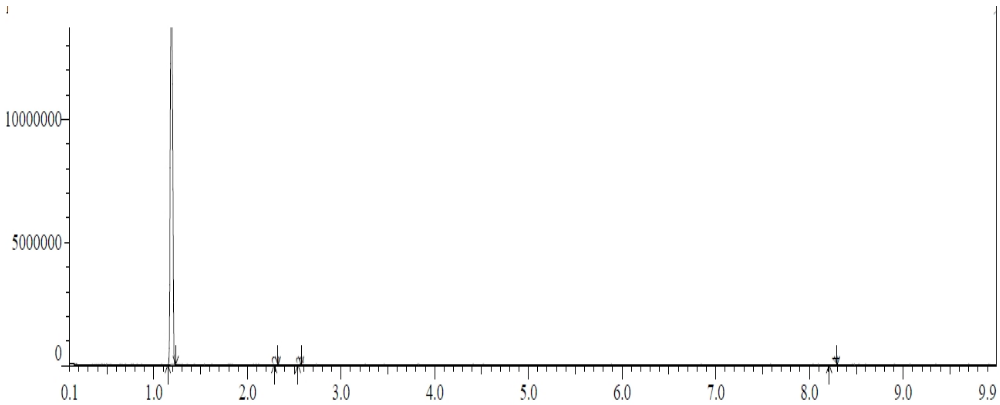

Figure 3. The Test Result of Fermented Wastes and *Rumen*

Table 3. Gas Profile on Fermented Solid, Liquid Wastes, and *Rumen*

Name	Concentration (%)
Methanamine, N-methyl- (CAS)	99.77
N-[2,2,2-Trifluoro-1-(isopropylamino)-1-(trifluoromethyl)ethyl]isovaleramide	0.06
8,9,9,10,10,11-Hexafluoro-4,4-dimethyl-3,5-dioxatetracyclo[5.4.1.0(2,6).0(8,11)]dodecane	0.07
Heptanal (CAS)	0.11

Based on data from biogas fermentation with a sample of solid and liquid waste with the addition of *rumen* does not produce methane gas (Fig. 3). This is because in the fermentation process the nitrogen content produced is very high (Table 3) so that bacteria have nitrogen poisoning. *Rumen* is a substrate remover microorganism that will produce secondary metabolic compounds in the form of methane gas. The fermentation process of crab picking residual waste with the addition of cattle *rumen* is not able to overhaul the substrate into secondary metabolism because microorganisms are poisoned due to the abundance of nitrogen in the waste. Wati *et al*. [12], the use of a lot of *rumen* will inhibit the flow of gas in the fermentation process because of the amount of water. The number of bacteria that is not equivalent to the number of substrates results in interbacterial competition so that the methane gas produced is small.

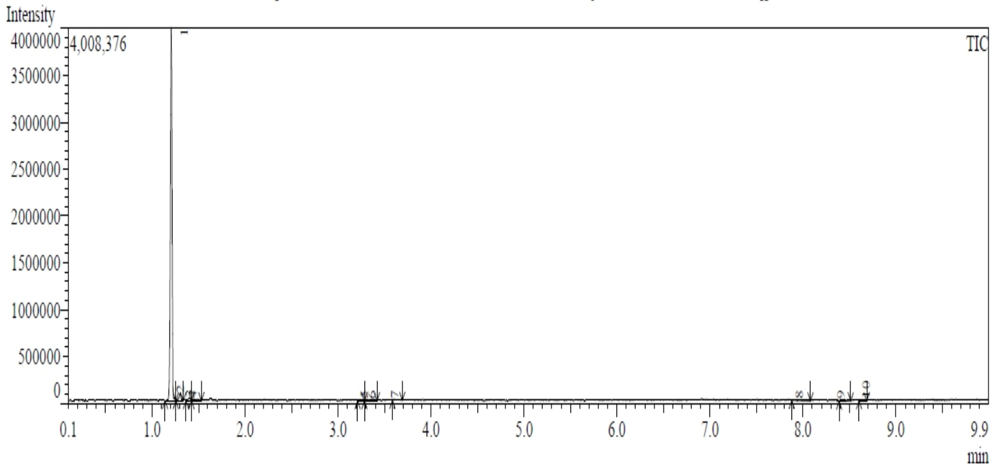

Figure 4. The Test Result of Fermented Wastes, *Rumen* and Molasses

Table 4. Gas Profile on Fermented Wastes, *Rumen* and Molasses

Name	Concentration (%)
TRANS-BETA-IONON-5,6-EPOXIDE	89.38
Methane, oxybis- (CAS)	2.42
Methane, thiobis- (CAS)	1.09
2,2'-(1,4-Phenylene)bis[4-(2,4-dichlorobenzylidene)-4,5-dihydro-5-oxazolone]	1.15
(2,3-Dimethylaziridin-1-yl)-(4,4,6-trimethyl-7-oxabicyclo[4.1.0]hept-2-ylidene)amine	0.83
1,2,5-Oxadiazole (CAS)	1.37
Cyclohex-1,4,5-triol-3-one-1-carboxylic acid	0.76
Pentanedioic acid (CAS)	1.05
HEXANAL	1.13
Dodecane, 1-bromo- (CAS)	0.80

Based on the data of biogas fermentation with crab picking waste, *rumen* and molasses formula capable of producing 2.42% methane gas (Fig. 4, Table 4) because the microorganisms found in the cattle *rumen* will consume nutrients obtained by the remaining crab picking waste and carbohydrates from molasses. Bacteria will produce secondary metabolism in the form of C / N. The carbon content (C) is obtained from molasses while nitrogen (N) obtained from the remaining crab picking waste containing protein and nitrogen is the result of protein remodeling. Lestarie *et al*. [4] the number of methanogenic bacteria will be directly proportional to the methane gas produced. This depends on the number of pegurai microbes with the nutritional needs found in the raw material. Nutrients in bacteria function to regenerate and produce secondary metabolites in the form of methane gas.

4. Conclusion

Biogas produced through anaerobic fermentation process from crab. The results showed that the fermentation of solid waste and liquid waste with a ratio of 1: 1 (w/w) produced 98.75% Methanamine,

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N-methyl- (CAS) gas; crab picking waste formula with the addition of cattle *rumen* in a ratio of 1: 1 (w/v) of 99.77% Methanamine, N-methyl- (CAS); and the formula for crab picking waste with the addition of bovine *rumen* and molasses in a ratio of 1: 1: 1 (w/v/v) can produce methane gas of 2.42%. Methane gas is best obtained from anaerobic fermentation processes with crab picking, *rumen* and molasses waste formulas. It is necessary to be tested using different *rumen* volumes and molasses to produce greater methane gas.

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