International Journal of Research in Advent Technology, Vol.5, No.8, August 2017
E-ISSN: 2321-9637
Available online at www.ijrat.org

Biogas from Microalgae: A New Perspective of Renewable Energy

Bertoka Fajar SP Negara [*], Dewi Purnama, Zahra Angelessy, Aradea Bujana Kusuma
Marine Science Department , Bengkulu University, Bengkulu 38371A, Indonesia.
[*]*Email: bfsp_negara@yahoo.com*

Abstract- Biogas was mixed gas which is produced from organic materials using methanogenic bacteria on anaerobic condition. Biogas could be produced from cow dung, water hyacinth, and cassava as row material. The objective of this study was to known the volume of gas produced by microalgae. This research was conducted in Marine Science Laboratory, Bengkulu University. This research used experimental method without adding the raw material. pH was measured every day during 30 days. Mangrove sediment was used as stater. *Chaetoceros* sp. was used as row material. Result showed *Chaetoceros* sp. could produce gas < 1 ppm and 503 mL gas volume. It shown that microalgae have a potency as biogas raw material.

Index Terms- Biogas, Chaetoceros sp., Microalgae, and Volume of Biogas

1. INTRODUCTION

Natural gas is fossil fuel gases consisting of methane (CH_4) that found in oil fields, gas fields and coal mines. Gas is an energy source that widely used for various purposes such residential, commercial and industrial. The uses of natural gas have been increasing every years. It is caused many benefits of using natural gas compared other energy sources [1]. Natural gas produced more efficient energy compared to other energy sources caused colorless, odorless, non-corrosive and non-toxic [2]. The main function of the use of gas for daily need such as fuel for cooking, heating, clothes dryer, and water heater. In addition, another functions of gas are as fuel for industrial manufacture of fertilizers, ink, plastics, paints, detergents, insect deterrents, etc [3].

The increased of gas need every years have an impact on the availability of gas in nature. Indonesian gas availability in 2050 reached 3289.44 million BOE (Barrel of Oil Equivalent) [4]. Naturally, gas was produced from the decay of organic matters by anaerobic bacteria that takes 59 years. The process production of gas from the decay of organisms is mostly from plant and animals. The process of heating and pressure in the layers of the earth also help the process production of gas. The formation process of gas that takes a long time by anaerobic bacteria to produce gas, makes natural gas into natural resources that can not be refurbished [5]. Nowadays, an alternative sources of gas raw material have been looking from land such as water hyacinth, sweet potatoes, cassava and cow dung. In the process of amplifying the raw material from these materials requires a lot of space which competion directly with human needs.

Naturally, Biogas is formed from the anaerobic fermentation. Anaerobic fermentation process could be convert carbohydrate into glucose. Acidification would be convert glucose into fat acid and ethanol, than methanesasion would be convert ethanol into methane [6]. Microalgae is one of marine plants that contain carbohydrates which could be convert into biogas. Furthermore, microalgae have rapid growth rate than land plants. mass culture of microalgae does not need much space. Utilization of microalgae as raw material for biogas is a novelty and should be developed as solution of renewable energy sources. The objective of this study was to known the volume of gas produced by microalgae.

2. MATERIAL AND METHODS

The research was conducted at Marine Science Laboratory, Bengkulu University. Cultivation performed for 11 hour in the 1.5 liter containers with controlled environment. Additional nutrients were required to support microalga growth in provided seawater media.

2.1. Culture of Microalgae

Microalgae *Chaetoceros* sp. was obtained from strain database of Surfactant and Bioenergy Research Center (SBRC), Bogor Agricultural University. The culture media used silicat, cobalamin, and epizym. The experiment used 1.5 liter containers, with working volume of one liters, 900 mL of culture medium, and 100 mL of microalgae, thus characterizing a stationary cultivation, in which, after inoculation there is no addition of fresh culture during the culture development (Lourenço, 2006). The culture media and the containers were previously sterilized in an autoclave for 20 minutes at 121 °C to prevent culture contamination. 100 mL of Chaetoceros sp. diluted into 900 mL sterile medium (1:9 v/v). The cultivations were submitted to constant aeration through diaphragm pump with air flow of 3 L min.-

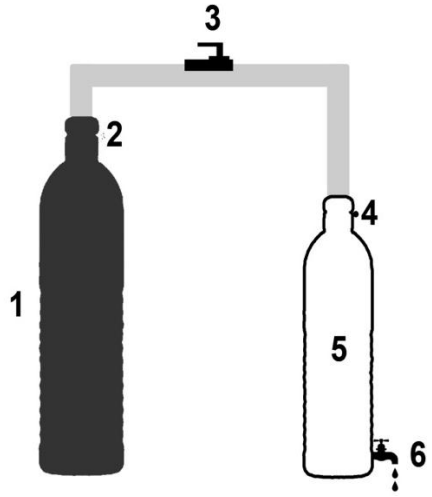
1, salinity of 35 ± 2‰. Room temperature and light intensity were kept at 28 ± 1^{o}C and 200 µE cm-2 s-1, using 40W fluorescent lamps, and the experiment was performed under continuous light [7].

2.2. Inoculum Preparation

Inoculum was made from a mixture of mangrove sediments and sea water sterile (1: 1) and filtered using calico cloth. Mangrove sedimen was taken using a core that inserted into mangrove sediments at 30 cm. Mangrove sediments contain some bacteria that can transform organic compounds into methane, it is possible to used mengrove sediment as inoculum.

2.3. Production of Biogas

Biogas production was done by anaerobic biodegradation on digester (Figure 1). 750 mL inoculum and 750 mL *Chaetoceros* sp. was mixed into the digester 1.5 L. anaerobic biodegradation performed for 30 days. Products of biogas will be transferred into the gas container. The gas products which is in the gas container measured by knowing the amount of volume of water that comes out.



Legend:

1. The sample bottle (1.5 L)
2. Inlet to enter the sample
3. Hoses connecting to collect gas
4. Inlet to enter the gas
5. Bottle for gas storage (600 mL)
6. Faucet for water discharge

Figure 1. Desain of Degister that Used on Production of Biogas from Microalgae

3. RESULTS AND DISCUSSION

3.1. Characteristic of Microalgae

Microalgae cell density of the cultivations was determined by cell direct counting during 20 hours on live medium (Fig 2). The experiments reported in this work lag phase occured during 2 hours of observation time with cell density of 13.533 cells/mL. Early log phases (exponential) occured during 6 until 10 hours of observation time with cells density of 24.333 cells/mL. Stationary phase occured during 10 until 11 hours of observation time with cells density of 66.066-82.066 cells/mL. Death phase occured during 13 until 16 hours of observation time, cells density were decrease to 57.600 - 43.400 cells/mL.

During lag phase, microalgae adapt themselves to growth conditions. It is the period where the individual microalgae are maturing and not yet able to divide. The log phase is a period characterized by cell doubling. The number of new microalgae appearing per unit time is proportional to the present population. The stationary phase is often due to a growth-limiting factor such as the depletion of an essential nutrient, and/or the formation of an inhibitory product such as an organic acid. Stationary phase results from a situation in which growth rate and death rate are equal. The number of new cells created is limited by the growth factor and as a result the rate of cell growth matches the rate of cell death. At death phase (decline phase), microalgae die. This could be caused by lack of nutrients, environmental temperature above or below the tolerance band for the species, or other injurious conditions.

In Nature, the microalgae growth does not wonder about kinetics, being the growth rate just the enough one for species survival [8]. Like any other species, the multiplication rate is highly dependent on environmental conditions, which are not constant in time being dependent of several factors. On the other hand, in artificial microalgae cultivation the goal is to favour the increasing of growth rate as much as possible or to push the metabolic route to follow one direction, if a particular metabolite has to be obtained.

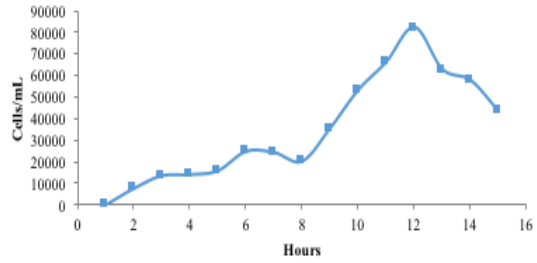


Figure 2. Growth Curve of *Chaetoceros* sp. on live medium during 20 hours

3.2. Gas Volume Analysis

The fermentation of microalga to produce biogas have lasted 30 days, until the biogas produced from microalgae. The fermentation used mangrove sediment as control, and also has measured for 30 days. Regarding the control trials, control trial produced 425 mL gas volume, whereas sampel produced 503 mL. Digester that contain micro algae and sedimen mangrove (sampel) produced more biogas than control, it caused they contained part of the nutrients on body of microalgae, which were fermented to be biogas. [9] reported methane can be produced from lipids, proteins and carbohydrates of microalgae.

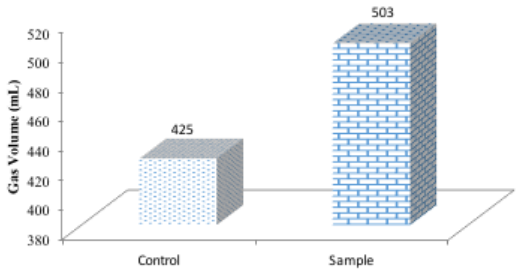


Figure 3. Gas Volume produced from Microalgae *Chaetoceros* sp. during 30 days fermentation used anaerobic digester

Microalgae cell wall contain proteins and carbohydrates, it can convert these organic components into biogas by anaerobic process. Although, sampel digester produced more biogas than contro, but it still poor compare than previous result [10]. Cell walls of some microalgae species are composed of complex carbohydrates that are hardly biodegradable by methane bacterial. These cell walls act as a protection of the intracellular organic mac- romolecules from bacterial attack, reducing biodegradability of microalgal. The results suggest that microalgal can be use as raw material of biogas, enhancing its bioavailability and/or biodegradability by anaerobic microorganisms. However, better results were achieved on sampel digester. Finally, the results obtained in this study demonstrates that microalgae especially *Chaetoceros* sp. may be applied on anaerobic digestion to produce biogas. Nevertheless, these results must be evaluated in continuous reactors for energy and economic aspects.

4. CONCLUSIONS

This study was devoted to produced gas by using microalgae as row material. Even though the microalgae efficiently produce biogas, The higher volume of gas was produced from *Chaetoceros* sp. (503 Ml), and concentration of methane was lower than 1 ppm.

REFERENCES

[1] Sitompul JP, Bayu A, Soerawidjaja TH, Lee HW. (2012): Studies of biogas production from green seaweeds. *Journal of Environment and Bioenergy*, **3**(3):132-144

[2] Kalia VC, Sonakya V, dan Raizada N. (2000): Short communication, anaerobic digestion of banana stem waste. *Bioresource Technology*, **73**:191-193.

[3] Sunarso, Johari S, Widiasa IN, Budiyono. (2010): The effect of feed to inoculums ratio on biogas production rate from cattle manure using rumen fluid as inoculums. *Journal of Science and Engineering*, **1**(2):41-45.

[4] Briand, X. dan Morand P. (1997): Anaerobic digestion of ulva sp. 1. relationship between ulva sp. composition and methanisation. *Journal of Applied Phycology*, **9**:511-524.

[5] Rodriguez, L., and Preston, T. R. (2006): *Biodigester installation manual, University of Tropical* Agriculture Foundation. Finca Ecologica, University of Agriculture and Forestry. Thu Duc, Ho Chi Minh City. Vietnam.

[6] Van Soest PJ. (1963): Use of detergents in the analysis of fibrous feeds. II. A rapid method for the determination of fiber and lignin. *J Ass Offic Anal Chem*, **46**:829-835.

[7] [APHA] American public Health Assocoation. (1998): Standar Methods for the Examination of Water and Wastewater. 20TH Edition. Baltimore (USA): Victor Graphics Inc.

[8] Yaich Hela, Garna Haikel, Besbes Souhail, Paquot michel, Blecker Christophe, Attia Hamadi. (2011): Chemical composition and functional properties of

Ulva lactuca seaweed collected in Tunisia. *Journal Food Chemistry*, **128**:895-901

[9] Sialve B, Bernet N, Bernard O. (2009): Anaerobic digestion of microalgae as a necessary step to make microalgal biodiesel sustainable. *Biotechnol Adv*, **27**(4):409–16.

[10] Ramos-Suárez, J. L, and N. Carreras. (2014): Use of microalgae residues for biogas production. *Chemical Engineering Journal*, **242**(2014): 86–95.