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Review articles; UTILIZATION OF SOLID WASTE PROCESSING SEAWEED INTO BIOENERGY

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ABSTRACT

purpose of this review article is to review the process of utilizing seaweed solid waste into bioenergy. Based on the literature study, information was obtained thatwaste from the seaweed processing industry can be reused, one of which is as an alternative form of making bioenergy. Utilization of seaweed in bioenergy can help reduce environmental pollution caused by solid waste from seaweed itself. The bioenergy produced from the processing of these wastes is into bioethanol and biogas. The potential of using seaweed waste into bioenergy is very important because seaweed is a renewable natural resource that will not run out so that it can support alternative renewable energy.

Keywords: *Bioenergy, Bioethanol, Biogas, Power plant. Renewable.*

INTRODUCTION

Seaweed processing produces solid waste in the form of dregs from the filtering and draining process (Riyanto, 1998 in Hartati, 2001). The management and utilization of solid waste from the seaweed industry is currently still not handled properly (Hartati, 2001). The waste is usually piled up at the disposal site, this will be a problem if the disposal site is no longer able to accommodate the solid waste produced and will cause an unpleasant odor (Afif, 2011).

Solid waste generated by the agar processing industry is usually only left to accumulate at the landfill site. Although not dangerous, the landfill has the potential to cause problems, especially if the landfill site is no longer able to accommodate the waste produced.

The development and utilization of solid waste from the seaweed industry as a fuel producer will support government policies in providing renewable energy, especially biofuels such as bioethanol, biodiesel, bio-oil and biogas. According to the Indonesian government's policy, the target for the use of gasohol (a mixture of premium and ethanol) in 2011-2015 is 3% of gasoline consumption and 5% in the period 2016-2025. To achieve this target, raw materials from sugar, starch and cellulose must be used (Meinita et al., 2011).

The cellulose content contained in the solid waste of the seaweed industry can be converted into energy. This article aims to examine the processing of solid waste from the seaweed industry into bioenergy.

Seaweed

Seaweed or algae are marine plants that cannot be distinguished between roots, leaves, and stems, so the whole body is called a thallus. The type of seaweed that is often used is Rhodophyceae (red algae) and the most widely cultivated in Indonesia is the Eucheuma species (Saputra, 2012). Eucheuma is a macroscopic seaweed, there are two types of Eucheuma which are quite commercial, namely Eucheuma spinosum (Eucheuma denticulatum), which produces -carrageenan and Eucheuma cottonii (Kapaphycus alvarezzii) as producer of -carrageenan (Anggadiredja, 2004). Seaweed contains carbohydrates, protein, a little fat, and ash which is mostly a compound of sodium and potassium salts. In addition, seaweed also contains vitamins (A, B1, B2, B6, B12, and C), beta-carotene, and minerals (K, P, Na, Fe, and I). Some types of seaweed contain more essential vitamins and minerals, such as calcium and iron, than vegetables and fruits. Some types of seaweed also contain high enough protein, these substances are very good for daily consumption because they have important functions and roles to maintain and regulate the metabolism of the human body (Saputra, 2012). Seaweed production data in Indonesia can be seen in the table below.

Table 1. Production of the Indonesian SeaweedYear

Seaweed Production					
	2015	2016	2017	2018	2019
Total (Tonnes)	11,269,000	11,686,000	10,456,000	10,018,000	9,746,000

Source: KKP, 2019

Waste Seaweed

Based on waste characterization known that waste Seaweed processing consists of two phases, namely the liquid phase and the solid phase. The liquid phase comes from the washing and precipitation of seaweed extraction, while the solid phase comes from the separation of the seaweed extract from the solid. The main composition of the solid phase is cellulose, while the other components are minerals. The water content of the solid phase can reach 68.4%, the ash content is 31%, and the fiber content is 20.1% (Basmal et al., 2003). One of the wastes produced by the agar product processing industry. Based on research data by the Center for Research on Product Processing and Socio-Economic Maritime Affairs and Fisheries in 2002-2003, the waste generated in agar processing ranges from 70-85%. The main composition of seaweed solid waste is cellulose, while the other components are minerals. Seaweed waste from the solid phase has a water content of 68.4%, an ash content of 31% and a fiber content of 20.1% (Basmal et al 2003).

Bioenergy

Bioenergy is energy obtained from biomass as a fraction of biodegradation products, waste, and residues from agriculture (derived from plant and animal origin), forestry and related industries, and a small part of biodegradation from industrial and municipal waste. Bioenergy plays an important role in achieving the target of replacing petroleum based transportation fuels with alternative fuels and reducing carbon dioxide emissions in the long term. The advantages of bioenergy, besides being renewable, are environmentally friendly, biodegradable, able to eliminate the greenhouse effect, and ensure the continuity of the raw materials (Hambali et al., 2007).

Bioethanol

Bioethanol is one of the alternative energy sources that can be used in handling energy and environmental crises. Bioethanol is produced by the fermentation process of simple sugars, starch, and biomass containing cellulose. Bioethanol raw materials that are often used are cassava, sugar cane, sap, sorghum, nipa sap, sweet potato, banana kepok, and so on. However, these raw materials have limited availability because they compete for human consumption needs, besides that these materials require large planting areas, and the bioethanol obtained is not optimal.

Industrial solid waste seawee dcontains cellulose which can be used as raw material for ethanol. Cellulose is composed of many simple sugar monomers. These simple sugar monomers are the main precursors used by S. cerevisiae to convert into ethanol under suitable environmental conditions (Jung et al., 2012).

Complete hydrolysis of cellulose will produce cellulose monomer, namely glucose. Cellulose can be hydrolyzed into glucose using water media and assisted with acid or enzyme catalysts. Cellulose hydrolysis can be carried out using an acid solution such as sulfuric acid (H2SO4) or enzymatically using the cellulase enzyme from Aspergillus niger (Eshaq et al., 2011). Optimization of the saccharification method for raw materials with the main content of cellulose is a factor that can increase the production of bioethanol. The efficiency and effectiveness of the bioethanol production process requires several production techniques in order to reduce the costs incurred for production in the use of medium and energy.

The procedure for making bioethanol from seaweed industrial waste according to Adini et al, (2015) is as follows:

1. Stock of breeding and rejuvenation of A. niger
2. Stock of breeding and rejuvenation of S. cerevisiae
3. Preparation of seaweed and agar waste Gracilaria sp.
4. Saccharification of seaweed flour and waste agar Gracilaria sp.
5. Making Medium Fermentation
6. Making Starter
7. Bioethanol Production

Biogas

One of the many types of bioenergy is biogas, which can be produced from a wide variety of organic materials such as manure, human waste, paper waste and food and materials such as water plants, water hyacinth, filamentous algae, and seaweed dregs (solid waste from the seaweed industry). The main content in biogas is methane and carbon dioxide. Methane gas which can later be used as fuel (Susanto and Abdillah, 2009).

Biogas is a flammable gas produced from the fermentation process of organic materials by anaerobic bacteria (bacteria that do not need oxygen to survive and reproduce). In general, all types of organic materials can be processed to produce biogas, such as animal manure and urine which are suitable for simple biogas systems (Erawati, 2010).

Seaweed waste has not been widely used as a biogas producer in Indonesia. The many types of seaweed that have not been utilized have the potential as raw materials for producing alternative bioenergy (algafuel). Abundant and disturbing seaweeds of the Ulva and Laminaria species have been used as biogas generators for fuel mixtures and power generation in Japan (Matsui et al., 2006).

Making biogas using seaweed dregs is done by using a continuous load digester with a displacement model because it is more practical and gas production can continue. By using a displacement digester, the stuffing can be added continuously so that the gas produced can be continuous. In the digester, the conditions are often acidic, so it is necessary to add lime such as Mg (OH)2 to raise the pH because the methane-forming bacteria are comfortable in an environment with a neutral pH or in the range of 6-8. It is necessary to add fertilizer as a nutrient for the growth of methanogenic bacteria. Nutrients needed by bacteria are C, N, P. Nutrient C is obtained from seaweed pulp carbohydrates, so to meet the N and P nutrients, fertilizers such as NPK need to be added. For starters, a ratio of weight of sediment and mashed seaweed is used as much as 2: 1. If the amount of sediment is 10 kg, then the mashed seaweed dregs must be as much as 5 kg which is then put into the digester and waited for 2-4 weeks to produce gas. methane. Furthermore, for the stuffing, namely seaweed that has been mashed 5 kg, it is enough to add it gradually in the digester.

The higher the carbohydrates in the seaweed dregs, the greater the biogas pressure that will be obtained because carbohydrates are one of the main elements which will later be fermented by methane-forming bacteria. into biogas. According to Sriyanti (2003), the high and low levels of sugar and alcohol content per gram are influenced by the amount of carbohydrate content. This shows that the higher carbohydrate content affects the alcohol content produced in the carbohydrate fermentation process.

The procedure of making biogas from pulp seaweed is as follows:

1. Dregs Seaweed by sea for two days
2. Decision Sediment Beaches sufficiently adapted to the size of the digester
3. Digester used are continuous load digester model of displacement
4. Making Starter and Field
5. Used as much as 500 grams of lime or buffer other on every entry of seaweed dregs into the digester. It is necessary to add fertilizer as a nutrient for the growth of methanogenic bacteria so that fertilizers such as NPK are added.
6. For starters, a ratio of weight of sediment and mashed seaweed that has been mashed is used as much as 2: 1. then put into the digester and wait for 2 to 4 weeks to produce methane gas.

Seaweed Dregs Biogas Power Plant The seaweed

dregs which are used as a source of energy for the plant are not for consumption, so they do not affect human food needs. Seaweed pulp has a very high methane content and is suitable for power generation. Seaweed dregs as a source of energy for the generator are then processed by machines to produce gas. And the gas is then used as fuel to drive a turbine that produces electricity.

Conclusion

Based on the literature study, information was obtained thatwaste from the seaweed processing industry can be reused, one of which is as an alternative form of making bioenergy. Utilization of seaweed in bioenergy can help reduce environmental pollution caused by solid waste from seaweed itself. The bioenergy produced from the processing of these wastes is into bioethanol and biogas. The potential of using seaweed waste into bioenergy is very important because seaweed is a renewable natural resource that will not run out so that it can support alternative renewable energy.

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