Biogas Production of Pineapple Juice and Fibres through Anaerobic Digestion

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Abstract

The biogas production of pineapple juice and fibres are conducted through the process of anaerobic digestion. The experiment was conducted with various ratios of pineapple fibres to pineapple juice. In this experiment, municipal waste acted as inoculum which is the source of microbial organisms such as bacteria. The reaction of inoculum with the substrates was experimented for 21 days and showed no displacement of water level in the test tube. Municipal waste is not effective to act as an inoculum for anaerobic digestion of pineapple juice and fibres to produce biogas through the observation. Thus, several causes of failure has been identified which is based on the inoculums used, size of bioreactor, and pH of the mixture.

Keywords: anaerobic digestion, municipal waste, pineapple

1. Introduction

In industries, waste utilization of fruits processing has become a major challenging and important job around the world. The wastes which include the fruit and the material inside itself are believed to produce more useful products by furthering it processes. Such purposes primarily for fermentation, extraction of biomass gas, extraction of bromelain enzyme and secondarily as low-cost raw material for the production of ethanol, phenolic anti-oxidants, organic acids, biogas and fiber production (Natarajan, Ramakrishnan, Lakshmanan, Palakodeti, & Rangiah, 2015). With recent development in technologies in the world which are very dependent on imported oil and oil imports continue to increase, these new method to produce renewable energy has mainly used in industry in able to reduce the cost of the raw materials. The transportation sector is mainly dependent upon oil with approximately 97% of the transportation energy derived from petroleum for transportation purposes (Nigam, 2000).

The pineapple cannery waste is a potential source of sugars, protein, vitamins and growth factors, can be used as a substrate for biomass gas production, and may reduce the costs of waste disposal (Nigam, 2000) because canneries are required to treat their waste before disposal in order to reduce the organic load. The increasing production of pineapple processed items, results in massive waste generations. This is mainly due to selection and elimination of components unsuitable for human consumption. Besides, rough handling of fruits and exposure to adverse environmental conditions during transportation and storage can cause up to 55% of product waste (Nunes, Emond, Rauth, Dea, & Chau, 2009). These wastes are usually prone to microbial spoilage thus limiting further exploitation. Further, the drying, storage and shipment of these wastes is cost effective and hence efficient, inexpensive and eco-friendly utilization is becoming more and more necessary (Natarajan et al., 2015). In the present study, the waste from pineapple cannery was examined for biomass gas production. Pertinent scientific and technological implications would produce better and more profitable markets for pineapple wastes.

This agro-industrial fruit waste consists of high moisture content of carbon source. The biogas has been accepted to be one of the best alternatives renewable energy. The organizing with these wastes with this appropriate technology can decrease an environmental problem, as well as reduce the global warming. The biogas production mechanisms are composed of acidogenesis and methanogenesis processes through anaerobic digestion of organic matter (Chulalaksananukul, Sinbuathong, & Chulalaksananukul, 2012). The produced biogas which achieved of 50% of methane has been addressed as a good quality of biogas. Anaerobic digestion has been widely used for the treatment of organic industrial wastes and agricultural wastes, including those from fruit and vegetable processing (Zupan & Grilc, 2007). Some of the fruits and vegetables are insufficient of nitrogen and contain high toxic

constituents such as limonin in citrus wastes. Biogas production from fruit wastes is an efficient method of waste treatment, resulting in a highly stabilized effluent which is odorless and neutral in pH (Bardiya, Somayaji, & Khanna, 1996).

The objective of this research is to determine the production of biogas through anaerobic digestion of pineapple waste in the form of juice and fibres with municipal waste water. The system was initiated with indigenous microorganism. The parameters affecting biogas production includes volume of the gas produced and the pH value.

2. Methodology

2.1 *Substrates and inoculum*

The pineapple was bought from the shop near Bandar Sri Alam and the inoculum used in this experiment is municipal waste water. This municipal waste water was collected from industrial company name Indah Water Konsortium located at Bukit Indah, Johor. The pineapples were kept in the laboratory chiller to keep it cool and fresh before being used for experimental studies. After that upon obtaining the pineapple juice and fibre, the pineapple is shredded in a blender and filtered to obtain the filtrate as fibre and the extract as juice.

2.2 *Anaerobic Digestion Operation*

The 2 L flask was a custom build to be used in this experiment. The body surface of the flask is being wrapped with aluminium foil as to prevent the growth of the algae. Each reactor is equipped with two outlet ports; one for the gas collector where the excess gas will be kept. The other one is for the effluent gas. The effluent gas is attached to a container for the water displacement observation. Biogas production was started up by applying with chopped pineapple peel solid waste. This raw material is then being shredded in a blender. The substrate of the blender consists of 200 g for the first experiment, 400 g for the second experiment and 600 g for the third experiment. The volume of the municipal waste is kept constant to 400 ml for each experiment. The pH value of both the municipal waste water and the pineapple substrate is recorded using pH meter before the addition of both solutions in the flask. The effects of pH value of the system, fibre to juice (fibre/juice) ratio were performed through the experiments with 44:49 ratio in this batch process experiment. Finally repeat the procedure to get the average result

.3 *Pilot studies*

The total amount of biogas was measured every week in 21 days by recording the displacement of water in the gas container regarding to the amount of water volume displaced by the existing gases. Besides that the pH value of the mixture of municipal waste water and pineapple substrate is also being measured every week.

3. Result and Discussion

The experiment went for 21 days and being observed for every week. The volume of gas produced by the reaction between mixture of pineapple juice and it's fibres with municipal waste are recorded and calculated through reading of the volume displacement in the test tube. The pH values are recorded by pH meter to test the growth of bacteria and the initial pH for every substance used was recorded as stated at Table 1.

Table 1: Initial pH value for the substances

Substance	pH value
Pineapple juice	3.6
Pineapple fibre	3.6
Municipal waste	6.5
Water	6.6

Table 2: pH value of the bioreactor

	pH Value					
	Exp 1		Exp 2		Exp 3	
	1	2	1	2	1	2
Initial	4.1	4.1	4.0	4.0	3.9	3.9
Final	3.4	3.5	3.1	3.0	2.4	2.5

Table 2 shows the pH value of the bioreactor containing municipal waste and substrate at initial and final of the experiment. The experiment was carried out in a lab with room temperature of 25 °C and average pH reading of 4.0. A fluctuation in pH value for each bioreactors indicated that the bacteria in the municipal waste has become less active. Methane-forming bacteria actives within the pH value of 6.8 to 7.2 and the bacteria only active in two temperature ranges, the mesophilic range from 30°C to 35°C and the thermophilic range from 50°C to 60°C (Gerardi, 2003). The pH value of the experiments should in between the range for the bacteria to become active and react for biogas production. A suggestion should be made to increase the alkalinity of the bioreactors to the desired pH alue by adding alkaline substance such as baking soda.

Table 3: Volume Displacement in the test tube

Week	**Volume Displacement**						
	Exp 1		Exp 2		Exp 3		Blank
	1	2	1	2	1	2	
1	Nil	Nil	Nil	Nil	Nil	Nil	Present
2	Nil	Nil	Nil	Nil	Nil	Nil	Present
3	Nil	Nil	Nil	Nil	Nil	Nil	Present

Table 3 shows that there is no change in the reading of the test tube as there is no displacement of water inside of the test tube. There are three possible factors for that to occur; the method of water displacement in the test tube to calculate volume of the biogas produced, and the source of inoculum used.

The blank subject consists of the same substrate as experiment 1 but the inoculum used was replaced with water. The main purpose of the blank is to act as reference to the experiment. In residential of low income in Malaysia, the municipal waste contains 54.04% of organic sources and the rest are mixed paper, newsprint, plastic, diapers, textile, rubber, wood, glass, aluminium and other substances (Badgie, Samah, Manaf, & Muda, 2012). Water is an inorganic compound as it does not come from hydrocarbons. Anaerobic digestion is a process which breaks down organic matter in simpler chemical components without oxygen. This process can be very useful to treat arising organic waste water such as organic farm waste and organic industrial and commercial waste (Fabian Monnet, 2003). The blank showed there was a volume displacement in a reaction between the pineapple waste and the water. Although the water is inorganic, there was a reaction due to the presence of bacteria in the water.

Anaerobic digestion is a process which breaks down organic matter in simpler chemical components without oxygen. This process can be very useful to treat arising organic waste water such as organic farm waste and organic industrial and commercial waste (Monnet, 2003). In the experiment, the inoculum used is not suitable for the reaction of pineapple waste to produce biogas. Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. The production of biogas undergoes without the presence of oxygen and the reaction is through anaerobic digestion (Lausund, 2014). The municipal waste acts as the inoculum source that contains diverse microorganisms such bacteria (Li, Chen, & Yu, 2014). This bacteria function as to break down waste organic material into methane and other gases which can be used to produce electricity or heat in the anaerobic digestion process (Abubakar & Ismail, 2012). In this experiment conducted, it is observe that there is small amount of biogas present in the reactor with zero displacement of water inside the test tube. This is due to the less microbial growth for the digestion process to occur, thus causing less production of biogas (Adsorption, 2007).

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