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THE IMPACT OF BIOSTARTER EM-4 AND BUFFALO FECES ON THE QUALITY OF BIOGAS CREATED FROM SUGARCANE BAGASSE FIBER

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ABSTRACT

Energy is one of the most important needs in life. That's because all human activities require energy to live. New breakthroughs need to be made to overcome the energy crisis, one of which is biogas by utilizing waste. Waste that can be used is sugarcane bagasse and buffalo feces, which have the potential to produce biogas. The purpose of this study was to determine the effect of a mixture of bagasse fiber and buffalo manure with the addition of EM-4 biostarter and without EM-4 biostarter that has the potential to produce biogas. Variations in the composition of AT and buffalo feces in this study were 50%SB: 50%BF, 40%SB:60%BF and 30%SB:70%BF without using the EM-4 biostarter. batch-type digester reactor type. The method used is the experimental method. The results showed that biogas production from the composition of a mixture of bagasse fiber with buffalo feces has an influence. Where the more buffalo feces added, the more gas produced. Then for the biogas production process using EM-4 biostarter and without EM-4 biostarter, it was found that the best in producing gas was using EM-4 biostarter, this was due to the function of biostarter which accelerates biogas fermentation so that the influence on biogas production was to use EM-4 biostarter.

Keywords : Sugarcane Bagasse, Buffalo Feces, Biostarter EM-4, Biogas Quality

1. INTRODUTION

Energy is one of the most significant human needs, and its significance rises directly to the level of life. Fuel oil (BBM) enjoys a very privileged position in meeting the nation's energy needs. Fuel contributes to 52.5% of the nation's entire energy consumption, next to gas (19.04%), coal (21.52%), water (3.73%), geothermal (3.01%), and new energy (0.2%) [1]. Renewable energy started in the 1970s as an alternative to nuclear and fossil energy development. According to Article 1 of Law 30 of 2007 concerning energy, green power is derived from fossil fuels that are high in nature and are not harmful to the environment. Geothermal heat, wind, carbon dioxide, sunlight, air flow, shifting ocean layer temperatures, and other renewable energy sources may all be produced sustainably with expert oversight [2]. Biogas is often used directly for cooking or changed into electricity via a generator [3].

Microorganisms produce biogas, a form of bioenergy, through the anaerobic biological process of fermentation. In general, the gas produced consists of 55–65% CH4, 35–45% CO4, 0–3% N4, and a little quantity of H2S. Biogas is a fuel with a calorific value of about 4500–6300 kcal/m3. The volume of 1 m3 of biogas is equivalent to 0.8 liters of gasoline, 0.52 liters of diesel, 0.62 liters of kerosene, 0.46 kg of LPG, and 3.5 kg of biomass. How much energy is in biogas depends on the amount of methane (CH4) in the package. At 9000

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kcal/m3, the calorific value of CH4 is relatively high. CH4 gas is recognized as an environmentally good raw material due to its capacity to burn completely and lack of smoke, which has a negative impact on air quality [4]. Biogas, as a novel renewable energy, must have standards for biogas production activities. The National Standardization Agency (BSN) had released 7,224 Indonesian National Standards (SNI) as of January 31, 2012. It was found that there is only one SNI related to biogas energy, namely SNI 7639:2011 concerning biogas reactors (biodigesters) that use glass fiber in a fixed dome structure. This standard tells you how to classify fiberglass-based fixed-dome biogas reactors (digesters), what quality standards apply, and how to test them [5]. Solid biomass and biogas waste from the forestry, agriculture, and plantation industries is the first waste with the most potential as compared to rice, corn, cassava, coconut, palm oil, and sugar cane waste. In Indonesia, the potential for solid biomass waste is 49,807.43 MW. In Indonesia, biomass and biogas energy are used to produce about 167.7 MW of electricity from sugar cane waste and 9.26 MW of biogas from the gasification process. Biomass investment costs range from 900 to 1,400 dollars per kilowatt-hour, whereas energy costs are between 75 and 250 dollars per kilowatt-hour [1]. In general, biomass is produced by utilizing organic waste, which can be helpful to the environment, so there is an environmental sanitation process.

The sugar cane bagasse, a a lignocellulosic waste from the sugar industry and agriculture, can be used to generate biogas [6]. Biogas is not only a green energy source, but it may also help in the reduction of environmental waste. Bagasse from the production of saka, or cane sugar, is an example, as is the retailing of unprocessed sugarcane juice. If nothing is taken to utilize this rubbish, it will have a damaging impact on the environment [6]. There are many studies that show bagasse can be used as an a component of a mixture to fill intestines to produce biogas. One instance is the study by [7]. The material was characterized in this study as an agricultural waste rich in element C with a C/N ratio of 150. For the maximum biogas production, it is necessary to gather bagasse during its growth phase in fresh conditions. The less water it has and the more it looks like straw, the less biogas it will create [8]. Because sugarcane bagasse is poorly digested and contains a high amount of lignocellulose, it is not recommended for use as animal feed [7]. Bagasse can be used as a biogas digester filler material. Cleaning up the environment and using trash to generate biogas are two methods to address the problems caused by waste. As microbes perform the anaerobic biological process of fermentation, they generate biogas, which is an example of bioenergy. The gas produced often consists of 55–65% CH4, 35–45% CO4, 0–3% N4, and a little amount of H2S. The calorific value of biogas, which ranges from 4500 to 6300 kcal/m3, is quite high. 0.8 liters of gasoline, 0.52 liters of diesel, 0.62 liters of kerosene, 0.46 kilograms of LPG, and 3.5 kilograms of firewood are all equivalent in volume to 1 m3 of biogas. The quantity of methane (CH4) in biogas affects the amount of energy. CH4 has a rather high calorific value, at 9000 kcal/m3. The capacity to burn completely and the lack of smoke, which reduces air quality, make CH4 gas a well-known environmentally friendly raw resource [4]. Because it is a new renewable energy source, biogas production requires standards. According to the National Standards Organization (BSN), it had 7,224 Indonesian National Standards (SNI) as of January 31, 2012. One SNI, SNI 7639:2011, referring to fixed-dome biogas reactors (also known as biodigesters), which utilize glass fiber, was found to be the only one especially connected to biogas energy out of the total number of SNIs. This standard describes how fiberglass-based fixed-dome biogas reactors (digesters) are classified, held to quality requirements, and tested. Compared to rice, corn, cassava, coconut, palm oil, and sugar cane waste, the first waste with the greatest potential is solid biomass and biogas refuse from the forestry, agricultural, and plantation sectors [5]. There is a potential for 49,807.43 MW of solid biomass waste in Indonesia as a whole. 9.26 MW of biogas is produced during the gasification process, and approximately 167.7 MW of biomass and biogas energy are used in Indonesia. Energy costs for biomass range between IDR 75/kWR and IDR 250/kW, whereas biomass investment costs range between IDR 900/kW and IDR 1,400/kW [1]. In general, organic waste is used to generate biomass, which is beneficial for the environment and necessitates a process of environmental purification.

Beyond sugarcane bagasse, waste from animals can also be used to generate biogas. In research conducted by (Dr. John Bielenberg, 2012), there are several shortcomings of sugarcane bagasse explained as follows, The first one is high Fiber Content: Sugarcane bagasse contains high levels of fiber, particularly cellulose, which is difficult for microorganisms to break down during the fermentation process. This can hinder biogas production because the fiber requires a longer time to decompose. The second one is Low C/N Ratio: Sugarcane bagasse tends to have a low C/N (Carbon/Nitrogen) ratio. This ratio can affect the fermentation process because microorganisms require a balanced proportion of carbon and nitrogen for optimal efficiency.

Due to these shortcomings in biogas production using sugarcane bagasse, it is necessary to add filler materials as mixing materials to accelerate biogas production. One suitable filler material is buffalo dung. Buffalo dung is chosen because it is quite effective in producing methane (CH4).

Making biogas from buffalo excrement, which includes a lot of cellulose, Raw materials in the form of solulose are easier for anaerobic microorganisms to digest [9]. Buffalo feces may be used not only as an essential component for the manufacture of biogas but also as a mixture. Buffalo feces include organic material that can breakdown and produce biological, chemical, and physical pollution problems if not treated appropriately. Inappropriate policies for managing animal excrement can cause environmental problems, diminish the quality of life for farmers and ranchers, and spark social conflict [10]. Buffalo dung may generate as much as 0.023 to 0.040 m^3 in biogas per kg. About 60–70% of the methane gas (CH_4) produced can be burned to produce biogas, which has a calorie content of 252 kcal/0.028 m^3 (1000 BTU/ft^3) [11]. Buffalo feces contain 0.6% nitrogen, 0.3% phosphorus (P_2O_5), 0.38% potassium (K_2O), 85% water, and a C/N ratio of 22.34% [12]. Therefore, buffalo feces are especially suited as a source of biogas production and as a biostarter in the fermentation process because they contain methane gas-producing bacteria found in ruminant stomachs. To accelerate the fermentation process, a mixture, EM-4, is required.

Effective Microorganisms (EM-4) is a mixed culture of beneficial microorganisms. EM4 can stimulate the development and growth of microorganisms; therefore, EM-4 can help speed up the fermentation process in organic materials. EM4 is a liquid that is yellowish brown in color and smells sour. It has a pH of 3.5 and is made up of 90% Lactobacillus sp. bacteria along with three other types of microorganisms that work together [13]. The purpose of this study was to determine the effect of a mixture of bagasse fiber and buffalo manure with the addition of EM-4 biostarter and without EM-4 biostarter to produce biogas. In this study the composition of 50% SB: 50% BF and 40% SB: 60% BF using EM-4 biostarter and without using EM-4 biostarter. Biostarter EM-4 is expected to accelerate fermentation in biogas so that gas is quickly formed. The use of bagasse fiber and cow dung is expected to increase the pressure value of the gas produced. This research was conducted at Padang State University at the Physics Laboratory, Faculty of Mathematics and Natural Sciences. With the title of this research, namely "THE IMPACT OF BIOSTARTER EM-4 AND BUFFALO FECES ON THE QUALITY OF BIOGAS CREATED FROM SUGARCANE BAGASSE FIBER".

2. METHOD

This research was an experimental study. The method in this research was investigative, where the stages of the research implementation include the construction of a biogas reactor, sample preparation, sample creation, addition of the mixture into the reactor, and data collection conducted over a period of 28 days. There were three composition variations utilized in creating SB and BF samples: 50% SB: 50%BF, 40% SB: 60%BF, and 30% SB: 70% BF with and without EM-4 biostarter Effective Microorganisms (EM-4) was a helpful microorganism-mixed culture. EM4 could stimulate the development and growth of microorganisms; therefore, it could accelerate the fermentation of organic materials. EM4 has a yellowish brown look, a foul odor, and a pH of 3.5. It was a liquid containing 90% Lactobacillus sp. bacteria and three other types of microorganisms (photosynthetic bacteria, Streptomyces sp., and yeast), all of which work together to achieve what was needed [13].

The issue addressed in this study is the involvement of the EM-4 biostarter and cow excrement made from bagasse fiber in regard to pH indicators, biogas pressure, and gas temperature. This study employed many items for the building of the digester, including a 30-liter drum, a gas tap stop, silicone glue, gas hose clamps, an electric drill, double-sided tape, scissors, gas hose, a tire valve, a drill bit, a knife, Daimaru paper glue, and gloves. Analytical scales, a tire pressure monitoring system (TPMS), a digital pH meter, a beaker, and a measuring cup were all used for this study's measurements. The used ingredients consist of buffalo waste, sugarcane bagasse fiber, EM-4, and water. A digester is a space built specifically for microbes to break down organic matter anaerobically in order to produce biogas; therefore, digester design must take this into account. In order for the fermentation process to continue optimally and the resulting biogas production to be maximized, the digester must be made airtight. The digester used is shown in Figure 1.

Fig. 1. Digester reactor

Fig. 1. shows the reactor form of a digester. This type of digester is fed in batches, and the filling material is changed for new material when the old material seems to stop producing gas. It is essential to think about the amount of material introduced into the digester reactor. The aggregate mass of the biogas filling material is 5 kg,

along with a water volume of 5 liters. The volumetric ratio between water and the EM4 biostarter is one milliliter of the biostarter per 1 liter of water. The filler consists of sugarcane bagasse fiber and cow dung. Figure 2 shows sugarcane bagasse fiber that is suitable for utilization.

Fig. 2. Sugarcane bagasse fiber

As shown in Fig. 2. the bagasse fiber must first be reduced at the Padang City Agriculture Service. This is done to reduce the size of the bagasse fiber. Cow feces were also collected from subjects in Air Pacah Village, Koto Tangah District, Padang City. The buffalo feces used in the present investigation are of recent date, therefore allowing their integration into bagasse after the mixing procedure. First-hand information is used to get data. Primary data refers to data that is gathered directly from the primary source. The primary data used are initial pH measurements taken when infill material is introduced into the digester and final pH measures taken after biogas fermentation for 30 days, gas temperature measurements, and gas pressure measurements.

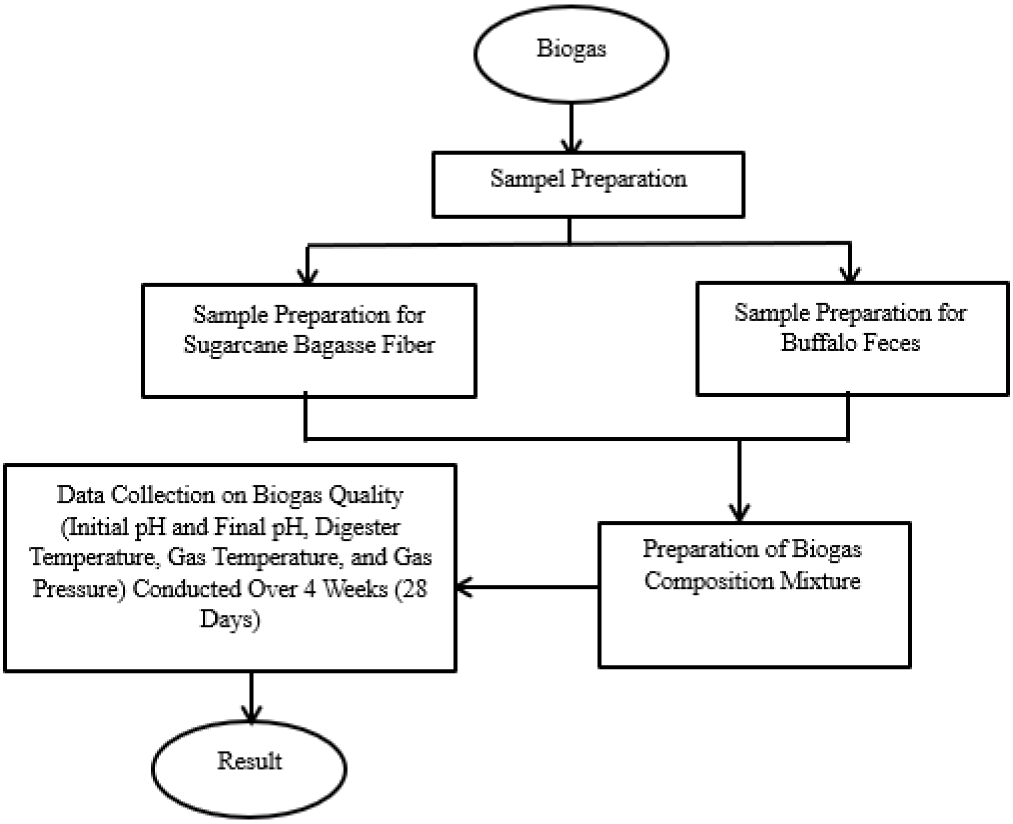


Fig. 3. Stages of Biogas Production Experiment

In fig, 3. represents the stages in biogas production. The biogas production process begins with the preparation of sugarcane bagasse and buffalo feces samples. Next, the stages involve mixing the biogas feedstock into the prepared digester. Once all the feedstock materials are mixed, the initial pH of the feedstock is measured, followed by a fermentation process lasting 28 days. After the fermentation process is completed, data on gas pressure, gas temperature, flame test, and final pH of the feedstock are collected.

3. RESULTS AND DISCUSSION

The sample has been stirred and mixed homogeneously with several variations in the composition of bagasse fiber (SB) and buffalo feces (BF), namely 50%SB: 50%BF, 40%SB: 60%BF and 30%SB: 70%BF using the EM-4 biostarter and without using the EM-4 biostarter.

The pH of the digester filling material was measured twice, once for the starting point pH as well as for the final pH. The initial pH is measured once the infill material has been prepared and is homogeneous. Consequently, the ultimate measurement of pH is obtained at the end of the fermentation process. The degree of acidity (pH) impacts the growth of methane-producing anaerobic microbes. Determine the acidic or alkaline nature of digester material for infill by determining the pH value. The initial pH and ultimate pH values based on various ratios of SB and BF, such as 50% SB: 50% BF, 40% SB: 60% BF, and 30% SB: 70% BF using EM-4 biostarter as well as not using EM biostarter, are shown below in Table 1.

Table 1. Presents the Data. Initial pH and Final pH of SB and BF without Biostarter EM-4 and with Biostarter EM-4.

Compositional V	**Variations**	**Initial pH**	**Final PH**	**Standard Term PH 5-8**
50% SB : 50% BF	Without EM-4	6,74	6,41	Achieved
	With EM-4	7,55	6,26	Achieved
40% SB : 60% BF	Without EM-4	6,72	6,05	Achieved
	With EM-4	6,64	6,56	Achieved
30% SB : 70% BF	Without EM-4	6,54	6,24	Achieved
	With EM-4	7,74	6,45	Achieved

Based on Table 1, the initial as well as concluding pH values of a 50% SB and 50% BF slurry without the EM-4 biostarter are 6.74 and 6.41, respectively. The initial and end pH values with 50% SB and 50% BF using the EM-4 biostarter are 7.55 and 6.26, respectively. Without employing the EM4 biostarter, the beginning and ultimate pH values are 6.72 and 6.05. The initial and greatest pH levels with a composition of 40% SB and 60% BF using the EM-4 biostarter are 6.64 and 6.56, respectively. Without using the EM-4 biostarter, the starting and ultimate pH values are 6.54 and 6.24. With a composition of 30% SB and 70% BF and the EM-4 biostarter, the initial and final pH values are 7.74 and 6.45, respectively. pH plays a crucial role in the anaerobic decomposition process. This is due to the fact that microorganisms are unable to achieve optimal growth or may perish if the pH conditions are not suitable, hence impeding the generation of methane gas. The ideal pH for microbial growth ranges from 6.8 to 7.8. Methanogenic bacteria require a pH range of 6.6 to 7 [12].

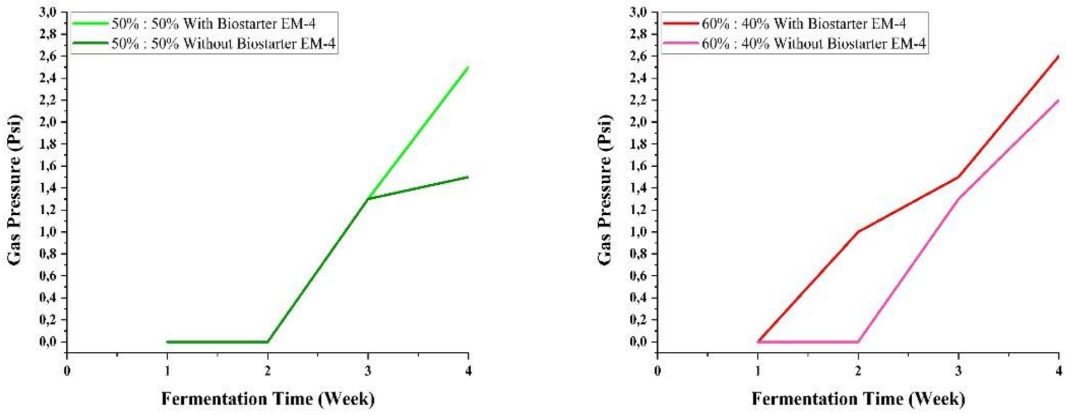
Based on the pH value obtained, it has met the optimum pH for biogas production. This is in accordance with research conducted by [1] which says that the more neutral the pH, the higher the CH4 levels, on the contrary, CO2 levels will be lower. At neutral pH can spur the development of methane bacteria (metanigen) so that at that pH acetic acid remodeling bacteria can grow and multiply optimally, this will have an impact on the production of gas produced.

Gas pressure measurements were obtained throughout Weeks 1, 2, 3, and 4. Using TPMS, gas pressure data was collected. The SB and BF gas pressure values with a composition of 50% SB: 50% BF, 40% SB: 60% BF, and 30% SB: 70% BF using EM-4 biostarter for 28 days are shown in Table 2 below.

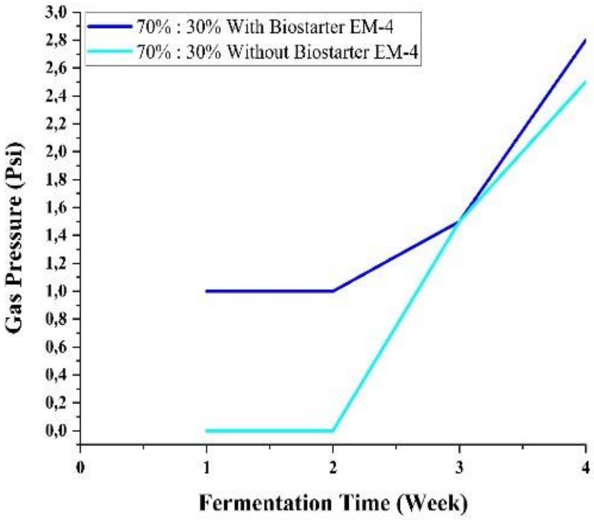
Table 2. SB and BF Pressure Values without the EM-4 Biostarter and with the EM-4 Biostarter

Compositional Variations		Gas Pressure (Psi)			
		Week 1	Week 2	Week 3	Week 4
50%:50%	Without EM-4	0 Psi	1 Psi	1,3 Psi	1,5 Psi
	With EM-4	0 Psi	1 Psi	1,3 Psi	2,5 Psi
40%:60%	Without EM-4	0 Psi	1 Psi	1,3 Psi	2,2 Psi
	With EM-4	1 Psi	1 Psi	1,5 Psi	2,6 Psi
30%:70%	Without EM-4	0 Psi	1 Psi	1,5 Psi	2,5 Psi
	With EM-4	1 Psi	1 Psi	1,5 Psi	2,8 Psi

According to Table 2, gas pressure increases every week. No gas was created in the first week once the composition was changed without the EM-4 biostarter. The table shows that the pressure is 0 psi. Varieties in composition using the EM-4 biostarter produced gas during the first week, with each composition having a gas pressure of 1 psi for the compounds 40%SB: 60%BF and 30%SB: 70%BF. It was discovered in the second week that gas was being produced regardless of composition. The composition of 50% SB and 50% BF creates 1 psi of gas with out the use of the EM-4 biostarter. Meanwhile, the composition 50%SB: 50%BF using the EM4 biostarter produces gas at 1 psi. This phenomenon occurs due to the lack of substantial biogas production during the second week. Without using the EM4 biostarter, the 50%SB:50%BF blend produced 1.3 psi of gas on day 21 of the third week. Meanwhile, a mixture of 50% SB and 50% BF utilizing the EM-4 biostarter creates 1.3 psi of gas. Without using the EM-4 biostarter, 40% SB/60% BF produces 1.3 psi of gas. Using EM-4 biostarter, the composition 40%SB:60%BF produces 1.5 psi of gas. Without using EM-4 biostarter, the composition 30%SB:70%BF generates 1.5 psi of gas. Meanwhile, a mixture of 30% SB and 70% BF utilizing the EM-4 biostarter creates 1.5 psi of gas. The composition of 50%SB and 50%BF without the EM4 biostarter produced 1.5 psi of gas in the fourth week. Using the EM-4 biostarter, the 50%SB:50%BF mixture generates 2.5 psi of gas. Without using EM-4 biostarter, the composition 40%SB:60%BF produces 2.2 psi of gas. Composition 40%SB: 60%BF in EM-4 biostarter yields 2.6 psi of gas. The gas generated by a composition that consists of 30% SB and 70% BF, in the absence of the EM-4 biostarter, is measured to be 2.5 psi. Additionally, 30% SB and 70% BF blended with the EM-4 biostarter create 2.8 psi of gas.



(a) (b)



(c)

Fig. 4. Gas pressure values every week without and with administration biostarter EM-4 (a) Composition: 50% SB, 50% BF (b) Composition: 40% SB: 60% BF (c) Composition: 30% SB: 70% BF.

Fig. 4. (a), (b), and (c) show that the samples that received the EM-4 biostarter created greater gas pressure. As fermentation time progressed, samples containing biostarter EM-4 exhibited a more pronounced rise in gas pressure, indicating that the gas formation process was occurring more rapidly. This means that adding EM-4 biostarter to biogas filling materials might speed up the fermentation process in biogas generators. Compositions containing EM-4 biostarter produced more gas than those that did not contain EM-4 biostarter. An accelerated fermentation process enables enhanced gas generation. From this study, it can be inferred that using the EM-4 biostarter has the potential to increase gas output and speed up the fermentation procedure while also improving the standard of the biogas produced.

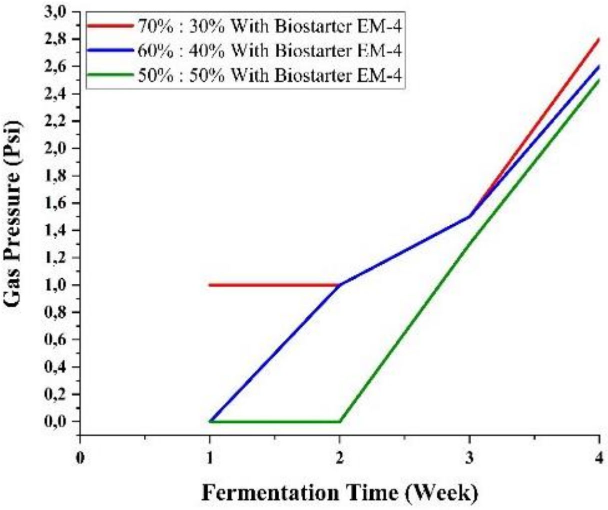


Fig 5. Gas pressure values with the provision of Biostarter EM-4 every week for all compositions

Figure 5 shows that a mixture of 30% sugarcane bagasse (SB) and 70% buffalo feces (BF) creates the highest gas pressure. In contrast, a composite substance comprising equal proportions of sugarcane bagasse and buffalo excrement exhibits the minimum gas pressure value. It is important to realize that the gas pressure values are significantly affected by both the use of EM-4 biostarter and changes in the mass of buffalo feces. The more buffalo excrement utilized as filler material in biogas, the greater the gas pressure value produced.

This suggests that the amount of buffalo excrement in the mixture is crucial to increasing gas generation. Thus, a composition of 30% sugarcane bagasse and 70% buffalo dung with EM-4 biostarter is the ideal choice for producing optimal gas pressure in the biogas production process.

On days 7, 14, 21, and 28, the ambient temperature of the gas was determined using TPMS equipment. Temperature during the biogas fermentation process is critical since it affects the survival of biogas processing bacteria. Temperature measurements are obtained throughout the course of the day. The temperature will decrease during the nighttime hours. The temperature value is additionally impacted by the ambient temperature. Table 3 shows the gas temperature values in samples of bagasse fiber and cow feces with a composition of 50% SB: 50% BF, 40% SB: 60% BF, and 30% SB: 70% BF without and with the EM-4 biostarter for 28 days.

The presence of an influence on increased pressure is associated with a longer duration of fermentation. Based on [1] research that the longer the fermentation process lasts, the higher the pressure produced. This has a relationship in line with the amount of biogas produced, which indicates that the activity of microorganisms is active in breaking down organic matter to produce gas. The pressure will be directly proportional to the production of biogas, if the pressure is higher, the gas produced will also be more.

Table 3.Compares the Temperatures at SB and BF on days 7, 14, 21, and 28 with and without Biostarter EM-4.

Compositional Variations		**Temperatur (C°)**				**Standar Temperatur Optimum Biogas**
		Days 7	**Days 14**	**Days 21**	**Days 28**	
50%:50%	Without EM-4	24	25	25	27	Achieved
	With EM-4	24	25	26	29	Achieved
40%:60%	Without EM-4	24	25	26	28	Achieved
	With EM-4	24	25	26	29	Achieved
30%:70%	Without EM-4	24	25	26	28	Achieved
	With EM-4	24	25	27	30	Achieved

According to Table 3, the gas temperature value obtained in each sample differs. The gas's temperature satisfies biogas temperature requirements. Temperatures range from 24-29 °C in composition variations that do not use the EM-4 biostarter. Composition adjustments utilizing the EM4 biostarter have a temperature range of 24–30 °C. The gas temperature in varied compositions without a biostarter was 24 °C on the seventh day. Meanwhile, the gas temperature for composition adjustments utilizing a biostarter is similarly 24 °C. The gas temperature in varied compositions without a biostarter was 25 °C on the 14th day. Meanwhile, the gas temperature for modifications in composition utilizing a biostarter is 25 °C. The gas temperature in varied compositions without the application of a biostarter was 26 °C on the 21st day. Meanwhile, the gas temperature for various compositions using a biostarter is 26–27 °C. On the 28th day, the gas temperature in varied compositions without a biostarter was 27–28 °C. Meanwhile, the gas temperature for various compositions utilizing a biostarter is 29–30 °C. The temperature in this study is suitable for the biogas generation process. There is no increase in gas pressure concurrent with the temperature increase during the fermentation process. A favorable temperature for the biogas production process is between 20 and 40 °C [14]. Methane-forming bacteria will not form if the temperature is higher than 40 °C or lower than 20 °C. The temperature in this investigation is consistent with previous findings. The optimal temperature for biogas formation is 28–30 °C. The temperature of biogas remains unaffected by the presence of biostarter or the composition of the biogas feed.

The goal of a flame test is to determine the color of the flame in the biogas. The flame test is conducted in order to assess the efficacy of the biogas produced. If the fire that is generated is unscented and is a blue flame color, it suggests the production of biogas includes a great deal of methane gas, but if the color in the flame created is red-orange, it shows CO_2 has become dominant in the biogas production. The user has provided a numerical reference. The colors of the fires in the AT and FS flame experiments with compositions of 50% SB: 50% BF, 40% SB: 60% BF, and 30% SB: 70% BF without the EM-4 biostarter and with the EM-4 biostarter are detailed in Table 3.

Good temperature conditions are one of the things that greatly affect biogas productivity. This is in accordance with research conducted by [1], the ideal temperature will make bacteria will easily develop so that the formation of methane gas will be fast. The temperature ratio in each digester is recorded during the biogas formation process, the temperature measured includes the reaction temperature. If the optimum temperature then the gas produced will be greater.

Table 4. shows SB and BF Flame Tests without and with the EM-4 Biostarter.

Composition Variation		**Color of Fire**
50% SB : 50% BF	Without EM-4	Reddish Blue
	With EM-4	Blue
40% SB : 60% BF	Without EM-4	Reddish Blue
	With EM-4	Blue
30% SB : 70% BF	Without EM-4	Blue
	With EM-4	Blue

Based on Table 4, samples with 50% SB: 50% BF and 40% SB: 60% BF without EM-4 biostarter showed a bluish red flame color. Specimens made using EM-4 biostarter in each composition variation showed a blue flame color. The blue flame color indicates a lot of energy and high frequency resulting in shorter wavelengths, while the bluish-red flame color indicates less energy and low frequency resulting in longer wavelengths. This is in accordance with the results of research conducted [16] which confirms that the blue color of the flame indicates a higher methane content than other gases, so it is in accordance with the results of the flame test that has been carried out. The color of the resulting flame indicates the level of heat of the fire and the content of the material being burned [17].

4. CONCLUSION

The influence of the composition of bagasse fiber and buffalo dung with the addition of EM-4 Biostarter and without EM-4 Biostarter on the quality of biogas is determined by the amount of buffalo dung used. If more buffalo dung is used as a mixing material, then more gas will be produced. This is evidenced by the higher pressure of gas produced as more buffalo dung is mixed with bagasse fiber. Based on the results of biogas production from a mixture of sugarcane bagasse fiber and buffalo excrement with a composition of 50%SB: 50%BF, 40%SB: 60%BF, and 30%SB: 70%BF, it was discovered that the composition is suitable for creating biogas. The composition 30%SB: 70%BF is most suitable for biogas production, followed by 40%SB: 60%BF and finally 50%SB: 50%BF. A comparison was conducted between the utilization of EM4 and the absence of EM4. Most biogas can be made with 30% SB:70% BF, 40% SB:60% BF, or 50% SB:50% BF when using EM4. Then, without employing EM4, the optimal approach to making methane is 30% SB: 70% BF, 40% SB: 60% BF, and 50% SB: 50% BF. According to the findings of this study, the best gas producer is one that uses EM4 with sequential compositions of 30% SB: 70% BF, 40% SB: 60% BF, and 50% SB: 50% BF. The combination of EM-4 biostarter and buffalo dung has the ability to generate enormous amounts of energy for biogas generation. It can be defined by the color of the flame produced, which is blue and is an indicator of high-quality biogas.

REFERENCES

[1] I. Kholiq, “Pemanfaatan Energi Alternatif Sebagai Energi Terbarukan Untuk Mendukung Subtitusi Bbm,” *Curr. Opin. Environ. Sustain.*, vol. 4, no. 1, p. i, 2012, doi: 10.1016/s18773435(12)00021-8.

[2] M. P. dkk Suci Prihatiningtyas, S.Si., Biodigester Untuk Biogas Penulis:, vol. 21, no. 1. 2019. [Online]. Available: http://journal.um-surabaya.ac.id/index.php/JKM/article/view/2203

[3] Zuliyana, “Pengaruh Kadar Air Umpan dan Rasio C/N pada Produksi Biogas dari Sampah Organik Pasar,” vol. 9, 2015.

[4] T. D. Retno L, P. Aplikasi Teknologi Isotop dan Radiasi -BATAN, P. Jumat, and J. Balai

Penelitian Bioteknologi Hasil Perkebunan, “Pemanfaatan Bagase Tebu Dan Limbah Nanas Sebagai Bahan Baku Penghasil Biogas Utilization of Sugarcane Bagasse and Pineapple Waste for Biogas Production,” 2012.

[5] Suminto, D. A. Susanto, and R. Lukiawan, “Kebutuhan Standar dalam mendukung pengembangan sumber energi bari (Biogas) Standards Requirement in Supporting the Development of New Energy Sources (Biogas),” *J. Stand.*, vol. 15, no. February 2019, p. 17, 2013, doi: 10.31153/js.v15i1.654.

[6] D. Aldi Budi Riyanta, “Biogas Kombinasi Ampas Tebu-Kotoran Sapi Sebagai Upaya Konversi Energi Terbarukan,” vol. 6, no. 2, pp. 175–180, 2017.

[7] T. Saputra, S. Triatmojo, and D. A. Pertiwiningrum, “Produksi Biogas Dari Campuran Feses Sapi Dan Ampas Tebu (Bagasse) Dengan Rasio C/N Yang Berbeda Biogas Production From Mixture Of Dairy Manure And Bagasse With Different C/N Ratio,” vol. 34, no. 2, pp. 114– 122, 2010.

[8] M. S.A. and O. B. O., “Evaluation of the Potential use of Bagasse and Sugar Millswaste Water as Substrate for Biogas Production,” *Int. J. Adv. Eng. Res. Sci.*, vol. 5, no. 1, pp. 101–110, 2018, doi: 10.22161/ijaers.5.1.15.

[9] I. P. A. Wiratmana, I. G. K. Sukadana, I. G. Ngurah, P. Tenaya, and L. Belakang, “Terhadap Produksi dan Nilai Kalor Biogas Kotoran Sapi,” vol. 5, no. 1, pp. 22–32, 2012.

[10] S. N. Sirajuddin, S. Nurlaelah, A. Amrawaty, and N. D. S. Saudi, “Tingkat Pencemaran Udara dari Limbah Feces Kerbau Ditinjau dari Persepsi Masyarakat yang Bermukim di Sekitar Pasar Hewan Bolu , Kabupaten Toraja Utara,” *J. Ilmu dan Ind. Peternak.*, vol. 8, no. 2, pp. 163–170, 2022.

[11] T. Haryati, “Biogas : Limbah Peternakan Yang Menjadi Sumber Energi Alternatif,” vol. 16, 2006.

[12] Pernanda, “Nilai Ph, Suhu, Nyala Api Dan Warna Api Biogas Yang Dihasilkan Pada C/N Feses Kerbau Dan Ampas Kelapa Dengan Lama Fermentasi Yang Berbeda,” no. February, p. 6, 2021.

[13] Y. Kurniati, A. Rahmat, B. I. Malianto, D. Nandayani, and W. S. W. Pratiwi, “Review Analisa Kondisi Optimum Dalam Proses Pembuatan Biogas,” *Rekayasa*, vol. 14, no. 2, pp. 272–281, 2021, doi: 10.21107/rekayasa.v14i2.11305.

[14] M. Lubis, “Analisis Potensi Jumlah Pembentukan Gas Metan Dari Limbah Ternak, Limbah Buah-Buahan, Dan Egeng Gondok,” *Nucl. Phys.*, vol. 17, no. 2, pp. 5–16, 2017.

[15] A. S. Lestari, Z. Chaidir, and O. N. Tetra, “Produksi Biogas Dari Limbah Cair Tahu Dengan Menggunakan Starter Kotoran Kuda,” *Kim. FMIPA Unand*, no. 1, pp. 1–5, 2010.

[16] Fairuz, A. 2015. Pengaruh Penambahan Ampas Kelapa Dan Kulit Pisang Terhadap Produksi Biogas Dari Kotoran Sapi. Universitas Lampung.

[17] Wahyu Kurniawan, H., Susi Lestari 2016. Uji Potensi Biogas Dari Limbah Jeroan Ikan Patin (Pangasius Sp.) Dan Campuran Kiambang (Salvinia Molesta) Secara Anaerob Batch. Jurnal Teknologi Hasil Perikanan, Vol.5, No.1:43-51.