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Effect of Raw Material Variations on the C/N Ratio of Biogas Potential Mixtures of Chicken Manure and Water Hyacinth

Pengaruh Variasi Bahan Baku Terhadap Rasio C/N dari Potensi Biogas Campuran Kotoran ayam dan Eceng Gondok

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Abstract

Penelitian ini bertujuan untuk menentukan rasio C/N (karbon/nitrogen) optimal dari campuran kotoran ayam dan eceng gondok dalam proses fermentasi anaerob, serta untuk mengevaluasi potensi produksi biogas dan energi listrik baik dengan penggunaan stater maupun tanpa stater. Dalam eksperimen ini, digunakan campuran 300 kg kotoran ayam dan 200 kg eceng gondok, dengan tambahan 75 kg stater, untuk mencapai rasio C/N yang lebih ideal. Proses fermentasi dilakukan dalam dua skenario: satu dengan stater dan satu tanpa stater, untuk membandingkan hasilnya. Hasil analisis menunjukkan bahwa penggunaan stater secara signifikan meningkatkan volume biogas yang dihasilkan, yaitu sebesar 89,06 m³, dibandingkan dengan 70 m³ yang dihasilkan tanpa stater. Selain itu, potensi energi listrik yang dihasilkan juga meningkat secara signifikan dari 329 kWh tanpa stater menjadi 418 kWh dengan stater. Peningkatan produksi biogas mencapai 27,23% dengan penggunaan stater. Temuan ini menunjukkan bahwa penggunaan stater tidak hanya meningkatkan volume biogas, tetapi juga efisiensi konversi energi, menjadikannya metode yang efektif untuk meningkatkan hasil Fermentasi Anaerob dan mencapai rasio C/N yang lebih ideal, yang pada gilirannya dapat mengoptimalkan produksi energi terbarukan dari bahan organik..

Kata Kunci : Biogas, Kotoran Ayam, Eceng Gondok, Stater, Rasio C/N, Energi Listrik

Abstract

This study aims to determine the optimal C/N (carbon/nitrogen) ratio of a mixture of chicken manure and water hyacinth in the anaerobic fermentation process, as well as to evaluate the potential for biogas and electricity production with and without the use of a starter. In this experiment, a mixture of 300 kg of chicken manure and 200 kg of water hyacinth, with an additional 75 kg of starter, was used to achieve an ideal C/N ratio. The fermentation process was carried out in two scenarios, one with a starter and one without a starter, to compare the results. The analysis results show that the use of a starter significantly increased the volume of Biogas produced, which was 89.06 m³, compared to 70 m³ produced without a starter. In addition, the potential for electricity generation also increases significantly, from 329 kWh without a starter to 418 kWh with a starter. The biogas production increased by 27.23% with the use of a starter. These findings suggest that the use of a starter not only increases the volume of Biogas but also improves energy conversion efficiency, making it an effective method to enhance anaerobic fermentation outcomes and achieve an ideal C/N ratio, which in turn can optimize renewable energy production from organic materials.

Keywords: Biogas, Chicken Manure, Water Hyacinth, Starter, C/N Ratio, Electrical Energy

1. Introduction

Chicken manure waste often causes environmental problems that can disrupt the comfort of life of the community around the farm. The disturbance usually occurs is an unpleasant odour caused by gas from livestock manure, especially ammonia gas and gas hydrogen sulfide. Prevention can be done To reduce environmental pollution by processing livestock waste. Chicken manure waste is generally only used directly as fertilizer or compost by farmers, even though it can also be used to convert into a potential renewable energy source in the form of biogas [1].

Waste from laying hen manure to produce biogas is very widely used. Based on research [2], research was conducted on the influence of variations in the type of faeces on biogas productivity using anaerobic fermentation. This research found that the efficiency of chicken faeces was higher than that of cow faeces at 2.5%, but the efficiency of cow faeces is 1.875%; this study also found that the calorific value of chicken faeces is higher than cow faeces with 30262.96, while the calorific value of cow faeces is 13052.98. Research [3] researched the development of a portable anaerobic biodigester producing biogas, using materials raw waste from laying hen manure produces 61.5 m^3 of methane gas using raw materials 603 kg for one period using a portable anaerobic biodigester with a capacity of 1,200 L with anaerobic fermentation method. The ratio of chicken manure is 10, with the percentage of carbon (C = 18.36%) and the amount (N = 1.70%) which has been studied in the study [4]. The C/N ratio in chicken manure is not ideal because in the formation of biogas, the ideal C/N ratio ranges from 20-30 [5].

With less than optimal biogas in chicken manure, adding organic materials to optimize the biogas results is necessary. Based on research [6] discussing the effect of types of organic waste on biogas production from chicken farm waste biomass materials with anaerobic fermentation methods and obtaining results with raw materials of chicken manure and water hyacinth are good results in mixing with a ratio of 1:1 with a biogas result of 0.6 L after the type of mixing of organic waste can affect the biogas results obtained.

Water hyacinth to be made into biogas is divided into 2, fresh water hyacinth and dry water hyacinth and the composition between fresh and dry water hyacinth is different. Research [7] examined the utilization of water hyacinth as alternative energy using fresh water hyacinth raw materials using an anaerobic fermentation method and obtained a result of 0.059 m^3 with raw materials of 70 kg of water hyacinth and cow dung. Research [8] examining the potential of water hyacinth from Rawapening for Biogas with variations in the mixture of cow dung obtained results with dry water hyacinth raw materials producing 2,119.61 mL of biogas with raw materials of 1 kg of dry water hyacinth and cow dung. With the composition of fresh and dry water hyacinth, by comparing the volume of biogas produced by freshwater, hyacinth is more optimal for the formation of biogas.

Several factors, including the C/N ratio and the starter used influence the mixing of raw materials for the formation of biogas. Based on research [9] with a study of the effect of the C/N ratio on biogas formation, this study uses the Anaerobic Fermentation method and results that the C/N ratio of 20-30 produces ideal biogas in biogas formation. In research [5] with a study of biogas potential by calculating the ideal C/N ratio in biogas production using the Anaerobic Fermentation method and getting the results of the C/N ratio ranging from 20-30 gives the best results compared to other C/N ratio values, this study shows a C/N ratio value of 10, indicating worse biogas results, with the results of CH4 levels at a C/N ratio of 30 of 40%. In research [10] examining the comparison of the potential of cow rumen and cow dung starters in processing faecal sludge into methane gas, this study uses the anaerobic fermentation method; this study gets the results that cow rumen has the potential to produce more methane gas than cow dung starters. In the study [11], this research study examined the concentration of cow rumen starter on biogas from vinasse. This study used the anaerobic fermentation method. This study showed that cow rumen concentration has an important role in producing biogas, with a volume of biogas produced of 370 mL from the best rumen concentration of 15%.

Based on the raw material filling system, digesters are divided into two, namely batch systems and continuous systems. Several studies have conducted experiments using batch and continuous-type digesters. In the study [12], a comparison of batch-type digesters and continuous-type digesters was obtained; the results showed that batch-type digesters were higher in producing biogas volume but lower in CH4 content quality than continuous-type digesters. In the study [13], a study was conducted on biogas production using batch-type digesters in the anaerobic process of coffee processing liquid waste, producing a stable volume of biogas. Because continuous digesters have the risk of air entering the digester when filling raw materials, it is different from the batch type where after the raw materials are entered, the digester will be opened until the biogas production runs out.

The amount of electrical energy that can be produced by biogas depends on the volume of Biogas. Studies on the potential for electrical energy that biogas can produce have been widely studied before. Based on research [14], it was found that biogas produced from all the faeces of 8 livestock commodities totalling 19,183,779 heads on the island of Bali has the potential to produce 246,130.81 m^3 of biogas per day and, if converted into electrical energy of 1.16 GWh/day.

From the problem of chicken manure that is not utilized and made into biogas, chicken manure has a less than ideal C/N ratio in the formation of biogas produced in research [3] [4]. In research [6] with variations of organic waste with raw materials of chicken manure, water hyacinth is an optimal mixture in the formation of biogas in the formation of biogas and then the parameters that need to be considered to optimize biogas results include the calculation of the C/N ratio in its mixing, in research [5] the ideal C/N ratio in the formation of biogas ranges from 20-30. The following parameter is the addition of a starter in the formation of biogas, which is very influential; in research [10], the rumen of cattle is the optimal starter in the formation of biogas for the variation of the rumen of cattle to be added, in research [11] the variation of the rumen starter of cattle that is good in the formation of biogas is 15% of the raw material. The digester used is a batch-type digester because the batch type produces a stable volume of Biogas, which has been studied in research [12].

This study will utilize the mixing of chicken manure and water hyacinth with the addition of cow rumen starter into biogas. This study uses fresh freshwater hyacinth in the formation of biogas, and then This study calculates the C/N ratio. The reason for choosing the calculation of the C/N ratio is because in mixing in the formation of biogas, the C/N ratio affects the biogas produced, calculating the potential of biogas using anaerobic fermentation with the help of superpro designer simulation by varying the mixing of chicken manure and water hyacinth with starter and without starter, the reason for this variation of raw materials is to get the ideal C/N ratio. This study also calculates the potential for electrical energy generated from the potential of biogas, which has a variation of the ideal C/N ratio. This study will also examine the potential for electrical energy generated from mixing chicken manure and water hyacinth with the addition of a starter and without a starter from the ideal C/N ratio. This study aims to obtain the potential of biogas from a mixture of chicken manure and water hyacinth with the addition of cow rumen starter and without starter by varying the raw materials to find the ideal C/N ratio in the formation of biogas using the anaerobic fermentation method with the help of superpro designer simulation. The second objective of this study is to obtain the potential for electrical energy generated from the potential biogas produced.

2. Method

This study examines the utilization of a mixture of chicken manure and water hyacinth by varying the raw materials to find the ideal C/N ratio value and comparing the results of starter and non-starter biogas treatments to optimize the biogas results produced using the superpro designer simulation method. The study began by collecting the content of chicken manure, water hyacinth waste, and starter, then varying the raw materials to obtain the ideal C/N ratio, and then designing the components needed for the simulation of biogas formation. After the components are designed. Then, the calculation of the biogas produced and the potential electrical energy from the biogas produced are carried out.

2.1 Collection Data

The data used in the biogas formation process helps in applying biogas formation simulations. Chicken manure has nutrients and organics consisting of protein, fat, fibre, calcium, phosphorus, BETN, ash, and water. Freshwater hyacinth contains water, ash, crude fibre, carbohydrates, fat, protein, phosphorus, potassium, chloride and alkaloids, and the content of cow rumen consists of protein, fat, fibre, calcium, phosphorus, BETN, ash and water, which are presented in table 1.

Table 1. Contents Dirt Chicken [15], Contents Water hyacinth Fresh Goiter [16], Contents Rumen Cow [17].

Compound	% rate		
	Chicken manure	Water hyacinth	Cow Rumen
Protein	39.09%	0.16%	8.42%
Fat	3.32%	0.35%	2.60%
Fibre	16.50%	2.09%	28.20%
Calcium	2.10%	-	0.53%
Phosphorus	1.44%	0.97%	0.55%
BETN	13.12%	-	30.24%
Ash	14.73%	0.44%	18.54%
Water	9.70%	92.6%	10.92%
Chloride	-	0.26%	-
Carbohydrate	-	0.17%	-
Alkonoid	-	1.44%	-
Calcium	-	1.52%	-
Total	100%	100%	100%

In finding biogas potential, it is necessary to calculate the C/N ratio of the raw materials used by varying them to find the ideal C/N ratio for biogas formation. The data used is the variation of the raw materials used.

Table 2. Material Variations Baku is used For Formation Biogas Without Starter and addition of starter

Chicken manure	Water hyacinth	Cow Rumen
100 Kg	100 Kg	15%
100 Kg	200 Kg	15%
100 Kg	300 Kg	15%
200 Kg	100 Kg	15%
200 Kg	300 Kg	15%
300 Kg	100 Kg	15%
300 Kg	200 Kg	15%

Table 2 is the raw material used by varying the raw material composition to produce biogas. The first column shows the amount of chicken manure used, the second column shows the amount of water hyacinth used, and the third column with the addition of a 15% cow rumen starter. Moreover, the third column is the cow rumen starter, which will be added by as much as 15%. Based on research [11] the addition of 15% can optimize the biogas produced. The first purpose of varying these raw materials is to determine the ideal C/N ratio to produce optimal biogas and analyze the effect of variations in the composition of raw materials on the C/N ratio. Moreover, the second purpose of adding this starter is to optimize the biogas results and determine the ideal C/N ratio from variations in the composition of raw materials to produce optimal biogas and analyze the effect of the starter from varying the composition of raw materials on the volume of Biogas produced.

Table 3. C/N Ratio of Raw Materials

Compound	Organic C (%)	N Total (%)	C/N ratio
Chicken manure	18.36%	1.70%	10.8
Water hyacinth	18.56%	0.53%	35.0
Cow Rumen	7.1%	0.3%	23

Table 3 shows the C/N ratio of raw materials; chicken manure has an organic C of 18.36% and a total N of 1.70% with a C/N ratio of 10.8 [4]. Then, in water hyacinth, there is an organic C of 21.23% and a total N of 0.28% with a C/N ratio of 75.82 [18]. Moreover, organic C in the cow rumen is 34.7% and 0.91%, with a C/N ratio 38.1 [19]. After obtaining organic C and total N, the next step is to calculate the C/N ratio of the mixture of chicken manure and water hyacinth with the addition of a cow rumen starter.

2.2 C/N Ratio Calculation

Theoretically, the ideal C/N ratio for biogas formation is around 20-30, meaning that for every 1 gram of nitrogen, 20 to 30 grams of carbon are needed to produce optimal biogas [4].

After knowing the total organic C and N content and varying the raw materials used, the next step, before carrying out the biogas formation process, is to calculate the C/N ratio so that the biogas produced is maximized by using equation 1 as follows [20].

$$Rasio\,\frac{C}{N} = \frac{(K(KS) \times C(KS)) + (K(EG) \times C(EG)) + (K(RS) \times C(RS))}{(K(KS) \times N(KS)) + (K(EG) \times N(EG)) + (K(RS) \times N(RS))} \quad (1)$$

Description:

K = Portion of Substrate component (%)
C = Carbon content in the substrate
N = Nitrogen content in the substrate
KS = Chicken manure
EG = Water hyacinth
RS = Cow rumen

The next step is to calculate the biogas potential after calculating the C/N ratio with the addition of 15% cow rumen and without a cow rumen starter.

2.3 Biogas Potential Calculation

Hydrolysis is the process of decomposing complex biomass into simple glucose. Acidogenesis is the process of breaking down monomers and oligomers into acetic acid, CO2, short-chain fatty acids, and alcohol. Acetogenesis is acetic acid, CO_2, and H_2, while methanogenesis is the change of compounds into methane gas carried out by methanogenic bacteria [21]. The reaction process to process a mixture of chicken manure and water hyacinth with the addition of cow rumen starter into methane gas and carbon dioxide is shown in Table 5.

1. Biogas Production Flow from a Mixture of Chicken Manure and Water Hyacinth Using a Starter and Without a Starter Superpro Software.

The biogas potential from mixing chicken manure and water hyacinth with and without a starter was determined using the Anaerobic Fermentation method. This method produces biogas with a high methane content and can use various types of organic materials to maximize their use as a renewable energy source and environmentally friendly waste processing solution [22].

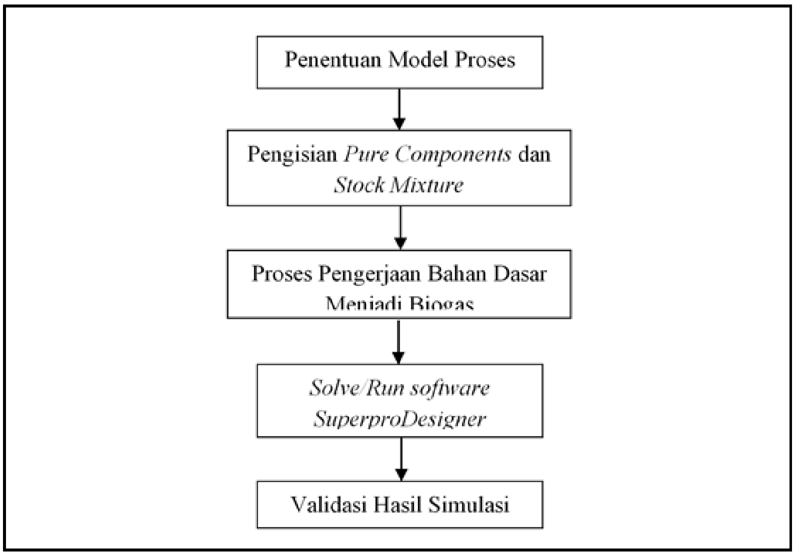


Figure 1. Biogas Production Circuit from Chicken Manure and Water Hyacinth with *Superpro Software.*

2. Process Mode Determination

Simulating Software Superpro uses the batch process with a duration according to the Superpro Software recommendation, namely 336 days. The reason for choosing the batch process is because the batch-type digester produces higher biogas volume [12]. The procedure unit used is fermentation using Anaerobic Digestion.

3. Pure Components and Stock Mixture Filling

The components are pure components, or Pure Compounds, which are compounds that react during the simulation. These components consist of chicken manure, water hyacinth, and starter content, as shown in Tables 1, 2, and 3.

4. Process of processing raw materials into biogas

In this procedure, raw materials in the Anaerobic Digester are prepared and processed. This procedure will produce methane and CO_2 through a chemical process assisted by bacteria, including hydrolysis, acidogenesis, acetogenesis, and methanogenesis. Biogas processing from a mixture of chicken manure and water hyacinth requires Anaerobic Digester components. The output of this process is a mixture of chicken manure and water hyacinth. The final product is biogas, which consists of methane gas and carbon dioxide. The raw materials for biogas are listed in Table 2. In this process, two procedural units are used, as shown in Table 4.

Table 4. Unit Procedure used

Procedure Unit	Process Input	Process Output
Mixing is a process of mixing ingredients so that they can combine into a homogeneous, uniform mixture.	The input used in this process is chicken manure, water hyacinth, and cow rumen, with contentas in Tables 1, 2, and 3. The raw materials used in the mixing process are in Tables 4 and 5.	The output of this process is chicken manure waste mixed with water hyacinth and cow rumen.
An anaerobic digester is a closed fermentation process that produces biogas without free oxygen.	In this process, the output from *mixing is inputted* in the form of chicken manure mixed with water hyacinth and cow rumen.	The output produced from this process is biogas, which contains methane gas and carbon. dioxide

In the Anaerobic Digester using the Anaerobic Fermentation method, 13 reaction processes occur to process raw materials into methane gas and carbon dioxide, as presented in Table 5.

Table 5. Reaction, Which Needed A Reactor Anaerobic Digester To Produce Biogas [17].

The reaction that occurs	Reactants		Products	
	Component	Mass Coef	Component	Mass Coef
Hydrolysis Carbohydrate	Carbohydrates Water	147.6 147.6	Glucose	295.2
Hydrolysis Fat	Fat	147.6	Glycerin Oleic Acid	36.8 110.7
Hydrolysis Protein	Proteins	147.6	Cystine	147.6
Acidogenesis Cystine	Cystine	164,1678	Lactic Acid Propionic Acid	90,0878 74.08
Acidogenesis Oleic Acid	Oleic Acid	0.6875	Acetic Acid Butyric Acid Ethyl Alcohol	1 1 1
Acidogenesis Glucose	Glucose	106,122	Acetic Acid Ethyl Alcohol	60,053 46,069
Acidogenesis Glycerin	Glycerin	0.8044	Propionic Acid	1
AcetogenesisEthyl Alcohol	Ethyl Alcohol	62,0729	Acetic Acid Hydrogen	60,053 2,0199
Acetogenesis Lactic Aci	Lactic Acid	90,0788	Acetic Acid Carbon Dioxide Hydrogen	60,053 28,0098 2,016
Acetogenesis Butyric Acid	Butyric Acid	88,106	Acetic Acid Carbon Dioxide	60,053 28,053
Acetogenesis PropionicAcid	Propionic Acid	74.08	Acetic Acid Carbon Dioxide Hydrogen	60,053 12,011 2,016
Methanogenesis Acetic Acid	Acetic Acid	60,053	Carbon Dioxide Methane	30 30,053
MethanogenesisCarbonDioxide	Carbon Dioxide Hydrogen	1 1	Methane Water	1.74 1

Table 5 Reactions needed by reactor anaerobic digester in produce biogas contains 13 reactions required from mixing chicken manure and water hyacinth and cow rumen starter, including carbohydrate hydrolysis, fat hydrolysis, protein hydrolysis, Acidogenesis cystine, acidogenesis Oleic Acid, Acidogenesis Glucose, Acidogenesis Glycerol, Acetogenesis Ethyl Alcohol, Acetogenesis Lactic Acid, Acetogenesis Butyric Acid, Acetogenesis PropionicAcid, Methanogenesis Acetic Acid, Methanogenesis Carbon Dioxide.

2.4 Simulation Validation

Validation, which was done on the study. This is to compare with study [3], which discusses the use of chicken manure to make biogas using the anaerobic fermentation method.

Table 6. Validation Results Simulation

Parameter	Research [3]	Validation
Raw material	Chicken manure	Chicken manure
Composition	Protein 39.09%, Fat 3.32%, fiber 16.50%, Calcium 2.10%, Phosphorus 1.44%, BETN 13.12%, Ash 14.73%, Water 9.70%	Protein 39.09%, Fat 3.32%, fiber 16.50%, Calcium 2.10%, Phosphorus 1.44%, BETN 13.12%, Ash 14.73%, Water 9.70%
Input Value	603 Kg	603 Kg
Output Value	61.5 m^3	63.91 m^3

Table 6 obtained validation of simulation results that refer to in research [3] with input 603 kg of raw material Chicken manure. The results of the superpro simulation in the reference study produced biogas with a volume of 63.91 m^3, and the results of the reference research produced biogas at 61.5 m^3. From the results of the comparative validation volume, It is known that the error value of the biogas occurred at 3.92%. This study can be said to be valid because it does not have an error value of more than 10%.

2.5 Biogas Conversion and Its Uses

The calculation of electrical energy that can be produced by biogas is available in Table 7.

Table 7. C/N Ratio of Raw Materials [14].

Its use	1 m^3 Biogas
Lighting	60 100 W lamp for 6 hours
Cook	Cooking 3 types of food for 5-6 people
Power	Running a 1 hp motor for 2 hours
Electricity	4.7 kWh of electrical energy

.

The potential for biogas produced by mixing chicken manure and water hyacinth and adding a starter to produce electrical energy is generated using equation 2.

$$Q = P \times \mathrm{L} \quad (2)$$

Description:

Q = Electrical Energy (kWh)
P = Biogas Potential (m^3)
L = Electricity In 1 m^3 (kWh)

In Equation 2, the electrical energy generated from the biogas potential is calculated using the following parameters: Q is the electrical energy generated, P is the biogas potential, and L is the electrical energy generated from 1 m^3 of biogas. It is known that 1 m^3 of biogas generates 4.7 kWh of electrical energy.

3. Analysis And Discussion

variations of raw materials used using equation (1).

Table 8. C/N Ratio Results From Raw Material Variations Without Starter

Chicken manure	Water hyacinth	C/N ratio
100 Kg	100 Kg	32
100 Kg	200 Kg	33
100KG	300 Kg	34
200 Kg	100 Kg	30.13
200 Kg	300 Kg	33.06
300 Kg	100 Kg	28.51
300 Kg	200 Kg	31.1

Table 8 shows the results of the C/N ratio with variations in raw materials. In raw materials, 300 kg of chicken manure and 100 kg of water hyacinth produced an ideal C/N ratio with a C/N ratio of 28.52, this ratio is ideal compared to other variations. Based on research [5] the ideal C/N ratio ranges from 20-30. This study produced a variety of C/N ratios, and it can be concluded that the influence of the composition of the raw materials used can affect the resulting C/N ratio.

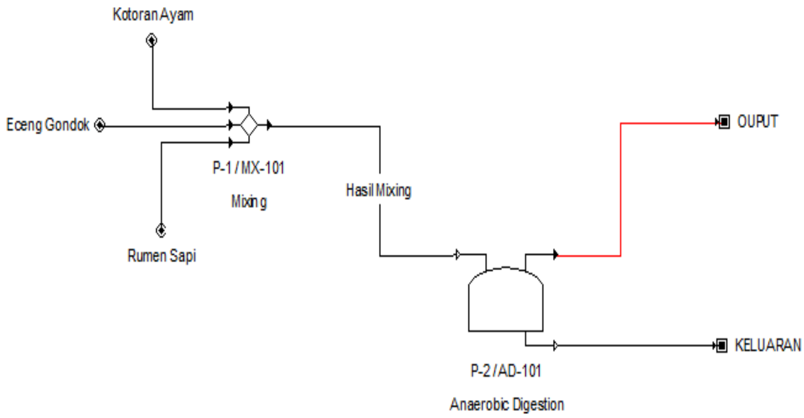
Table 9. Results of C/N Ratio of Raw Material Variations with Starter Addition

Chicken manure	Water hyacinth	Cow Rumen	C/N ratio
100 Kg	100 Kg	30 Kg	31
100 Kg	200 Kg	45 Kg	32
100 Kg	300 Kg	60 Kg	33
200 Kg	100 Kg	45 Kg	29
200 Kg	300 Kg	75 Kg	32
300 Kg	100 Kg	60 Kg	27
300 Kg	200 Kg	75 Kg	30

Table 9 the results of the C/N ratio of the raw material variations with the addition of starter. Table 11 there are three variations that have an ideal C/N ratio in the formation of biogas and show that the variation of the mixture of 300 Kg of chicken manure and 200 Kg with the addition of 15% with a C/N ratio of 30, a variation of 300 Kg of chicken manure and 100 Kg of water hyacinth with the addition of 15% cow rumen starter with a C/N ratio of 27.17. And a variation of 200 Kg of chicken manure and 100 Kg of water hyacinth gets a C/N ratio of 29. The three variations of raw materials, with the addition of cow rumen as a starter, show three ideal C/N ratios. Based on research [5], the ideal C/N ratio ranges from 20-30. The variation of the C/N ratio produced in this study was due to the influence of variations in the composition of raw materials affecting the resulting C/N ratio.

The C/N ratio without starter, the amount of raw material used is 3:1 to obtain the ideal C/N ratio, but to use the ideal C/N ratio starter for biogas formation, the amount of raw material used is 3:2, 2:1 and 3:1 with the addition of 15% starter. This can be concluded by adding a rumen starter, cows have three variations of raw materials with an ideal C/N ratio in biogas formation.

3.1 Biogas Potential from a Mixture of Chicken Manure and Water Hyacinth with the Addition of Cow Rumen



Picture 2. Single Line Diagram Anaerobic Fermentation Process Simulation *Superpro Designer*

Figure 2 is a single-line diagram *of* the anaerobic fermentation process of the superpro designer simulation . The reactor arrangement used in this simulation is shown in figure 2. The anaerobic fermentation process uses 2 procedure units, namely mixing and anaerobic digester. The first flow of chicken manure and, water hyacinth waste, and cow rumen starter with varying compositions are entered into the mixing section to be mixed; then the mixing output flows to the Anaerobic Digester input section.

Table 10. Biogas Results From Variations of Raw Materials Without Starter

Chicken manure	Water hyacinth	C/N ratio	Biogas Results
100 Kg	100 Kg	32	24 m^3
100 Kg	200 Kg	33	24.5 m^3
100KG	300 Kg	34	25 m^3
200 Kg	100 Kg	30.13	47 m^3
200 Kg	300 Kg	33.06	48 m^3
300 Kg	100 Kg	28.51	70 m^3
300 Kg	200 Kg	31.1	69 m^3

Table 10 is the result of the C/N ratio of the raw materials used for biogas formation, showing the volume of biogas produced varies between 24 m³ to 70 m³. The variation of raw materials that has the highest volume with a biogas amount of 70 m³ is due to the C/N ratio being the ideal C/N ratio, with methane gas produced of 88.54% and carbon dioxide of 11.45 obtained from 300 kg of chicken manure and 100 kg of water hyacinth, this variation of raw materials has a high biogas volume compared to other variations because this variation of raw materials has an ideal C/N ratio with a ratio of 28.51 compared to other variations of raw materials. based on research [5] the ideal ratio is at 20-30 compared to other variations of raw materials.

From the results of the volume of Biogas produced, this study produced higher biogas compared to the study [3] which was able to produce 61.5 m^3 of biogas with 603 kg of raw materials. This is because this study added water hyacinth composition in the formation of biogas to optimize the biogas results obtained.

Table 11. Results of C/N Ratio of Raw Material Variations with Starter Addition

Chicken manure	Water hyacinth	Cow Rumen	C/N ratio	Biogas Results
100 Kg	100 Kg	30 Kg	31	31.05 m^3
100 Kg	200 Kg	45 Kg	32	35.01 m^3
100KG	300 Kg	60 Kg	33	39.14 m^3
200 Kg	100 Kg	45 Kg	29	58 m^3
200 Kg	300 Kg	75 Kg	32	66.16 m^3
300 Kg	100 Kg	30 Kg	27	84.94 m^3
300 Kg	200 Kg	75 Kg	30	89.06 m^3

Table 11 is the biogas result from the raw materials used with the addition of starter, this table shows that the ideal ratio is C/N 30, C/N ratio 27 and C/N ratio 29, which is obtained from mixing 300 kg of chicken manure and 200 kg of water hyacinth with 75 kg of cow rumen, mixing 300 kg of chicken manure and 100 kg of water hyacinth with 60 kg of cow rumen and mixing 300 kg of chicken manure and 100 kg of chicken manure with 60 kg of cow rumen, these three variations of raw materials produce the highest biogas results and methane levels, this is because the variation of these raw materials shows that the C/N ratio is in the range of 20-30.

From the simulation results using Superopro Software by Mixing Chicken Manure and Water Hyacinth with the Addition of Cow Rumen Starter with input of 300 kg of chicken manure, 200 kg of water hyacinth and 75 kg of cow rumen starter, it can produce the highest volume of other raw material variations with a volumetric flow of 89.06 m^3 With a mass composition of 88.40 % gas methan And 11.59 % carbon dioxide. or methane gas produced as much as 78.72 m^3 and Carbon Dioxide as much as 10.322 m^3 .

Then it can be concluded that from the results of the addition of cow rumen starter, the volume of Biogas produced is higher than without a starter with a percentage increase in biogas yield of 27.23%, this occurs because the cow rumen contains various microorganisms, including methanogenic bacteria that play an important role in biogas production. Cow rumen starter is rich in these microorganisms, so adding it to the Biogas raw material can increase the volume of Biogas produced.

3.2 Potential Energy Electricity From Biogas Conversion

The calculation to find the amount of electrical energy that can be produced by biogas from chicken manure and water hyacinth using a starter and without a starter is carried out using equation 2. The electrical energy produced is presented in table 12.

Table 12. Potential of Electrical Energy

Treatment	Electrical Energy
Without Stater	329 kWh
Stater Addition	418 kWh

Suppose the electrical energy that can be produced by the starter addition treatment is 418 kWh, while the electrical energy produced by the treatment without a starter is 329 kWh. The production of biogas volume greatly affects the electrical energy produced, so from this study, it was found that adding a starter in the mixture of chicken manure and water hyacinth has a large electrical energy compared to without a starter in the formation of biogas. With a capacity of 418 kWh, biogas from mixing chicken manure with water hyacinth with the addition of a starter can be used as a renewable energy source.

4. Conclusion

From the results the research conducted, it resulted in biogas production in a digester without a starter with an ideal C/N ratio variation of 28 and the highest biogas yield was 70 m^3 and electrical energy of 329 kWh, while biogas production in a digester with the addition of a starter with an ideal C/N ratio variation of 30 and the highest biogas yield was 89.06 m^3 and electrical energy of 418 kWh. The increase in biogas production using a starter and without a starter was 27.23%. The effect of variations in raw materials on the C/N ratio for biogas formation greatly influences the formation of biogas produced if the C/N ratio is not ideal, then the formation of biogas is not optimal. The potential for biogas and electrical energy from a mixture of chicken manure and water hyacinth with the addition of a cow rumen starter is higher than without using a starter.

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