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Utilization of Blood Meal, Slaughterhouse Waste and Bio Gas Slurry into Fertilizer

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Abstract. In slaughterhouses the burden of waste such as excessive blood volume causes waste process with sewage treatment pond cannot work optimally. Blood should be separated and processed into other products such as blood meal. This study aims to prove that addition of blood meal produces good quality organic fertilizer. In this research, the fermentor used in the composting process was biogas slurry. The study used CRD (Complete Randomized Design) with 4 treatments: without blood meal; blood meal 6.5%; blood meal 13% and blood meal 19.5%. There was no difference between the treatments at fertilizer temperature, pH and C/N except treatment 19.5% blood meal on C/N. Application of blood meal by 19.5% in the fourth week on C/N was 12.17 as a requirement for mature fertilizer. The treatment by adding 375 g blood meal on 6 kg livestock feces and 6 kg feed leftover while use biogas slurry as the fermentor was a novel organic fertilizer formula.

Keywords: blood meal, C/N, organic fertilizer, slaughterhouse waste, slurry

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1. Introduction

In 2019, the number of cattle slaughtering in North Sumatra Province was 104,480 or an average of 286 heads every day. These cattle slaughtered in the Mabar slaughterhouse which is located in Medan city plus slaughterhouses in other cities and in the district which managed by the government of North Sumatra Province. The number was lower than reality because there were cattle slaughtered at small slaughterhouses organized by the community [1].

A high number of cuts, for example in the Mabar slaughterhouse causing the initial waste to have a very high concentration of pollutants and a sewage treatment pond which contains with microbial slurry has to use to decompose the initial waste [2]. In reality, in the Mabar slaughterhouse the sewage treatment pond is not work. This usually is occurred because microbial activity of the slurry decreased as excessive waste load, such as excessive blood volume flow into treatment pond. The contents of blood is no longer appropriate when treated using the sewage treatment pond and another alternative is to process become blood meal.

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According to [3] one of the main fertilizers allowed to be used in organic farming was blood meal.

At the slaughterhouse, blood rot causes odors that cause social problems in the slaughterhouse environment. Although in some areas some of the blood is used for local culinary such as in the Mabar, Medan, but the utilization of this blood is not that many, so more blood is left and discarded. [4] stated that blood from slaughterhouses located outside of urban areas should be recycled into organic fertilizer and used for fertilizing horticultural crops. [5] stated that in Korea the cost of removing blood slaughtered animals was very expensive so it was better to be processed into organic fertilizer/compost.

Blood is a bioactivator in making compost due to its high N content. In making compost with the help of microorganisms, with the proper addition of N will stimulate the proliferation of microorganisms, which in turn will help increase the acceleration of fertilizer decomposition and improve the quality of the fertilizer. In addition, blood contains elements of good P and K so that the addition of blood to compost will ultimately increase the content of the elements N, P and K in the fertilizer made. The content of N, P and K blood meal according to the standards of the Ministry of Agriculture is 13%, 2% and 1% respectively [6]. Referring to the benefits of bloodmeal than if it is allowed to have an impact on the environment, this study tries to make treatments used blood meal.The objectives of this study was to prove treatments by using blood meal on making compost will caused good quality of compost.

In composting process, biological decomposition activities occur predominantly in the aerobic environment. Decomposition is carried out by microbial decomposers namely bacteria, fungi and other microorganisms under controlled conditions [7]. In composting, control on physical, chemical and biological factors are carried out so that the fermentation takes place faster and to get good quality compost and to avoid odor problems. The odor can arise when the composting anaerobic reaction occurs, for example because the humidity is too high so there is a lack of O2 supply [8] [9].

Biogas slurry has not yet been used as a fermentor in making fertilizer. Biogas slurry was used as fermentor in this research and the slurry comes from rumen contents biogas input originating from slaughterhouses. Slurry is rich in microbes and this relates to the fact that the rumen is part of the digestive system of cattle which is rich in microbes [10]. By [11] states that the population of rumen-filled bacteria is very large, namely 109 - 1012 chopped cells/ml of rumen contents. The main species of bacteria in rumen contents are Cellulose digesters include Ruminococcus albus, R. falvefasiens, Bacateriodes succinogenes, Butyrivibrio fibrosolvens, Clostrodium lockheadii.

Biogas slurry has undergone anaerobic fermentation so that it can be composted and directly used to fertilize plants. [12] found that the addition of slurry dose to Turi fertilization correlated with increasing microbial population in Turi roots (Sesbania grandiflora) and caused higher total plant height, total leaf, stem diameter, number of branches and leaf size. Research conducted by [13] shows that biogas slurry is rich in macro elements, namely N, P and K and micro elements such as Ca, Mg, Fe, Mn, Cu and Zn.

[14] stated that microorganisms act as inoculating agents because they are able to function themselves in a new process such as from slurry then to function themselves in the composting process. Likewise, microorganisms that have multiplied in a compost heap, if taken part of the compost heap, existing microorganisms will be able to reproduce again if transferred to a new compost heap. There are several main factors that determine the success of composting, including microorganisms that are used to help accelerate the process of decomposition of organic matter.

2. Materials and Methods

2.1. Materials

2.1.1. Compost basket and waste loading

16 compost baskets was designed from bamboo to have enough air space. Waste loading were cow feces, leftover feed/leaves and corn stalks, blood meal and as fermentor was biogas slurry.

2.2. Methods

The study was conducted using a completely randomized design and there were 4 levels of blood meal. Cow's blood has been cooked with biogas, then dried naturally and mashed into blood meal.

The level of blood meal in the study were P_0: without blood meal; P_1: addition of 125 g blood meal (6,5%); P_2: addition of 250 g blood meal (13%); P_3: addition of 375 g blood meal (19,5%). The level of addition of blood meal were adjusted to the provisions of the C/N ratio of compost making. The parameters observed were pH of compost, temperature and C/N ratio.

2.3. Research Implementation

In this study, as raw material was livestock feces and leftover feed. At the slaughterhouse where research material/feces were taken, the forage was 60 days old corn waste, which was then choppered. The remainder of the feed consists of pieces of corn leaves and corn stalks where the leftover feed was usually thrown around livestock cage.

Before conducting a blood utilization study, a preliminary study was conducted to determine the presence of microorganisms in the slurry biogas. Biogas slurry was taken from biogas outlet, then filtered using a muslin cloth and put into a plastic container.

Then put 1 kg of brown sugar for every 50 liters of biogas slurry which is expected to stimulate the microorganisms. Previously brown sugar had been thinly sliced so that it was quickly mixed evenly with slurry biogas. The hole of plastic container covered with plastic. Observations were made and the observations showed that the plastic cover was bulging, meaning that CO2 was formed as a result of the utilization of sugar by microorganisms. From these results it can be concluded that in the biogas slurry, there are still strains of active microorganisms and these strains have facultative properties. Furthermore, if biogas slurry has been proven to contain active microorganisms, then the research materials were prepared in the form of feces, leftover food and blood meal.

Table 1. The Research Treatment of Compost Fertilizer Quality by Bioactivating Blood Meal Treatment of Slaughterhouse Waste and Biogas Fermentor Slurry

Treatments	Amount of material	Ratio of C/N
P0	6 kg feces, 6 kg leftover feed without blood meal	33.80
P1	6 kg feces, 6 kg leftover feed with125 gr blood meal	31.85
P2	6 kg feces, 6 kg leftover feed with250 gr blood meal	27.20
P3	6 kg feces, 6 kg leftover feed with375 gr blood meal	24.90

Table 1 shows the amount and type of research material and the calculated C/N ratio. Calculation of C/N ratio was carried out on the content of C and N materials that have been analyzed at the Central Laboratory, Faculty of Agriculture, University of Sumatra Utara.

For each treatment all ingredients were mixed, watered with biogas slurry. Watering was carried out using a sheet up to about 60% wetness while stepping up so that all the ingredients were mixed evenly with biogas slurry. When all the ingredients had been mixed, the ingredients were put into a compost basket and stored in a room so as not to be exposed to sun and rain. The height of the pile of material was 30 cm to achieve good aeration and compacting does not occur in the pile of material [15]. Data is collected weekly from the first week to the fourth week. Data taken in the form of data pH, temperature and C/N ratio.

3. Result and Discussion

The results of the study were obtained through observation for 4 weeks.

3.1. pH of fertilizer by bioactivating blood meal and biogas fermentor slurry on slaughterhouse waste

Table 2 were data on the average pH of fertilizer by bioactivating blood meal and biogas fermentor slurry. Based on the results of the study it showed that the average pH of compost was 9.23, with the highest average in the control treatment of 9.5 while the lowest average in the treatment of P2 was 9.08.To see the effect of the treatments, analysis of variance was done and the results was that the treatment has an insignificant different effect on pH of the fertilizer. This means that the addition of blood does not have a different effect on pH.

Table 2. Average pH of Fertilizer by Bioacting Blood Meal of and Biogas Fermentor Slurry

Treatments	Repetion (weeks)				Average
	1	2	3	4	
Control	9,3	9,3	9,4	10,0	9,50[a]
P1	8,2	8,7	9,6	10,3	9,20[a]
P2	8,3	8,9	9,0	10,1	9,08[a]
P3	7,8	8,9	9,9	9,9	9,13[a]

In a study conducted by [15] on cattle feces where data were collected weekly, pH range was at 6.9 - 9.3. This pH value was the same as the pH value in this study. There was a tendency to increase the pH was likely due to the degradation of organic acid bonds. Subsequently by [15] also said that at the end of composting, high pH will be caused by the buffering effect of bicarbonate. Compost that has a high pH can be recomposed by adding materials that have a low pH level, and the results will be even better because it will inhibit NH_3 volatilization during the composting process.

3.2. Temperatureof fertilizer by bioactivating blood meal of slaughterhouse waste and biogas fermentor slurry.

Table 3 were data on the average compost temperature during the study. The temperature of compost fluctuates due to the working pattern of microorganisms.

Table 3. Average Temperature (°C) of Fertilizer by Bioacting Blood Meal of Slaughterhouse Waste and Biogas Fermentor Slurry

Treatments	Repetition (weeks)				Average
	1	2	3	4	
Control	35.25	33.14	31.29	30.14	32.46[a]
P1	35.75	33.00	31.57	31.00	32.83[a]
P2	37.00	33.57	31.29	30.29	33.04[a]
P3	36.50	33.71	31.57	30.71	33.13[a]

Based on the results of the study it can be seen that the average compost temperature is 32.86 °C, with the highest average compost temperature in the P3 treatment at 33.13 °C while the lowest average compost temperature in the control treatment was 32.46 °C. To see the effect of the treatment, analysis of variance was done. Of the four treatments, there were no significant changes. This was likely because the ingredients for all treatments are the same. The only difference was the level of blood meal administration and in totality the initial C/N ratio for all treatments is within a normal range. According to [2] in general, the compost process consists of 2 phases, namely the biooxidative phase and the maturation or curing phase. The biooxidative phase is divided into 3 phases:

1) The mesophilic phase lasts between 1 to 3 days. In this phase mesophilic bacteria and fungi degrade components such as sugars, amino acids, proteins, etc. and rapidly raises the temperature. In this study on the second day there has been an increase in temperature for all treatments. In the initial conditions, the temperature of the mixture of materials was the same for all treatments, which was 32ºC and the following day there was an increase in temperature for all treatments in the range of 35ºC - 37ºC. Temperature increases occur linearly for several days.

2) Thermophilic phase in which thermophilic bacteria degrade fat, cellulose, hemicellulose and some lignin. In this phase there is a maximum degradation of organic matter as well as destruction of pathogens. In this phase the temperature rise continues and this happens in studies where the temperature rise continues until the seventh day. The range of temperature rise on the seventh day is in the range of 36ºC - 39ºC. Temperature fluctuations in this study can be seen in Figure 1

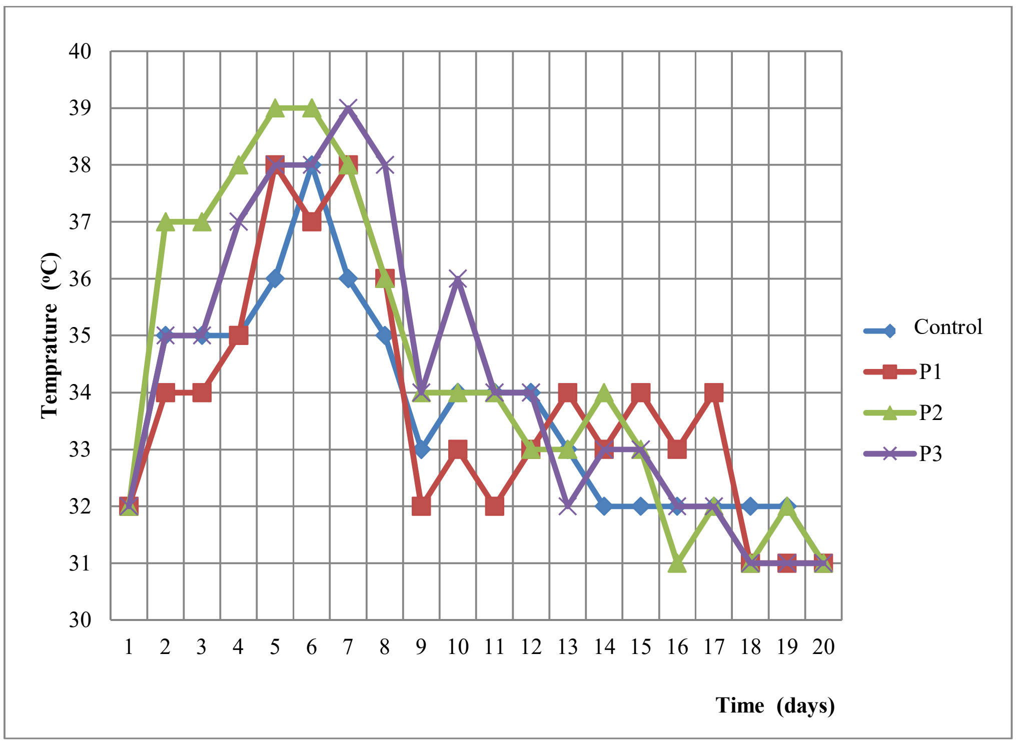

Figure 1. Temperature Fluctuations in the Research on Making Compost with Blood Meal Bio-activators of Slaughterhouse Waste and Biogas Slurry Fermenters

According to [16] the thermal process in composting would be followed by physico-chemical conditions. In this condition, actually the more influential was the consumption of O2 than the change in temperature itself. With the growth of microorganism populations, the need for O2 would increase. In this research, it was assumed that there was an aerobic microorganism development even though the fermentor used comes from the biodigester outlet where the digester has an anaerobic atmosphere, because some of the rumen contents of microorganisms are facultative. Thus, the temperature at the time of maximum degradation does not have to be accompanied by elevated temperatures, in this study the temperature increased to 39ºC whereas in other studies for example, the temperature increased to around 55ºC - 60ºC [15]. Maximum degradation is more dependent on the type of living microorganisms and one indicator is the consumption of O2. In this study O2 consumption data retrieval was not carried out. This study uses a composting container in the form of a basket made of bamboo skin and has enough air holes so that it can accommodate the needs of many microorganisms for O2.

3) The cooling phase in which there is a decrease in temperature in line with reduced microbial activity due to the almost complete degradation of organic matter. At this time the compost heap is dominated by mesophilic bacteria that finish all the remaining organic material such as sugar, cellulose and hemilesulose. In this study, the phase of decline occurred slowly starting on day eight. Physio - chemical conditions also occur with changes in pH. From the initial condition where the pH of the mixture was around 7, at the end of composting the pH was around 9.

From the temperature parameters it can be concluded that the condition of the compost material mixture will affect the types of microorganisms that develop with the note that the fermentors provided contain a variety of microorganisms. So in fact, fermentors originating from biogas slurry where the biogas substrate comes from the rumen contents will facilitate the fermentors with an abundance of microorganisms.

Of the four treatments, all showed the same temperature fluctuation trend. This is likely due to the substrate in the same four treatments and the same amount of fermentor, only at P3 where the highest blood meal content of 375 grams occurs a little slowing. This was consistent with the statement of [17] that a high N content would slow down the work of microorganisms.

3.3. C/N Ratio of fertilizer by bioactivating blood meal of slaughterhouse waste and biogas fermentor slurry.

Slaughterhouse waste that can be utilized but in reality causing problems are blood, feces and leftover feed. In small scale slaughterhouses, the waste is disposed of in the environment. Blood has a high protein content so it has the potential to be used as a bioactivator in composting. In another study, blood was tried to supplement animal feed but was not very popular due to the presence of an antinutrient substance, keratin. [18] mentioned that blood meal could only use 3-6% for chicken feed. Besides that, through palatability test, it is known that the blood taste is less favorable for cattle. Blood digestibility is also low. The most possible possibility for the utilization of blood is for bioactivators in composting by first processing it into blood meal. In developed countries, blood and bone meal is very popularly added to improve the quality of compost [5].

In this study there were 4 treatments, namely control / without the addition of blood meal, the addition of 3 levels of blood meal, namely 125 gr (6.5%), 250 gr (13%) and 375 gr (19.5%). All four treatments had a mixture of materials that were still in the range of C/N ratio which was 25 35 [19]. The C/N ratio of the four treatments were as follows P0: 33.8; P1: 31.85; P2: 27.2 and P3: 24.9.

The effort to find out the C/N ratio of the treatment was by first analyzing the compost mixture material, namely blood, feces and leftover food at the Central laboratory, Faculty of Agriculture, Universitas Sumatera Utara. After knowing the contents of C and N then the calculation was done. Fermentation was carried out in 4 weeks where every week a composite sample were taken which were then tested in a Central laboratory. Table 4 shows the condition of the C/N ratio during the composting process.

Table 4. C/N Ratio of Fertilizer by Bioactivating Blood Meal of Slaughterhouse Waste and Biogas Fermentor Slurry

Time (Weeks)	Treatments	C-org Average	N-total Average	C/N
1st	Control	34.05	1.59	21.42
	P1	33.42	1.96	17.05
	P2	33.42	2.01	16.62
	P3	31.59	2.03	15.56
2nd	Control	32.92	1.74	18.92
	P1	32.45	2.00	16.23
	P2	33.38	2.11	15.82
	P3	34.63	2.30	15.06
3rd	Control	31.28	2.07	15.11
	P1	30.65	2.29	13.38
	P2	31.59	2.32	13.62
	P3	30.34	2.35	12.91
4th	Control	31.18	2.11	14.78
	P1	27.49	2.00	13.75
	P2	28.59	2.18	13.11
	P3	28.24	2.32	12.17

The results of the study were showed in Table 4 and 5 and the average C/N ratio after 4 weeks was 17.55, P1 15.10, P2 14.79 and P3 13.93 respectively. To see the effect of the treatment, analysis of variance was done. Of the four treatments, there was a significant different between control and P3. This means that the addition of blood meal as much as 19.5% caused a difference in the C/N ratio of fertilizer.

Table 5. Average of C/N Ratio of Fertilizer by Bioactivating Blood Meal of Slaughterhouse Waste and Biogas Fermentor Slurry

Treatments	C/N
Control	17.55[a]
P1	15.10[a]
P2	14.79[a]
P3	13.93 [b]

From Table 5, there are several trends as follows:

1. Increasing time causing the organic C decreases
2. Increasing time causing the total N increases
3. Increasing time causing the C/N decreases

These trends were also found by [18] whom mentioned that the greatest decrease in C in the thermophilic phase/first week. In this study, the decrease in component C in the first week was found at P3. This possibility was correlated with the highest blood meal. Blood meal is a bioactivator so that it facilitates the development of more microbial substances while at the same time helps better degradation of compost material.

[20] mentioned that compost was a microbial process. In the composting process, microorganisms need energy sources derived from the degradation of C and N for their development and activities. The C/N they need is around 25 - 35, considering that microorganisms require 30 parts of C for each N unit. More assimilation of C by microorganisms is needed, which is why in compost mix materials an arrangement is needed so that there is a balance of C with N which is realized in the C/N ratio. In this study, the treatments made had a C/N value still in the range of microorganism requirements, namely P0, P1, P2, and P3 respectively at 33.8; 31.85; 27.2; and 24.9. C was contributed by the leftover feed which was corn crop waste. By assimilating C then a decrease in C content as manifested in this study where with increasing time there is a decrease in C content.

The N content will increase with increasing time. N comes from the breakdown of proteins into simple peptides which eventually become free amino acids, CO2 and water. In addition, the result of cellulose overhaul will produce volatyle fatty acids and keto acids which then become amino acids. The addition of N also comes from the microorganisms themselves, where the bodies of microorganisms are a source of amino acids for compost.

The C/N value was one of the most important indicator of matured compost [18] which was 10-20. However, according to [20] that a C/N ratio of 12 is ideal for compost to be applied to plants. Compost that still has a high C/N, if applied to plants is not good, because there will be immobilization of N.

From the results of this study it was known that combination of biogas slurry derived from the contents of cow's rumen with blood meal were very well for making compost. Especially P3 which was consisted of 6 kg livestock feces, 6 kg feed leftover and 375 g blood meal and used biogas slurry as fermentor was a novel formula as in 4 weeks C/N of the compost was 12.17. While on research by [21] C/N of compost after 8 weeks of composting became 19.6. [22] after 51 days composting found C/N between 14 to 16. As all the materials of P3 were wastes which in slaughterhouse in Sumatera Utara Province were not managed and cause negative effect on environment. Moreover, up till now, there is a crucial need to find good, cheap and environmentally friendly fertilizer.

In addition, in the fourth week, through physical observation, ground lice and worms were found. [23] stated the application of organic fertilizer containing blood meal facilitates the development of earthworms. At the end of the composting period, the mixture of ingredients has dark colored and smelly soil. All of these were indicators of good quality compost.

4. Conclusion

The conclusion from this study is that from each treatment there is no difference between the treatment at compost temperature, pH and C/N except P3 treatment by using 19.5% blood meal. Treatment of P3 which were consisted of 6 kg livestock feces, 6 kg feed leftover and 375 g blood meal and used biogas slurry as bioactivator was a novel formula for making fertilizer. This was due to the C/N was 12.17 after 4 weeks composting which was seldom to find among researchs.

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