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Production of Solid Organic Fertilizer from Biogas Slurry Waste

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Abstract. This research aims to process a slurry of biogas production waste (biogas slurry) to produce solid organic fertilizers. The experiment was started by analyzing the biogas slurry to determind its nitrogen and carbon content. It was found that the C/N rasio of the slurry did not meet a standard for organic fertilizer raw materials, therefore other organic wastes such as rice husk charcoal, coconut shell charcoal, tofu waste and goat manure were added. To produce the organic fertilizer, biogas slurry was mixed with those organic wastes at a certain ratio. The results showed that adding tofu waste, rice husk charcoal, coconut charcoal and goat manure increased the C/N ratio of the organic fertilizers. The highest C/N ratio of the organic fertilizer was obtained at a ratio of biogas slurry to coconut shell charcoal of 1: 2. Based on this research, it is recommended to conduct further research using more materials to produce a more precise C/N ratio.

INTRODUCTION

The by-product of biogas production creates problems because it pollutes the environment. The waste definitely requires an extensive land disposal and produces unpleasant odors which could lead to unhealthy and dangerous environment. To solve the problems, the waste from the biogas production can be further utilised to produce organic fertilizer [1,2]. Utilization of biogas waste as an organic fertilizer is similar to a composting process. This composting process involves anaerobic microorganisms to help decompose the compostable material [3].

Organic fertilizer is a fertilizer made from organic material or living creatures that have died [4–6]. These materials contain nutrients with more than one element. Nutrient contents in organic fertilizer are not as high as in inorganic fertilizers. However, organic fertilizers have specific features such as having an ability to improve the physical properties of soil, improving top surface of soil layer, increasing valuable microorganisms, and improving the absorption and water storage of the soil. Therefore, organic fertilizers are expected to improve the soil fertility. The fertilizer produced from slurry biogas is organic fertilizer because the raw materials of the fertilizer are organic components Biogas production from livestock manure, such as from horse manure will lead to a slurry waste which is rich with macro and micro-organic elements that are needed by plants. Some of the elements in the slurry are in the forms of proteins, cellulose, lignin and others [7]. Those elements are not replaceable by chemical fertilizers. The macro organic materials in the organic fertelizers are nitrogen (N), potassium (K), phosphorus (P) and others, while the micro elements are magnesium (Mg), calcium (Ca), amino acids and others [8].

It is expected that the biogas slurry waste from horse manure could be utilize directly to produce organic soil. Organic fertilizer could be applied in the soil to improve soil structure and provide nutrients needed by plants [9]. To produce good quality of organic fertilizer, the raw materials need to have a certain value of C/N ratio. To improve the C/N ratio, some other organic wastes could be added. To improve the carbon content, high carbon content organic waste such as rice husk and coconut charcoal could be added. Whereas to improve the nitrogen content of the biogas slurry, goat manure coul be added.

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METHODS

Materials

Biogas slurries were obtained from the production of biogas from water hyacinth and horse manure. The slurry was mixed with organic wastes, namely tofu solid waste, rice husk charcoal, coconut shell charcoal and solid goat manure. Table 1 shows the characteristics of the raw materials.

TABLE 1. The characteristics of the raw materials.

Materials	C/N	N	P	K	C-Organik
Water Hyacinth biogas slurry	26.97				8.73
Horse manure+EM4 biogas slurry		0.20	0.048	0.23	6.83
Tofu solid waste		5.55	0.34	2.41	
Rice husk charcoal		0.57	0.07		41.44
Coconut shell charcoal	74.3		1.7	1.4	74.3
Goat dung		5.55	0.34	2.41	

Procedure

A certain ratio of biogas slurry and organic wastes was mixed and composted in a composting equipment. The compost was kept until it was mature and analyzed its pH, micro and macro elements as well as C/N ratio.

RESULTS AND DISCUSSION

There were two types of slurry biogas used in this research. Slurry biogas from slurry waste of anaerobic digestion of water hyacint waste and slurry biogas from anaerobic digestion of horse manure. The first slurry was mixed with tofu solid waste and rice husk charcoal, while the second slurry was mixed with coconut husk charcoal and goat manure.

Compost from water hyacinth biogas slurry

The C/N ratio of the water hyacinth bioga slurry which was used in this research was 26.97%. According to a regulation of the Indonesia Minister of Agriculture No. 70 / Permentan / SR.140 / 10/2011, C/N ratio for compost is 15-25. To improve the C/N ratio and nutrients, two materials were added in the composting process to study its effect to the quality of the compost. Previous research suggested that adding rice husk charcoal to a biogas slurry waste from anaerobic digestion process of a vegetable could improve the nutrients of N, P and K of the solid organic fertilizer product [10].

TABLE 2. C/N ratio of compost from slurry biogas of water hyacint

No	**Material**	**Ratio**	**Carbon concentration (%)**	**Nitrogen concentration (%)**	**C/N**
1		1:1	11.80	0.68	17.35
2	Slurry: Tofu	1:3	11.02	0.79	11.23
3	waste	1:5	8.87	1.23	8.96
1		1:1	1.05	0.22	4.77
2	Slurry: rice	1:3	1.27	0.26	4.88
3	husk	1:5		0.36	
	charcoal		5.10		15.17

The C / N ratio is one of the important parameters to know the quality of the compost. This ratio is used to know organic fertilizer is mature enough or not. Physically, the mature organic fertilizer is characterized by its color, texture and smell. The color of the compost becomes dark brown, the texture is soft and easily crushed, and it has a compost smell.

Table 2 shows the effect of adding tofu solid waste and rice husk charcoal into nitrogen and carbon content of the compost. It could be seen that the higher the ratio of tofu solid waste, the lower the C/N ratio. This is because the tofu waste contains high protein content. The best compost of tofu waste addition was obatined at a ratio of slurry to tofu waste of 1:1. Apart from decreasing the C/N ratio, tofu waste could help in decreasing the heavy metal contents which may present in the soil [11].

In the addition of rice husk charcoal into the biogas slurry, it can be seen that the higher the addition of the rice husk, the higher the C/N ratio of the compost. The best compost was obtained from the ratio of slurry:rice husk charcoal of 1:5. At this ratio, the C/N ratio was 15.17 which meets the standrad for organic composts.

Compost from Biogas Slurry of Horse Manure

To produce a good quality of compost, the biogas slurry from horse manure was mixed with goat manure and coconut shell charcoal. The C/N ratio of the mature compost is shown in Table 3.

TABLE 3. C/N ratio of compost from biogas slurry of horse manure

No	Materials	Rasio	Carbon concentration (%)	Nitrogen concentration (%)	C/N
1	Slurry:	1:1	5.80	0.42	13.81
2	Goat	1:2	8.70	0.56	15.54
1	Slurry:	1:1	9.05	0.31	29,19
2	coconut shell charcoal	1:2	10.27	0.43	22,84

It can be seen from Table 3 that adding goat manure increased the C/N ratio of the compost, whereas adding cococnut shell charcoal decreased the C/N ratio of the final compost. The best compost with goat dunk addition obatined at a ratio of slurry to goat dunk of 1:2, while the best compost for coconut charcoal addition was obtained at a ratio of slurry to charcoal of 1:2. Both composts meet the Indonesian standard of organic fertilizer which has C/N ratio of 15-25.

pH of the Compost

pH could be used to determine the quality of the compost. Nutrients of the organic fertiliszer could be easily absorbed by plant roots at neutral pH. At nutral pH, most nutrients are water soluble. To study the quality of the compost, the pH of all composts were monitor during the composting process. Table 4 shows the pH measurements of the composts at initial and final composting processes.

TABLE 4. Results Measurement of pH on the manufacture of organic fertilizers

No	Aditive Materials	Rasio	Initial pH	Final pH
1	Goat dung	1:2	6	7
2	Coconut shell charcoal	1:2	6	7
3	Rice hucks charcoal	1:5	6	7
4	Tofu	1:1	6	8

It can be seen from Table 4 that the composts which meet the C/N standard have neutral pH ranging from 7-8. Thus the organic fertilizers produced from this research could be applied to improve the quailty of the soil, rooting of the plants and provide micro and macro nutrients which are needed by the plants [12,13].

CONCLUSION

Biogas slurry from the anaerobic digestion of water hyacynth and horse manure could be process to produce compost by adding other solid organic wastes. The composts which meet the Indonesian standard for organic fertilizer were obtained at a composition of slurry: tofu soilid waste of 1:1, slurry: rice husk charcoal of 1:5, slurry: goat dung of 1;2 and slurry : coconut husk charcoal of 1;2 which gave a C/N ratio of 17.35, 15.17, 15.54 and 22.84, respectively. All the composts were at neutral pH. But, the highest C/N ratio of the organic fertilizer was obtained at a ratio of biogas slurry to coconut shell charcoal of 1: 2. Based on this research, it is recommended to conduct further research using more materials to produce a more precise C/N ratio.

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REFERENCES

1. A. C. Adityawarman, *J. Ilmu Produksi dan Teknol. Has. Peternak*. **3,** 171–7 (2015)
2. E. Vebrianti, E. Purwanti and A. Apriman, *J. Peternak. Indones.* **14** 270–8 (2012)
3. E. Sundari, E. Sari and R. Rinaldo, *Prosiding SNTK TOPI (2012)*
4. R. Juliani, R. Fika, R. Simbolon, W. H. Sitanggang and J. Berghauser, *J. Pengabdi. Kpd. Masy.* **23,** 220–4
5. N. Sianturi, A. Siahaan and S. Simangunsong, *Tapanuli Journals* **3,** 163–9 (2020)
6. S. Hadisuwito, *Membuat pupuk kompos cair* (AgroMedia) (2007)
7. S. Wahyuni, *Panduan praktis biogas* (Penebar Swadaya Grup) (2013)
8. S. Sunaryo, *J. PPKM Unsiq I,* 21–30 (2014)
9. D. P. Putra, B. Susilo, W. A. Nugroho and A. M. Ahmad, *J. Keteknikan Pertan. Trop. dan Biosist.* **2,** 53–64 (2014)
10. E. F, E. P and Apriman, *Angew. Chemie Int. Ed. **6**, 951–952 (1967)*
11. M. Danial, N. A. S. Taufieq, W. Sanusi, Jurnal Chemica **9**, 12–19 (2008)
12. S. W. Utami and B. H. Sunarminto, Pengaruh Limbah Biogas sapi terhadap ketersediaan hara makro-mikro inceptisol *J. Tanah dan Air* **11** 12–21 (2014)
13. A. Prasetyo, W. Hadi and E. Listyorini, *J. Tanah Dan Sumber Daya Lahan* **1,** 27–38 (2014)