Methane Gas Production Test From Forage Swamp with Ensilase Method As Bio-gas Plants

by Sofie Sandi

Submission date: 19-Oct-2022 07:20PM (UTC+0700)
Submission ID: 1929575184
File name: est_From_Forage_Swamp_with_Ensilase_Method_As_Bio-gas_Plants.pdf (279.31K)
Word count: 3417
Character count: 17794

Sriwijaya Journal of Environment

P-ISSN: 2527-4961 E-ISSN: 2527-3809

Methane Gas Production Test From Forage Swamp with Ensilase Method As Biogas Plants

Erra Kartika[1*], Nuni Gofar[2], Sofia Sandi[3]

[1]*Students of Management of Environment, Graduate Program, Sriwijaya University*
[2]*Department of Soil Science, Faculty of Agriculture, Sriwijaya University*
[3]*Department of Animal Husbandry, Faculty of Agriculture, Sriwijaya University*

Abstract

This study aims to test the production of methane gas from forage swamps by ensilase as biogas plants. Treatment levels consisted of 3 treatments P1 (100% Kumpai tembaga grass (*Hymenachne acutigluma*)), P2 (50% Kumpai tembaga grass (*Hymenachne acutigluma*) + 50% Kemon air (*Neptunia oleracea lour*)), P3 (100% Kemon air (*Neptunia Oleracea lour*)) and 5 replications. The result of the diversity analysis showed that silage swamp silage ensilase process significantly (p <0,05) to methane gas formation. The best composition was obtained from the treatment of P1 Kumpai tembaga grass (Hymenachne acutigluma) 100%.

Keywords: Production, Methane, Forage Swamps, Ensilase, Biogas Plants.

Abstrak (Indonesian)

Penelitian ini bertujuan untuk menguji produksi gas metana dari hijauan rawa dengan cara ensilase sebagai biogas tanaman. Taraf perlakuan terdiri dari 3 perlakuan P1 (100% Rumput kumpai tembaga (Hymenachne acutigluma)), P2 (50% Rumput kumpai tembaga (Hymenachne acutigluma) + 50% Kemon air (Neptunia oleracea lour)), P3 (100% Kemon air (Neptunia oleracea lour)) dan 5 ulangan. Hasil analisa keragaman menunjukkan bahwa proses ensilase silase hijauan rawa berpengaruh nyata (p<0,05) terhadap pembentukan gas metana. Komposisi terbaik diperoleh dari perlakuan P1 kumpai tembaga (Hymenachne acutigluma) 100%.

Katakunci: Produksi, Metana, Hijauan Rawa, Ensilase, Biogas Tanaman.

1. Introduction

Rapid population growth in line with rapid industrial growth resulting in increased energy demand and declining environmental quality. Meanwhile, the number of fossil fuels is increasingly limited. Utilization of alternative renewable energy sources and environmentally friendly can be an option. In Europe, energy policy is increasingly promoting the generation of energy from renewable sources, 27% of renewable energy by 2030 and reducing by 40% of greenhouse gas emissions [1]. One renewable energy is biogas or methane fermentation.

Methane gas is usually present in nature where the destruction of organic matter by bacteria occurs without oxygen (anaerobes), such as swamps or muddy sections of the lake. Therefore, methane gas is often called swamp gas. Indonesia has a wealth of natural resources that are very abundant to produce alternative energy sources. The area of swamp in South Sumatera Province is 613,795 ha consisting of 455,949 Ha of swamp and 157.846 Ha of swamp [2]. In principle weed or plant biomass has potential as a material for bioenergy manufacture, such as biogas, and bioethanol [3]. Biogas is one of the relatively simple renewable energy sources produced by anaerobic fermentation of organic materials. Silage is feed fermented in fresh form by the lactic acid bacteria (LAB) with a high water content under anaerobic conditions and produce most of its products such as lactic acid, in addition to improving feed quality lactic acid in silage can act as a natural preservative and silage will have long shelf life [4]. The swamp forage silage has the potential to produce methane gas during the ensilase or fermentation process, due to the overhaul of organic matter and the presence of lactic acid bacteria which helps in producing methane gas. Methane is produced from acetic acid, hydrogen and carbon dioxide. Methanogenic bacteria use hydrogen, carbon dioxide and acetic acid to form methane [5].

Biogas from plants is one of the relatively simple renewable energy sources produced by anaerobic fermentation of organic materials. This efficient and inexpensive energy can overcome the society's dependence on fuel oil which is currently increasingly rising and its sources are getting more and more limited. Information on the production of methane gas from silage from forage swamp so far has not been much studied, therefore it is necessary to conduct research on the potential of methane gas production from the swamp green silage. The results of this study are expected to be used as one of the basic development of biomass utilization of the swamp forage silage into the source of biogas production as an alternative energy to reduce the dependence of fossil fuel use.

Article History:
Received: 7 September 2017
Accepteed: 7 December 2017
DOI: 10.22135/sje.2017.2.3.72-75

*Corresponding Author: errakartika@gmail.com

2. Experimental Section

The study was conducted from January to March 2017 at the Nutrition and Feeding Laboratory, Livestock Study Program, Agricultural Faculty of Sriwijaya University and Environmental Laboratory, Environment Agency of South Sumatera Province. The tools used are scales, 2 L plastic derivatives (silos), compressor faucets, rubber caps, masking tape, sprayer, analytical balance, pH meters, gas chromatography.

The materials used consisted of kumpai tembaga grass (Hymenachne acutigluma), kemon air (Neptunia oleracea lour), Molases, H_2SO_4 0.3 N, Acetone and CH_4 standard.

The research design used was Completely Randomized Design consisting of 3 treatments and 5 replications. Each treatment consists of:

P1 = Making silage made kumpai tembaga grass (*Hymenachne acutigluma*) 100%

P2 = Making silage made kumpai tembaga grass (*Hymenachne acutigluma*) 50% and kemon air (*Neptunia oleracea lour*) 50%.

P3 = Making silage made kemon air (*Neptunia oleracea lour*) 100%

The mathematical model of this study design is as follows [6] :

Yij =

Information :

Y_{ij} : Value Observation
: Middle value
: Effect of additive from the I-th repeat treatment on j-observation
: An experimental error of a repeat treatment on j-observation
I : Number of treatment
J : The number of replications

2.1. Silage Making

Stages of silage making can be done by kumpai termbaga grass and kemon air cut into pieces along 2-5 cm, after cut into pieces kumpai tembaga grass and kemon air withered for 24 hours. Each treatment was mixed with molasses that serve as an inoculant of 3% and then fed into each 2-liter plastic gauge and compacted until there was no air space, then sealed and kept in a dry place and not exposed to sunlight directly for 21 days, because the ensilase process lasts a maximum during the third week [7].

2.2. Test of Silage Characteristics

The silage product is harvested after 21 days, the silage harvested before it is evaluated its quality is first aerated to remove harmful gases, after which samples are taken from each treatment and replicate aseptically. Sampling is done by taking the top, middle and bottom silos and taken to the laboratory of Nutrition and Feed for Sriwijaya University for analysis. Analysis of physical quality to know the texture, color and smell done by organoleptic observation then the result is analyzed descriptively.

1 g sample of silage supplemented with 2 ml of distilled water (1: 2), and then allowed to stand for 4 hours while stirring every 1 hour, then the pH was measured using a pH meter.

2.3. Silage Nutrition Quality Test

Determination of dry matter (DM), organic matter (OM) and crude fiber (CF) through proximate analysis [8], analyzed in Nutrition and Feed Feed Laboratory, Agriculture Faculty, Sriwijaya University.

2.4. Methane Gas Production Analysis

Production of methane gas produced from silage was analyzed using gas chromatography (GC), the analysis was done at the Laboratory of Environment Agency of South Sumatera Province. Methane gas test method by gas absorption method using gas chromatography (GC). Methane gas production was tested in 4 Periods: 0 Days, 7 Days, 14 Days and 21 Days to determine methane gas production during ensilase.

3. Results and Discussion

3.1. Quality Silage Forage Swamp

Good silage can be seen from the quality of the resulting physical quality and nutritional quality. Physical observation of silage forage of swamp after the process of ensilase for 21 days against color, texture, smell and pH can be seen based on the physical characteristics of the silage. Observations on the color, texture, smell and pH silage of wet forests can be seen in Table 1.

Information : P1 (Silage making made kumpai tembaga grass (*Hymenachne acutigluma*) 100%) , P2 (Silage making made kumpai tembaga grass (*Hymenachne acutigluma)* 50% dan kemon air (*Neptunia oleracea lour*) 50%), P3 (Silage making made kemon air (Neptunia oleracea lour) 100%). Different superscript letters in one column show significant differences at the test level ($p < 0.05$) BNT.

Table 1. Shows that the silage forage swamps gives a color difference that is yellowish green and brownish green in each treatment. In report that a good quality silage will be bright green to yellow or or brownish green depending on the silage material used [9]. The results of the three treatments were P1, P2 and P3 were yellowish green and brownish green showed no damage or decay during the fermentation period. Silase that contains too much acetic acid will be yellowish, but if excess butyric acid will be slimy and bluish green color and good silage will show the same color with its original color before fermentation [9].

From table 1. The texture of silage forage of swamp did not show the real difference until the time of ensilase for 21 days, the texture yielded intact and compact, on the treatment of P1 which is made from raw grass texture kumpai which produced a little coarse as well as at treatment of P2 which made from mixture of grass kumpai and kemon air texture produced a little rough, while the treatment of P3 made from raw water kemon texture produced smooth, intact and compact.

The odor in the silage forage swamps shows a typical fermented and perfumed acidic odor after 21 days of ensilase which can be seen in Table 1. The treatment of P1 has an acidic odor, P2 has an acidic and fragrant odor compared to P3 which has a stronger smell of acid and fragrance, it is suspected that P1 treatment is produced more lactic acid, whereas in the treatment of P2 and P3, alcohol is also produced because of the scent and smell. Odor generated from

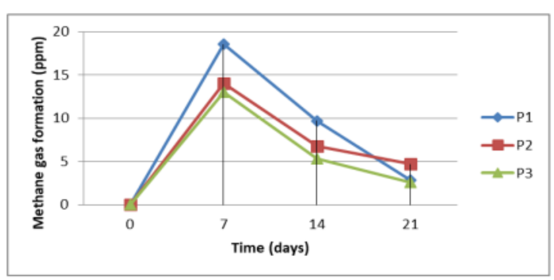

Figure. 1. Methane Gas Formation For 21 Days

Table 1. Physical characteristix of silage forage swamp after the 21 Days ensilase period

Treatment	Color	Texture	Smell	pH
P1	Yellowish green	Whole and Compact	Acid	$4{,}21^{a} \pm 0{,}073$
P2	Yellowish green	Whole and Compact	Acid and Fragrance	$4{,}36^{a} \pm 0{,}075$
P3	Brownish green	Whole and Compact	fragrant sting	$4{,}44^{a} \pm 0{,}105$

Information : P1 (Silage making made kumpai tembaga grass (*Hymenachne acutigluma*) 100%) , P2 (Silage making made kumpai tembaga grass (*Hymenachne acutigluma)* 50% dan kemon air (*Neptunia oleracea lour*) 50%), P3 (Silage making made kemon air (Neptunia oleracea lour) 100%). Different superscript letters in one column show significant differences at the test level (p <0.05) BNT.

silase is a result of lactic acid characterized by a less stinging smell [10]. Fragrant odor does not necessarily reflect a quality silage, because the scent is derived from the high etaol produced by mixed yeast acetic acid. Good silage is homofermentatif characterized by a sting that does not sting, because lactic acid is almost odorless [9].

From the analysis of diversity showed treatment significantly (p <0,05) to pH. Average pH ranges from 4,21 to 4,44. The results showed that the lowest pH was in treatment P1, while the highest pH was found in P3 treatment. This shows that P1 treatment has the highest acid condition and is classified into good pH criteria even close to the excellent silage criteria, whereas P3 treatment is classified into moderate silage kriteia. The quality of silage can be classified into 4 criteria based on pH that is: excellent with pH 3,2-4,2, both pH 4,2-4,5, medium pH 4,5-4,8, and Bad pH > 4,8 [11]. At first fermentation process there is high mikrobial diversity, until the end of silage process of microbial diversity dominated by lactic acid bacteria one of them is *L. plantarum*. The BAL contained in this silase results in a decreased silage pH [12].

The results of observations on the quality of nutrient silage for wetlands can be seen in Table 2.

Information : P1 (Silage making made kumpai tembaga grass (*Hymenachne acutigluma*) 100%) , P2 (Silage making made kumpai tembaga grass (*Hymenachne acutigluma)* 50% dan kemon air (*Neptunia oleracea lour*) 50%), P3 (Silage making made kemon air (Neptunia oleracea lour) 100%). Different superscript letters in one column show significant differences at the test level (p <0.05) BNT

The result of the diversity analysis on the quality of the swamp forage has no significant effect (p> 0,05) to the swamp forest silage DM. DM silage forage of swamp produced by each treatment ranged from 49.67% -50.49%. The treatment of P3 with DM value of 50.49% which is the highest yield, P3 with kemon air (*Neptunia oleracea lour*) composition 100% has increased the content of DM after silage.]

The result of the diversity analysis on the quality of the swamp forage has no significant effect (p> 0,05) to the OM silage forage swamp. OM of swamp silage produced by each treatment ranged from 58.47% -60.12%. Treatment P1 has the highest BO content of 60.12% with the composition of kumpai tembaga grass (*Hymenachne acutigluma*) 100%. This is expected because P1 treatment has high CF content, along with the highest CF result on P1 treatment that is 32,68%. The result of BNT test to CF showed P3 treatment was significantly different (p<0,05) to P1 and P2 treatment. P3 treatment with a composition of kemon air *(Neptunia oleracea lour)* silage has a crude protein content is high, the results of research the chemical composition of Kemon air *(Neptunia oleracea lour)* consists of 28.02% crude protein dry matter, crude lipid 2.08% dry matter, crude fiber 17.25% dry matter [13].

Table 2. Quality of Nutrition Silage Forage Swamp

Treatment	DM%	OM%	CF%
P1	$49{,}72 \pm 0{,}03$	$60{,}12 \pm 1{,}59$	$32{,}68^{a} \pm 2{,}01$
P2	$49{,}67 \pm 0{,}05$	$58{,}47 \pm 4{,}40$	$27{,}33^{a} \pm 2{,}13$
P3	$50{,}49 \pm 1{,}91$	$59{,}27 \pm 3{,}31$	$24{,}12^{b} \pm 0{,}66$

Information : P1 (Silage making made kumpai tembaga grass (*Hymenachne acutigluma*) 100%) , P2 (Silage making made kumpai tembaga grass (*Hymenachne acutigluma)* 50% dan kemon air (*Neptunia oleracea lour*) 50%), P3 (Silage making made kemon air (Neptunia oleracea lour) 100%). Different superscript letters in one column show significant differences at the test level (p <0.05) BNT.

Table 3. Methane Gas Formation For 21 Days (ppm)

Treatment	To-0 day (ppm)	To-7 day (ppm)	To-14 day (ppm)	To-21 day (ppm)
P1	$0{,}00 \pm 0{,}00$	$18{,}55^{a} \pm 4{,}66$	$9{,}68^{a} \pm 2{,}35$	$2{,}80^{a} \pm 0{,}57$
P2	$0{,}00 \pm 0{,}00$	$14{,}04^{a} \pm 1{,}15$	$6{,}76^{a} \pm 1{,}04$	$4{,}68^{a} \pm 0{,}64$
P3	$0{,}00 \pm 0{,}00$	$12{,}99^{a} \pm 2{,}56$	$5{,}31^{a} \pm 1{,}77$	$2{,}53^{a} \pm 0{,}84$

nformation : P1 (Silage making made kumpai tembaga grass (*Hymenachne acutigluma*) 100%) , P2 (Silage making made kumpai tembaga grass (*Hymenachne acutigluma)* 50% dan kemon air (*Neptunia oleracea lour*) 50%), P3 (Silage making made kemon air (Neptunia oleracea lour) 100%). Different superscript letters in one column show significant differences at the test level (p <0.05) BNT.

3.2. Methane Gas Formation During Ensilase Process

The result of the diversity analysis showed that silage swamp silage ensilase process significantly ($p < 0{,}05$) to methane gas formation. The first week of methane gas production each treatment ranged from 12.99 to 18.55 ppm. The second week of methane gas production each treatment ranges from 5.31-9.68 ppm and in the third week of methane gas production each treatment ranges from 2.53-4.68 ppm.

Based on table 3. It can be seen that the formation of methane gas is highest or peak on the 7th day where the initial phase of the ensilase or fermentation phase occurs, this phase is the initial phase of the anaerobic reaction. In the first week where this phase is the initial phase of anaerobic reaction. This phase lasts from several days to several weeks depending on the material composition and silage conditions. On the 7th day P1 treatment showed the highest concentration of 18,55 ppm. That methane (CH4) is produced from acetic acid, hydrogen and carbon dioxide. Methanogenic bacteria use hydrogen, carbon dioxide and acetic acid to form methane [5]. Acid-producing and methane-producing bacteria work together symbiosis, acid-producing bacteria form ideal conditions for methane-producing bacteria, while methane forming bacteria use acid generated acid producing bacteria.

The decrease of methane gas concentration in the treatment of P1, P2 and P3 occurs on day 14 and day 21, this is because the shake up of nutrients substance is getting less. In the third week of the stable phase, this phase is a continuation of the second phase. The stable phase causes the activity of the fermentation phases to decrease slowly so there is no significant increase or decrease in pH, lactic acid bacteria, and total acid [14].

The highest production of methane gas in P1 treatment along with the pH at the most acidic P1 treatment of pH 4, 21 indicates higher organic acid content, so that the fermentation process can take place optimally and produce methane optimally. High concentrations of acetic acid may increase methane formation [15]. The bacteria will act actively at a specific pH range and show maximum activity at optimum pH, mentioned that one important factor in anaerobic fermentation process is pH [16].

.

4. Conclusion

The concentration of methane gas most widely produced on the treatment P1 is the composition of the kumpai tembaga grass *(Hymenachne acutigluma)* 100%, in line with the content of BO in treatment P1 which reached 60.12% and low pH conditions is 4.2.1. Silage forage grass composition kumpai tembaga grass *(Hymenachne acutigluma)* 100% could potentially be used as a source of renewable energy from biogas plants.

Acknowledgement

The authors thanks to Sriwijaya University for funding of this work through Hibah Profesi with contract number 1023/UN9.3.1/LPMP/2016.

References

[1] European Commission. "A policy framework for climate and energy in the period from 2020 to 2030", COM/2014/015 final, 2014. 1–18.

[2] Khodijah NS. "The relationship between climate change and rice production in swampland in southern Sumatra", Enviagro, Journal of Agriculture and Environment, Vol. 8 No.2, 2015. Pp 83-91.

[3] Winarni P, Trihadiningrum Y, Suprijanto. "Biogas Production from Eceng Gondok". Surabaya: Environmental Engineering Department, Ten November Institute of Technology. 2011

[4] McDonald, P., Henderson A. R., Heron S. J. E. "The Biochemistry of Silage", 2nd Ed. Marlow (GB): Chalcombe Publications. 1991

[5] Juanga, J. "Optimizing Dry Anaerobic Digestion of Organic Fraction of Municipal Solid Waste". Asian Institute Technology, Thailand. Master Thesis. 2005.

[6] Steel, R. G. D., J. H. Torrie. "*Principles and Procedures of Statistics". Translation. 2nd Edition. Publisher PT.* Gramedia Pustaka, Jakarta. 1991.

[7] Herlinae. "Physical characteristics of silage mixture of cassava leaves (*manihot esculenta*) and kumpai grass (*hymenachine ampleexicaulis*)".Journal of Tropical Animal Science, 2(4). Desember 2015.

[8] AOAC. "Official Methods of Analysis. Association of Official Analytical Chemists". Benjamin Franklin Station, Washington. 2005.

[9] Rostini, T., Zakir M. W., Ramli N., dan Lubis D. ""Effect of Different Water Level on Quality of Fermented Silage Rations Complete Local Raw Material". Scientific Magazine Kopetis Region XI Kalimantan, Vol. 1, No 2, October 2009: 194-202.

[10]Lendrawati. "Quality Fermentation and Nutrition of Complete Ration Silage Based on Corn, Palm and Cassava Sides". Thesis. Graduate School of IPB, Bogor. 2008.

[11]Macaulay, A. "*Evaluating Silage Quality*". http://wwwl.agric.gov.ab.ca/$departement/deptdocs.nsf/all/for4909.html [February 2017]

[12]Ridwan R, Rusmana I, Widyastuti Y, Wiryawan KG, Prasetya B, Sakamoto M, Ohkuma M.. "Fermentation characteristics and microbial diversity of tropical grass-legumes silages". *Asian Australas J Anim Sci.* 2015. 28(4):511-518.

[13]Ali, A. I. M., Sandi S., Muhakka., dan Riswandi. "The Quality of Forage Feed at swamp tend Pampangan swamp buffalo". Proceedings InSINas, 2012

[14]Elferink SJWHO., Driehuis F., Gottschal JC., dan Spoelstra SF. "Silage Fermentation Processes and Their Manipulation". Netherlands: Food Agriculture Organization Press. 2010

[15]Vervaeren, H., Hostyn, K., Ghekiere, G., Willems, B. "Biological ensilage additives as pretreatment for maize to increase the biogas production". Renewable Energy 35, 2010. 2089–2093.

[16]Yadvika S, Sreekrishnan TR, Kohli S, Rana V. Enhancement of Biogas Production from Solid Substrates Using Different Techniques - a Review. *Bioresource Technology Vol. 95* 2004. Hal. 1–10 Elsevier Ltd.

Methane Gas Production Test From Forage Swamp with Ensilase Method As Bio-gas Plants

ORIGINALITY REPORT

8%	5%	5%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Sofia Sandi, Fitra Yosi, Meisji Liana Sari, Nuni Gofar, Muhamad Nasir Rofiq. "Swamp Forage Silage Organic Acid Profiles and Influence of Silage Liquid Organic Acid Salts Against Pathogenic Bacteria In vitro", International Journal of Poultry Science, 2020 Publication	1%
2	Sofia Sandi, Miksusanti, Mardiyanto, Fitra Yosi, Meisji Liana Sari. "Preparation And Characterization of Bio-\Polymeric Nano Feed Incorporating Silage-Derived Organic -Acids And The Polar Fraction of Papaya Leaf Extract", Journal of Physics: Conference Series, 2018 Publication	1%
3	journal.ipb.ac.id Internet Source	1%
4	core.ac.uk Internet Source	1%

5	S Sandi, E Sahara, A T Novitasari, A I Munawar Ali, A Susanda, F Yosi, Asmak. "The Effects of Probiotic from Hymenachne Acutigluma Silage in Feed to the Length of Small Intestine and Caeca in Pegagan Ducks", IOP Conference Series: Earth and Environmental Science, 2021 Publication	1 %
6	d.researchbib.com Internet Source	1 %
7	unsri.portalgaruda.org Internet Source	1 %
8	insightsociety.org Internet Source	1 %
9	"Biofuel Production Technologies: Critical Analysis for Sustainability", Springer Science and Business Media LLC, 2020 Publication	1 %
10	Didi Jaya Santri, Hilda Zulkifli, Aldes Lesbani, Hermansyah, Yenny Anwar, Ermayanti, Vita Meylani, Ahmad Fudholi. "Analysis of Swamp Microalgal Isolates from South Sumatra as Biofuel Candidates", International Journal of Design & Nature and Ecodynamics, 2021 Publication	1 %
11	www.jurnal-iktiologi.org Internet Source	1 %

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		