# THE USE OF RUMEN LIQUID AND *Saccharomyces cerevisiae* AS ACTIVATORS IN BIOGAS PRODUCTION FROM FRESH MARKET GARBAGE

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**Abstract**

*The purpose of the study was to know the effect of rumen liquid and Saccharomyces cerevisiae as fermentation activator on the quantity of produced biogas from fresh market garbage; also the quantity as well as quality of biogas, slurry and sludge resulted from semi pilot project of the biogas production, as well as the economic feasibility of the process. This 4 x 3 factorial patterns experiment was done based on completely randomized design. The first factor was dosage of rumen liquid: 2,5%, 5%, 7,5% and 10% (v/w), while the second factor was dosage of S.cerevisiae: 0 gr/kg, 2 gr/kg and 4 gr/kg of garbage. The experiment was done in triplicate. The economic feasibility of the process analyzed based on B/C ratio and BEP of the semi pilot project of the process. The result indicated that the mixture of 5% of rumen liquid and 4 gr S.serevisiae/kg of garbage provide the highest biogas production, followed by 5% of rumen liquid and 2 gr S. cerevisiae/kg of garbage, namely: 8.7 l/kg and 7.8 l/kg of garbage respectively. The biogas has good quality because it contains 60-63% of methane. Concerning its quality, the sludge produced are potential to be use as organic fertilizer. The results also indicated that the biogas production process is economically feasible.*

**Key words:** rumen liquid, *Saccharomyces cerevisiae*, fresh market garbage, biogas, economic feasibility

## INTRODUCTION

Rumen liquid is one of slaughterhouse wastes that frequently disposed into drainage system. This waste disposal system may cause environmental nuisance particularly pose health hazard to human due its content of millions microorganisms. However, rumen liquid may be useful to be used as an activator in producing biogas through anaerobic fermentation. Since some of rumen liquid microorganisms are cellulolitic and methanogenic bacteria. Rumen is part of digestion system in ruminant where the microbial fermentation occurs. This fermentation process is similar to that in biogas digester [3]. So that, microorganism in rumen liquid will have significant role in producing biogas by accelerating degradation process of organic matter in fermentation substrate to produce methane. However, sometimes this degradation process results in too low pH that may kill most microorganisms in the digester. Therefore, this process needs more acidophilic micro-organisms. One of the microorganisms that can be used for this purpose is *Saccharomyces cerevisiae*. The addition of this yeast may increase degradation rate of cellulose and stimulate the growth of cellulolitic bacteria and fungi [10]. The increase of the two microorganism's population is important. Both of them will cooperate in increasing cellulose degradation. Besides, *S.cerevisiae* will decrease propionate acid and increase acetic acid proportions in Volatile Fatty Acid (VFA) [4] [6], and increase acetogenesis after VFA formation, and the resulted acetic acid will be

increased accordingly [2]. Acetic acid is a main precursor of methane. Therefore, the more acetic acid produced the highest the methane generated.

On the other hand, nowadays Indonesia particularly Java Province is facing a great problems in managing a huge volume of domestic waste particularly fresh market garbage. Usually, this type of waste is disposed into dumping site along with other type of domestic wastes. Unfortunately, the dumping site is becoming limited in capacity due to the scarcity of land. So, there is a need to find other methods to manage the garbage that has no great requirement for land. Biogas production process can be introduced as an alternative to solve this problem. However, there is no information of biogas production from fresh market garbage particularly the one that using rumen liquid and *S. cerevisiae*. Therefore, research aimed to know the effect of rumen liquid and *S. cerevisiae* as fermentation activator on the quantity of produced biogas from fresh market garbage; and the quantity as well as quality of biogas, slurry and sludge resulted from semi pilot project of the biogas production, as well as the economic feasibility of the process.

## MATERIALS AND METHODS

Materials used in this study are from slaughterhouse of Bandung District, West Java and yeast *S.cerevisiae* from Microbiology Laboratory, Bandung Institute of Technology. Fresh garbage is collected from Gede Bage Fresh Market Center representing all fresh market of Bandung Municipality. The garbage consists of vegetables, fruit peels and other soft organic wastes. The garbage was cut into 10 mm length. Commonly, biogas production is performed in liquid state, but in this experiment dry biogas production was applied to reduce water usage. The water content of feedstock is maintained as high as 60%. *Albizzia falcata* sawdust was used to increase C/N ratio of the garbage as substrate of fermentation to the value of 30, so that in 1.75 kg of substrate there are 1.450 gram of garbage and 250 gram of sawdust. The volume of digester is 2 liter. NaOH was also used in measuring the volume of biogas. The experiment was performed based on 4x3 factorial patterns with completely randomized design. The first factor was dosage of rumen liquid, viz., 2, 5%, 5%, 7, 5% and 10% (v/w), while the second factor was dosage of *S.cerevisiae*, i.e., 0 gr/kg, 2 gr/kg and 4 gr/kg of garbage. The experiment was done in triplicate. The obtained data analyzed using ANOVA, and the different effect among treatment factors was tested using Duncan multiple-range test. The best treatment is used for semi pilot project experiment with the volume of feedstock ten time of the laboratory's. Quality of biogas is meassured based on the percentage methane content. The quality of slurry and sludge is meassured using its C/N ratio and pH. The economic feasibility of the process was analyzed based on B/C ratio and BEP of the semi pilot project of the process.

## RESULTS AND DISCUSSIONS

The quantity of biogas produced from dry biogas production using rumen liquid and *S. cerevisiae* as fermentation activator is presented on Table 1. The result of ANOVA shows that rumen liquid interacts with *S. cerevisiae* in increasing the quantity of biogas produced ($P<0.01$). The result of Duncan Multiple-range test (Figure 1) furthermore shows that the highest quantity of biogas produced (16,490 ml) is provided by treatment combination of 5% of rumen liquid and 4 gr of *S.cerevisiae*/kg of garbage (P2N2); however, the quantity of biogas produced is not differing than that provided by 5.0% of rumen liquid/kg of garbage and 2 gr of *S.cerevisiae*/kg of garbage (P2N1), i.e., 14,990 ml. The effect of P2N2 is significantly differing than those of the rest of treatments ($P<0.01$). This result shows that the optimum dose of rumen liquid that can be supplemented in biogas production of fresh market garbage is 5 %/kg of garbage in combination with *S.cerevisiae*.

Table 1. Production of biogas in average (ml)

| Treatment | Rumen liquid dose[1)] | | | | | |
|---|---|---|---|---|---|---|
| *S.cerevisease* dose[2)] | P0 | P1 | P2 | P3 | P4 | Total |
| N0 | 5111 | 6671 | 8913 | 9575 | 9304 | 79148 |
| N1 | 6415 | 9741 | 14990 | 13398 | 9326 | 108100 |
| N2 | 8005 | 12247 | 16490 | 11945 | 11317 | 120008 |
| Total | 39322 | 57118 | 80784 | 69836 | 60195 | 307254 |

Legend:
1) P0 = 0.0 % of rumen liquid (v/w)
P1 = 2.5 % of rumen liquid (v/w)
P2 = 5.0 % of rumen liquid (v/w)
P3 = 7.5 % of rumen liquid (v/w)
P4 = 10.0 % of rumen liquid (v/w)
2) N0 = 0 gr of *S. cerevisiae*/kg of garbage
N1 = 2 gr of *S. cerevisiae*/kg of garbage
N2 = 4 gr of *S. cerevisiae*/kg of garbage

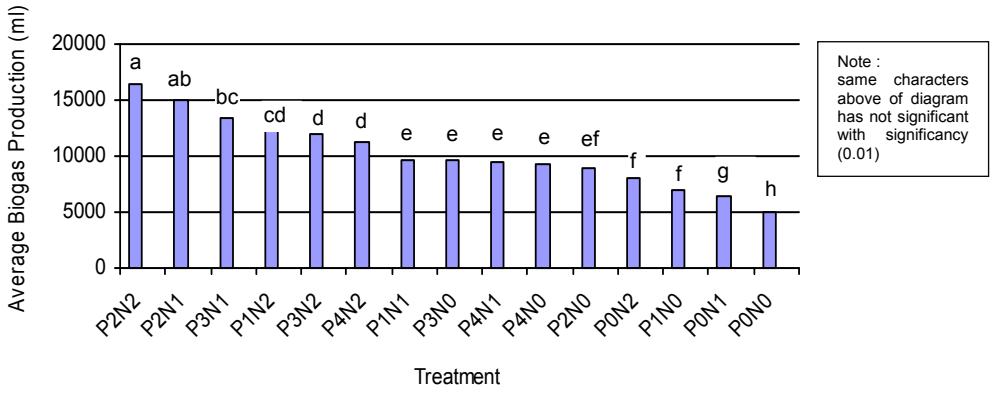


Figure 1. The different effect among the treatment combinations of rumen liquid and *S. cerevisiae* doses (ml)

The result also indicated that the increasing dose of *S.cerevisiae* from 2 gr/kg of garbage to 4 gr/kg of garbage results in non significant increase of biogas quantity. The conditions in digester were similar to that in rumen. The addition of *S. cerevisiae* culture to ruminant diets has improved the digestibility of dry matter, crude protein, and hemicelluloses; has increased ruminal bacterial numbers and activity, which in turn leads to increase degradability of forages and flow of microbial N postruminally; and has decreased ruminal lactate concentrations [9] [8]. It means as lactic acid is the precursor of biogas, the increasing dose of the yeast will not increase the concentration of lactic acid significantly, hence the production of biogas resulted from P2N2 and P2N1 are not differing.

Next, semi pilot project experiment indicated that P2N2 and P2N1 are also result in similar quantity and quality of biogas produced namely 8.7 l/kg garbage with 60 % methane content and 7.8 l/kg garbage with 63% methane content. This similarity is due to the C/N ratio of the feedstocks, that is 30 for both. Usually, biogas produced from municipal waste in landfill is 45 – 60% [7]. Therefore, the produced biogas can be classified as good biogas based on the percentage of methane.

The effects of P2N2 and P2N1 on pH and C/N ratio of the resulted sludge were not significantly different. The final pH are 6.83 and 6.8, while the C/N ratio are 20.1 and 20.7

respectively ($P<0.01$). A good organic fertilizer is characterized by neutral pH and C/N ratio of 10-20 [5]. Moreover, finished composts with C/N ratios above 20 will probably have very low mineralization potential: therefore, availability coefficients will be very low. At very low C/N ratios (e.g. 8 to 10) N availability coefficients may increase to approximately 0.5 [1]. Therefore, the sludge is potential to be used as organic fertilizer.

On the basis of semi pilot project experiment, with the assumption of operational period of 6 years, the B/C ratio of this biogas production is 2.1, which means that every US $ 1 will generate profit of US $ 2.1. In a year period, the BEP of biogas production is 99,086. It means that break event point of this biogas production will be reach if this production generates 99,086 kg of solid fertilizer, 568,000 liter of liquid fertilizer and 1,982 $m^3$ methane.

## CONCLUSIONS

The results indicated that the mixture of 5% of rumen liquid and 4 gr *S. serevicae*/kg of garbage provide the highest biogas production, followed by 5% of rumen liquid and 2 gr *S. serevicae*/kg of garbage, namely: 8.7 l/kg and 7.8 l/kg of garbage respectively. The biogas has good quality because it contains 60-63% of methane. Concerning its quality, the sludge produced are potential to be use as organic fertilizer. The result of study also indicates that the biogas production process is economically feasible.

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