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Problems Solving on Cacao Plantation By Biomethanization Technology

N. Ginting

Animal Production Program Study, University of Sumatera Utara, Padang Bulan, Medan, Indonesia
Correspondent author: nurzainahginting@gmail.com

Abstract. Indonesia is the third largest exporting cacao country in the world. There are several problems in cacao plantation, either come from insect or fertilizer. In addition, there is energy problem especially in rural area, as ratio of modern energy only 65%. The results showed that biomethanization technology;i.e biogas could solve these problems. Insects which live in cacao pod will be stopped their lifecycles as the cacao pod will be used as an input for biodigester. Sludge that come from biodigester could be used as fertilizer. 5.501.180 kWh electricity will be produced from all fermented cacao pod if it is utilized instead of wasted.

Keywords: *cacao plantation, insects, fertilizer, energy, biogas, Indonesia*

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1. Introduction

There are enormous cacao plantations in North Sumatera Province,Indonesia; either belong to people or to Indonesia government. In 2012, potentially pod cacao production in North Sumatera Province is about 122.255 ton with an assumption that cacao growth is 0,3%. 92,7% of total cacao plantation belongs to people instead of national or big private plantation and locate in rural area.

North Sumatera Province has a good temperate and soil for cacao plantation. However, thereare two major problems that harm cacao production. The first problem comes from *Helopeltis sp, Conopomorpha cramerella* which harms cacao production 25% and 80% respectively. Both of them are insects which live on cacao pod which scatter on farmyard. People do not care on cacao pod because they let cacao pod scattered after they take cacao fruit from the pod.

The second problem comes from fertilizer. Fertilizer is not enough to cover farmer's need. In order to overcome both problem, there is a technology i.e., biomethanization by constructing a biogas digester. Through biomethanization, pod cacao will be collected and use as substrate for biogas digester. Then, sludge from biogas will be used as fertilizer.

Biogas produces renewable energy. In Indonesia ratio for modern energy is 65% which means that only 65% of Indonesia people is facilitated with electricity and 35% especially who live in rural area is feasible as there is enormous biomass for biogas input. Cacao pod for example, could be used to improve modern energy ratio in rural area.

Figure 1. Cacao tree and fruit

Biomethanization technology give significant benefis such as biogas. Biogas processing is depended onto several factors such as input/biomass, microbes, plant design, construction materials, climate and the inter-relation among these factors (Ward *et al*., 2008).

Research on biogas in Indonesia have been conducted since decades, however the research has not covered many subjects. One subject that is worth to be investigate is cacao pod. Until nowadays, cacao pod is thrown scatterly on cacao plantation and trigger insects such as *Helopeltis sp* and *Conopomorpha cramerella* which harms cacao production.

Population of such insects become increase as long as Climate Change occurs and not only outbreak in cacao plantation but also in paddy and coffee. Production loss is significant enough and harm Indonesian's food security (Republik Indonesia, 2011).

Table 1. Nutrient Content of Cacao Pod

Nutrient Content (%)	Cacao Pod	
	Fresh Cacao Pod	Fermented Cacao Pod
Water Content	82,92	84,65
Fat	1,74	1,89
Rough Cellulose	32,47	24,79
Rough Protein	9,33	12,52

Livestock Research Center (2011)

In rural area of Sumatera Utara Province, people usually have livestocks such as cow, buffalo, lamb, goat although only a small number. Manure from these livestocks is source of digester microbes. Table 2 shows methane production from livestocks manure in Indonesia.

Table 2. Methane production from livestock manure

Manure	Fresh Manure (kg/day)	Methane Production (Litre/day)
Cow Dairy	10-15	280-340
Cow	23	750-1000
Buffalo	14	450-480
Goat	2	30

Widji (2007)

2. Materials and Methods

2.1. Materials

- natural cacao pod
- fermented cacao pod by local microorganisms
- cow dung
- biodigesters
- gas Metre

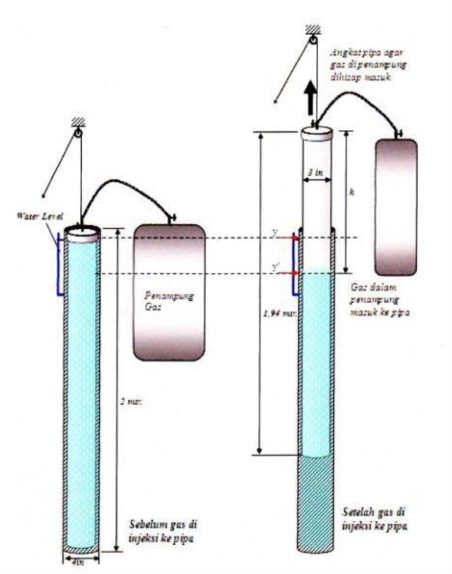

Figure 2. Gas Metre Prototype

2.2. Method

The research method used Completely Randomized Design (RAL) and the treatments were pod cacaocombines with animal waste.

T1: 25% cow dung, 75% cacao pod

T2: 50 % cow dung, 50% cacao pod

T3: 75 % cow dung, 25% cacao pod

T4: 25% cow dung, 75% fermented cacao pod

T5: 50% cow dung, 50% fermented cacao pod

T6: 75% cow dung, 25% fermented cacao pod

There were six replications:

6 laboratories scale biogas digesters were used (capacity 500 liters)

Cow dung was mix with cacao pod and water outside before altogether were inserted into biodigester. Then, from 3-inch inlet pipe, a rattan stick was used to slowly shake material in the biodigester in order to reduce material include microorganisms stuck on base of biodigester. Ginting (2010) found that 10 minutes shaking caused better gas production than unshaking.

Parameters: the parameters were gas production, pH and sludge fertility (C/N ratio).

HRT (Hydraulic Retention Time) 30 days. 6 Gas Meters for gas production measurement were created with 1 bar pressure.

3. Results and Discussion

Table 3. Gas Production

Treatments	Replication						Total	Mean
	1	2	3	4	5	6		
T1	91,29	85,84	68,87	78,70	84,50	62,94	472,14	78,69
T2	97,29	85,85	68,67	77,12	83,11	68,68	480,72	80,12
T3	57,27	62,95	74,39	63,82	67,70	68,79	394,92	65,82
T4	103,07	91,56	62,95	77,55	85,50	68,67	489.30	81,55
T5	114,46	97,29	85,86	94,72	102,70	97,29	592,32	98,72
T6	62,95	62,3	57,96	59,52	63,47	62,98	369,18	61,53
							2798,58	

Table 4. Duncan Test on Treatments

Treatments	**Mean**	**5% Differentiation**	**1% Differentiation**
T6	61,53	A	A
T3	65,82	A	A
T1	78,69	A	A
T2	80,12	Ab	Ab
T4	81,55	B	Ab
T5	98,72	Bc	B

Based on Duncan Test, T4 and T5 showed gas production were significantly different (5%) from other treatments. T4 and T5 contained 75% and 50% fermented cacao pod. Although there was no different between T4 and T5, there was a tendency that application of fermented cacao production more than 50% will decreases gas production.

According to Goenadi and Prawoto (2007) fresh cacao pod contains chemical compounds which harm microorganism’s growth, especially theobromin (0,17 – 0,22%) (EFSA, 2008). Others are lignin (38,78%), kafein (1,8 – 2,1%) and tannin 2,04%. Tannin causes protein and carbohydrate fromcacao pod become unavailable for microorganism thus microorganism growth as well as enzim production. All of these microorganisms’ anti-growth substrat possibly caused lower gas production inP1, P2 and P3 as these treatments used fresh cacao pod (Leinmuller et al., 1991).

In order to minimize effect of anti-growth substrate, a fermentation process could be used. Research conducted by Manik and Ginting (2011) used local microorganisms such as Rhizopus sp, Saccharomyces sp and Lactobacillus sp could decreased cellulose while increased protein content on agriculture waste such as coffee peel. Fermentation also decreased anti-growth substrate as application until 30% of fermented coffee peel improved pig growth (age 1-3 months). Other research was conducted by Nainggolan and Ginting (2012) by applied fermented cacao pod (still used same local microorganisms) until 40% improved pig growth (age 2-4 months).

Fermentation is a process either aerob/anaerob as microorganism which are used in fermentation is combination of aerob/anaerob microorganisms (Adams and Moss., 1995). Lactobacillus and Saccharomyces are anaerob while Rhizopus is aerob. These microorganisms work together in a symbiosis mutualism system. As they produce enzim which break carbohydrate, protein compounds of organic materials, a temperature will increase like in this research almost sixty degrees Celcius. As the results anti-growth substrate contain will decrease (Purnama, 2004).

Application of fermented cacao pod in this research showed that gas production was higher than fresh cacao pod. This result is in relation with previously researchs which mention that fermentation could decreased microorganism anti-growth substrate such as theobromin, tannin and lignin. However, there is a tendency that more than 50% fermented cacao pod decreased gas production.

Higher gas production also because microorganisms from cow dung in biodigesters were facilitated with higher protein and simpler compound of carbohydrate (Table 1) as the result of fermentation. However, application of more than 50% fermented cacao pod had a tendency to decrease gas production. Possibly this occurred due to accumulation of anti-growth micricroorganimssubstrate which not totally loss since temperature of fermentation is only below 60 degrees Celcius.

Fermentation in this research by using local microorganism is easy to be done by people in the rural area of North Sumatera Province. Rhizopus is cultivate from tempe and Saccharomyces is cultivated from tape. Tape and tempe are consumed almost regularly by people in the rural area as they are cheaper and source of protein and enzim. Lactobacillus is cultivated from rotten milk.

Average C/N ratio from biogas sludge in outlet in this research was about 19,7 which means that all input had been digested and fermented so that complex compound became simpler. According to Sutejo (2002) sludge C/N ratio below 20 is good to be applied as fertilizer for vegetation. As

C/N ratio was good, another research still in progress, i.e., the effect of sludge biogas on performance of livestock grass and the effect of sludge biogas on cacao production.

The highest gas production was produced by T5 where there was equal percentage of fermented cacao pod and cow dung. Dry matter content of fermented cacao pod was about 84% and cow dung about 30% and water was added to balance the dry matter content. 1 kg fermented cacao pod produce about 36 litres methane gas. In 2012, potentially there will be about 122.255-ton cacao pod which could produce 4.401.180 cubic methane. If one cubic methane could produce 1.25 kW electricity (Widji, 2007), fermented cacao pod in North Sumatera Province provided 5.501.475 kW electricity.

4. Conclusion

Application of 50% fermented cacao pod together with 50% cow dung as biogas input produced significantly methane and one kg fermented cacao pod produce 36 l methane. Total electricity is produced as much as 5.501.180 kW in 2012 if all 122.255 ton fermented cacao pod utilized by biomethanization technology. In addition, sludge biogas contain 19,7 C/N ratio which means sludge isgood to fertilize vegetation. If all of cacao pod use as input for biogas, there is no place for insects such as *Helopelthis* and *Conomorpha* to live.

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