Effect of Sugarcane Top Fermented Using *Phanerochaete* chrysosporium and *Cytophaga*sp to Dry Matter Degradation and Methane Emission

Wisri Puastuti[1,*] Dwi Yulistiani[1] and Susana IW Rakhmani[1]

[1] *Indonesian Research Institute for Animal Production, Indonesian Agency for Agricultural Research and Development, Bogor, Indonesia*
[*]*Corresponding author. Email:* wisri_puast@yahoo.com

ABSTRACT

The study evaluated dry matter degradation and methane gas emissions from sugarcane top-fermented to substitute grass. The first part of the research was to process sugarcane top using *Phanerochaete chrysosporium* (PC) and *Cytophaga* sp (CS) compared to sugarcane top without fermentation (SC). The second part of the research was to evaluate the degradability characteristics of unfermented sugarcane top (SC), fermented sugarcane top using *Cytophaga* sp (CS) and grass (G) which were measured in sacco for 0, 2, 4, 8, 12, 16, 24, 48, and 72 hours and methane gas emissions were measured in vitro. The experiment was carried out using RAL and replicated 3 times in sacco and 5 times in vitro. Results showed that the protein content of SC (4.52%) was less than PC (5.87%) and CS (5.71%), but there was no significant difference (P>0.05) between both PC vs. CS. Results of in sacco dry matter (DM) degradability test showed that the amount of dissolved fraction (a) from CS was not significantly different (P>0.05) with SC but was lower (P<0.05) than G. The number of fractions degraded at a specific time (b) and the degradation rate (c) of CS, SC and G were similar, but the degradability values for 24, 48, and 72 hours incubation of CS and SC were lower than that of G. The highest methane emission per DM degradability produced in CS = 34.4 ml/g followed by SC = 27.6 ml/g and G = 27.3 ml/g. It can be concluded that the processing of sugarcane top through fermentation can increase the protein and energy content. Although the DM degradation of fermented sugarcane top was low, the methane emission was higher than that of grass, indicating that sugarcane top fermentation can not replace grass function.

Keywords: *Fermented sugarcane top, degradation, methane emission.*

1. INTRODUCTION

Sugarcane top as a source of fiber feed has the potential to replace grass. Elephant grass contains 11.5% protein, 69% Neutral Detergent Fiber (NDF), 33.6% Acid Detergent Fiber (ADF) and 3.53% lignin [1] and sugarcane top contains 5.56% crude protein (CP) while crude fiber (CF) was 42.30% [2], NDF 74.38%, ADF 49.55%, lignin 7.36%. High fiber content can reduce feed digestibility. In addition, the use of feeds with high fiber content as energy sources will result in high methane emissions.

Feed processing utilizing fermentation technology is one of the options available for improving sugarcane top quality. Therefore, utilizing *Phanerochaete chrysosporium* for fermentation can help improve the quality of sugarcane top [3,4]. *Phanerochaete chrysosporium* can use cellulose which acts as a carbon source for its growth substrate and degrade lignin effectively. *Phanerochaete chrysosporium* fungi produce abundant ligninase enzyme so that in the process of lignin degradation by the ligninase enzyme is perfectly fermented sugarcane top [4].

Cytophaga sp bacteria are also known to be able to degrade fiber. The isolate cultures of *Cytophaga flavobacteria* and *Cytophaga huchnosonni* are widely used for the hydrolysis process, which can help convert cellulose into sugars and the biological hydrolysis of cellulose by *C. hutchnisonni* bacteria was more efficient compared with isolated other bacteria [5]. Based on the literature study, the study aimed to evaluate dry matter degradation and methane gas emissions from sugarcane top fermented to substitute grass.

2. MATERIAL AND METHODS

2.1. Sugarcane Top Processing

The sugarcane top used in this study was the top of the plants that had been harvested for their sugar cane, then chopped, dried, and finely grounded. The starter *Cytophaga* sp and *Phanerochaete chrysosporium* came from the microbiology laboratory of ITB, Bandung. Sugarcane top has been sterilized by steaming and then fermented using *Cytophaga* sp for 5 days and *Phanerochaete chrysosporium* for 4 days.

2.2. Evaluation of Sugarcane Top in sacco and in vitro

In sacco. The in sacco degradability evaluation was performed on unfermented sugarcane top, *Cytophaga* sp fermented sugarcane top, and elephant grass used rumen fistula cattle fed 50% grass and 50% concentrate. Nylon bags containing 5 g of sample were incubated in the rumen for 0, 2, 4, 8, 12, 16, 24, 48, and 72 hours. After the incubation period, the bags were washed with running water until the water was clear. Each treatment was repeated 3 times. Determination of the value of dry matter (DM) degradation characteristics in the rumen was calculated based on the Neway program [6].

In vitro. In vitro degradability evaluation was performed on unfermented sugarcane top, fermented sugarcane top of *Cytohpaga* sp, and elephant grass following the procedures from the previous study [7]. Methane gas production was measured according to procedures in previous studies [8, 9]. The experiment was done in a completely randomized design with 5 replications.

Data Analysis. Data collected were analyzed using the general linear model procedure in SAS package version 9.1. Means values were compared using Duncan's Multiple Range Test.

3. RESULTS AND DISCUSSIONS

3.1. Nutrient content of sugarcane top

Nutrient content of sugarcane top without fermentation (SC) and sugarcane top with fermentation (PC = sugarcane top fermented by *P. Chrysosporium* and CS = sugarcane top fermented by *Cytophaga* sp) are presented in Table 1. It showed that the composition of SC was significantly different (P<0.05) with fermented sugarcane top PC and CS, especially in protein and fiber content. The increased protein content was due to the bioconversion of organic materials that broken down into fungi body components [10]. Furthermore, it was said that changes in fiber content were due to degradation of this crude fibre by ligninase and cellulose produced by inoculants. The difference in PC vs. CS inoculants caused differences (P<0.05) in fiber and energy content. As energy source, CS has more potential than PC as indicated by the energy content of GE.

Table 1. Chemical composition of non-fermented and fermented sugarcane top

Treatment	Protein	Ash	NDF	ADF	Lignin	GE
	%					Kcal/kg
SC	$4.52^{b}\pm0,54$	$7.90^{b}\pm0.62$	$74.38^{c}\pm1.48$	$49.55^{b}\pm0.29$	$7.36^{c}\pm0.26$	$4256^{ab}\pm9.62$
PC	$5.87^{a}\pm0.24$	$9.06^{a}\pm0.10$	$78.15^{b}\pm0.45$	$54.63^{a}\pm0.79$	$10.99^{b}\pm0.26$	$4145^{b}\pm81.47$
CS	$5.71^{a}\pm0.15$	$8.76^{ab}\pm0.12$	$82.61^{a}\pm0.78$	$48.89^{b}\pm3.33$	$14.67^{a}\pm0.30$	$4302^{a}\pm69.71$

Values with different superscripts showed significantly different (P < 0.05), SC = sugarcane top; PC = sugarcane top fermented by *P. chrysosporium*; CS = sugarcane top fermented by *Cytophaga* sp; NDF = Neutral detergent fiber; ADF = Acid detergent fiber; GE = Gross Energy.

3.2. Characteristics of Degradation in sacco Sugarcane Top

Dry matter degradation value of elephant grass and sugarcane top increased as incubation time in the rumen increased. Elephant grass DM, on the other hand, had a greater degradation value than fermented and non-fermented sugarcane top (Figure 1 and Table 2). The degradability value of fermented sugarcane top was slightly higher than that of unfermented sugarcane top, but the difference was not statistically significant.

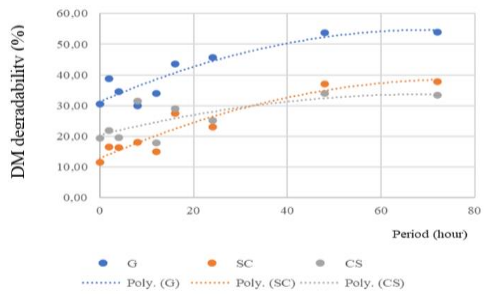

Figure 1. DM degradation pattern of sugarcane top vs elephant grass. G = elephant grass; SC = unfermented sugarcane top; CS = sugarcane top fermented by *Cytophaga* sp.

Table 2. The degradation characteristics of sugarcane top vs. elephant grass

Treatment	DM Degradation					
	a (%)	b (%)	c (%/h)	24 h	48 h	72 h
G	$32.37^a±1.44$	$30.94^a±2.19$	$0.02^a±0.01$	$45.65^a±10.32$	$53.69^a±2.05$	$53.97^a±2.24$
SC	$12.27^b±1.32$	$26.71^{ab}±2.65$	$0.03^a±0.01$	$26.41^b±2.50$	$37.11^b±0.44$	$34.42^b±3.60$
CS	$16.12^b±3.01$	$23.21^b±5.47$	$0.04^a±0.04$	$31.84^b±3.37$	$32.23^c±3.24$	$36.64^b±3.88$

Values with different superscripts showed significantly different ($P < 0.05$)

The low values of a (degraded fraction at 0 hours of incubation) and b (digested fraction at a specific time) of SC and CS indicated that these materials were not easily dissolved and were difficult to digest. The DM digestibility values for 24, 48, and 72 hours incubation of SC and CS were lower than that of G. It was suspected that the bacteria *Cytophaga* sp had not decomposed sugarcane top after 5 days of fermentation.

3.3. Methane gas emission

Methane gas production from rumen fermentation showed no significant difference (P>0.05) between G and SC but significantly different (P<0.05) with CS. If the methane emission was calculated from the total gas, the three feed ingredients did not differ. At the same time, the highest emission of methane gas from digested dry matter was produced from CS (34 ml/g), followed by G (27.3 ml/g), and SC (27.6 ml/g). This showed that processing increased the digestibility of sugarcane top, resulting in higher methane gas emissions. Methane gas emission in this study was higher than the previous report [11]. Sugarcane top without fermentation produced methane gas as much as 12.36% of the total gas or 21.53 ml/g of digested dry matter.

Table 3. Production of in vitro fermentation gas from grass and sugarcane top

Treatment	Total Gas (ml)	CH4 (ml) (ml)	CH4/Total Gas (%)	CH4/ DM Degradation (ml/g)
G	73.7^a	6.9^b	9.36^a	27.3^b
SC	61.5^b	5.5^b	8.94^a	27.6^b
CS	79.5^a	8.0^a	10.06^a	34.4^a

Values with different superscripts showed significantly different ($P < 0.05$)

4. CONCLUSION

Sugarcane top processed through fermentation using *Phanerochaete chrysosporium* and *Cytophaga* sp resulted in relatively the same composition. It can also increase the protein and energy content. Although the DM degradation of fermented sugarcane top was low, the methane emission was higher than that of grass, indicating that sugarcane top fermentation cannot replace grass function.

AUTHORS' CONTRIBUTIONS

All authors of this paper have an equal contribution from preparing proposals, conducting experiments to writing papers.

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