THE UTILIZATION OF THE COMPLETE RUMEN MODIFIER ON DAIRY COWS

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ABSTRACT

An experiment on the use of Complete Rumen Modifier (CRM) to improve dairy cow productivity and to mitigate enteric methane production has been conducted. Sixteen lactating dairy cows were distributed into 4 groups by using compelete randomized design (CRD). Group I (Control) fed by basal diet consisted of elephant grass and concentrate 7.5 kg/hd/dy (CP 16% and TDN 70%), Group II (Pro. *Woodii*) fed by basal diet + probiotic *Woodii*, Group III (Pro.N*oterae*) fed by basal diet + probiotic *Noterae*; Group IV (CRM-*Noterae*) fed by basal diet + CRM + Pro.*Noterae*. Measurements were conducted on body weight gain, average daily gain, feed conversion ratio, milk and methane production. Results showed that CRM-*Noterae* increased ADG by 72% (1.29 vs 0.75 kg) and improved FCR (9.2 vs 15.6). Probiotic *noterae* as single treatment or combined with CRM increased fat and total solid content of milk from 3.18% and 10.58% in control group to become 3.91%; 11.31% and 3.55%; 11.02%, respectively. The lowest methane production was recorded in Group IV. The combination of CRM and *Noterae* reduced percentage of methane production by 14%. It is concluded that combination of CRM and *Noterae* can improve dairy cow performance and decrease methane production. Probiotic *Noterae* improved milk quality.

Keywords: complete rumen modifier, A. woodii, A noterae, methane, dairy cow

INTRODUCTION

National milk production is only able to meet of approximately 30% of national milk demand (Ditjennak, 2005). This is mainly due to the low productivity of dairy cows in the country, which is 10-17 liters/head/day. In this condition, the average national consumption of dairy products per capita per year is only 4.16 kg/capita/year compared to in Cambodia (12.97 kg/capita/year) and Bangladesh (31.55 kg/capita/year).

Factors affecting productivity of dairy cows are the feed availability both quantity and quality, quality of male, age of first birth, breastfeeding, milking frequency, climate and health and hygiene management (Schmidt *et al*., 1988). Feedstuffs with the conditions of low quality and not sustainable availability throughout the season have a significant adverse impact on the production of milk from dairy cows in the country. Low quality forage has negative impact for the environment due to high methane produced during its fermentation in the rumen.

Various types of feed additives to inhibit the formation of methane gas by several types of mechanisms have been reported, among others, according to the nature of the toxic to methanogenic bacteria such as derivative compounds of methane (Boccazzi and Patterson, 1995; Miller and Wolin, 2001); based on hydrogenation reactions (Fieves *et al*., 2003; Thalib, 2004; Machemuller, 2006); based on the chemical compounds (Obashi *et al*., 1995; Thalib, 2004); protozoa defaunator (Jouany, 1991; Thalib 2004; Thalib *et al*., 1994; Thalib e*t al*., 1996). Two Asetogenic bacterial isolated from rumen of deer, *A.noterae* and *A.woodii*, reported (Thalib, 2008) reduced enteric methane production up to 11.6% (*noterae* culture) and 9.4% (*woodii* culture). The inhibition ability of these two cultures to methanogenesis was increased to become 28.8% and 20.6%, respectively, when they are combined with defaunator (Aksapon SR and others).

Feed additive reported in the current paper is consisted of some components with have multi-function, such as defaunator, inhibitor of methanogenesis, bacterial growth factors, bacterial and other hydrogen sink. The feed additive reported than is called Complete Rumen Modifier (CRM). The main component of CRM is *sapindus rarak* fruit in the form of crude extract or directly milled from the fruit. The crude extract of *Sapindus rarak* alone increased ADG of sheep by 44%, improved FCR by 20% (Thalib *et al*., 1996). Other studies by Wina (2005) indicated that crude extract of *sapindus rarak* increased ADG of sheep by 40% and cattle by 20%, respectively. Saponins contained in the *sapindus rarak* fruit was reported be effective as defaunator of protozoa as well as an inhibitor of methanogenesis (Thalib *et al*., 1996; Thalib, 2004). *A. noterae* and *A. woodii* bacteria in the rumen produce acetic acid according to the Wood-Ljungdahl reaction where fermentation of substrate by acetogenic bacteria increase acetic acid production. Acetic acid is a lipogenic acid which is responsible in fat formation, therefore the use of CRM in ration of dairy cow is expected to increase fat content of milk.

The objective of this study was to improve quality and production of milk and reduce methane emission from rumen fermentation by using *Complete Rumen Modifier.*

MATERIALS AND METHODS

Defaunating agent was prepared from *sapindus rarak* fruit (Thalib *et al*., 1994), *Albizia falcataria* and *Sesbania grandiflora* leaves powder and bacterial isolates were prepared according to Thalib *et al*. (2010) and microbial growth factors (MGF) was prepared according to Thalib *et al.* (1998).

In *in vivo* experiment, 16 lactating dairy cows were distributed into four groups of treatments each group is consisted of 4 animals. The groups were:

I. Control Group, without treatment (Control: C)
II. C + Probiotic *woodii* (Pro.*woodii*)
III. C + Probiotic *noterae* (Pro.*noterae*)
IV. C + CRM containing probiotic *noterae* (CRM-*noterae*)

The basal diet offered was consisted of elephant grass (*ad libitum*) and concentrates (16% protein and 70% TDN) at level of 7.5 kg/head/day. The animals were allowed to adapt to the experiment diets for about two weeks and the dietary treatments were kept continuously for 12 weeks of experiment. The amount of feed offered and residue was recorded every day to obtain data on feed consumption. Measurement of milk production was conducted every day, while quality of milk was conducted every week for 10 weeks. Collection of faeces was conducted for one week to obtain data of dry mater intake (DMI) and *in vivo* dry matter digestibility.

In *in vitro* experiment to determine methane emission, the inoculums was extracting from fresh cow manure. The *in vitro* was carried out in accordance with the procedures of Theodorou and Brooks (1990). Methane gas production was measured according to procedures Thalib *et al.* (2010). Experimental data were tested by using analysis of variance based on completely randomized design (CRD), and differences among the treatments were tested with least significant difference test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

All the animals were in the same production status, namely first lactation period. The body condition and reproductive status observed and recorded indicated that estimation of body score for all animals is 2 of range 1-5 in accordance with body condition scoring chart (Edmonson *et al.*, 1989).

The dietary treatment was conducted along with the improvement of the body score condition after the partus. In this condition, the animals required certain amount of nutrients, particularly protein and energy. Concerning about these, therefore the concentrate offered to the animals was formulated to contain 16% of protein. Thus the animals must receive about 7.5 kg concentrate per head per day. The data on body weight of the animals following dietary treatment program is showed in Figure 1 and Figure 2. It seems that there was high improvement in body weight after one month of dietary treatments application (Figure 1). After that, the body weight was relatively stable after 2 months of dietary treatment application. After two months of dietary treatments application, the body score condition was increase to become 2.75 - 3 from body score of 2 at the beginning of the experiment.

Body weight of the animals among the treatments at the beginning of the study could not be randomly assigned to obtain a uniform weight, thus the average initial body weight obtained for the treatment I was 333 kg; treatment II was 328 kg; treatment III was 358 and treatment IV was 324 kg. Results on body weight gain (BWG) indicated that among the groups of treatments (Figure 2), group IV has the highest average BWG. It was assumed that CRM contribute to the improvement of body weight of animals in Group

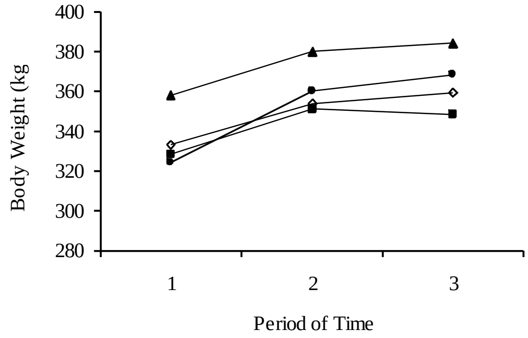

Figure 1. Average Body Weight of Aanimals in Each Treatment Group during the Experiment Period. ◊: Control; ■: Pro.Woodii; ▲: Pro.Noterae; ●: CRM-Noterae

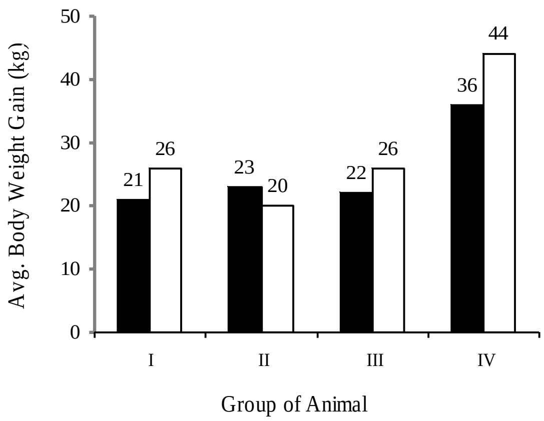

Figure 2. Average of Body Weight Gain (kg) of Animal in Each Treatment Group. I: Control; II: Pro.Woodii; III: Pro.Noterae; IV: CRM-Noterae; ■: 4 Weeks, □: 8 Weeks

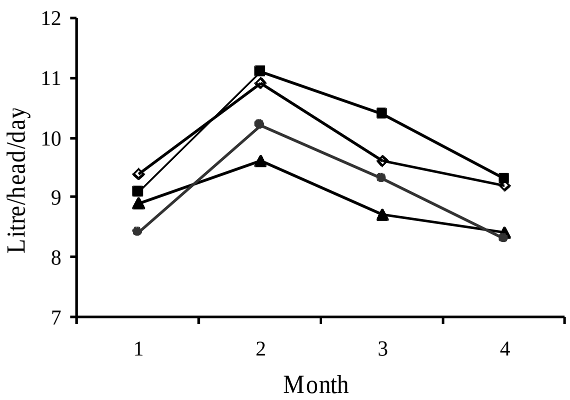

Figure 3. Average Milk Production from Each Group of Treatment during The Experiment. ◊: Control; ■: Pro.Woodii; ▲: Pro.Noterae; ●: CRM-Noterae

IV as reported previously on the study by Thalib *et al.* (2010) on sheep, that the CRM increased average daily gain of sheep by 45% with an increasing in feed efficiency by 18%. However, the value of BWG in Group IV (44 kg) did not differ significantly than those in group I (26 kg). It is assumed that because the number of replications per treatment is limited (ie. n = 4) which can not be avoided due to a shortage number of the animal.

Data on dry matter intake (DMI), average daily gain (ADG) and feed conversion ratio (FCR) are shown in Table 1. There is no significant difference in DMI and ADG values among the treatments, but it appears that the feed conversion ratio of CRM-*noterae* (treatment IV) was much better than other treatments. Feed conversion ratio showed in Table 1 was observed only during a period of body condition improvement. While, during the lactation period, feed conversion ratio is calculated for milk production and the calculation was based on ratio of the amount of dry matter diet consumed (in kg) per amount of milk produced (in L). There was no difference of feed conversion ratio for milk production among the treatments, that is for treatment I = 1.18; II = 1.19; III = 1.34 and IV = 1.28.

Dry matter intake is a basic fundamental value which determines whether the amount of nutrients that are available can meet the requirement for the animal production and health. In addition, given ration formulation will also determine the efficiency of feed (NRC, 2001). The amount of dry matter offered and consumed by the animals can be estimated according to body weight and fat content target of milk ($\geq$4% of fat). According to NRC (2001), the dry matter required for the certain body weight and fat content of milk of animals used in the experiment was 2-4% of body weight. The results of the study showed that the animals consumed dry matter feed about > 3% of body weight (Table 1). Therefore, it was assumed that the animals received sufficient nutrients for their maintenance and production.

The average milk production during four months of observation (one month before treatment and 3 months during treatment), are presented in Figure 3. There was no difference in the value of average milk production among the treatments. All the group of treatments showed similar trend of milk production, which indicated that the animals received adequate provision of concentrate. Milk production for all treatments

Table 1. Mean Values of DMI, ADG and FCR of The Animals During Recovery Condition (in 4 Weeks).

Treatments	DMI (kg/head/day)	ADG (kg/day)	FCR
Control	11.7	0.75	15.6
Pro.*woodii*	12.2	0.82	14.9
Pro.*noterae*	11.9	0.79	15.1
CRM.*noterae*	11.9	1.27	9.2

Table 2. Average Fat, Protein, and Total Solid Content of Milk Measured for 10 Weeks Period

Treatments	Fat	Total solid	Protein
	……………………(%)……………………		
Control	3.18[a]	10.58[a]	2.76
Pro.*woodii*	3.30[a]	10.64[a]	2.75
Pro.*noterae*	3.91[c]	11.31[c]	2.75
CRM.*noterae*	3.55[b]	11.02[b]	2.78
Average	3.49	10.89	2.76

Different superscript in the same column shows the significant different (P<0.05).

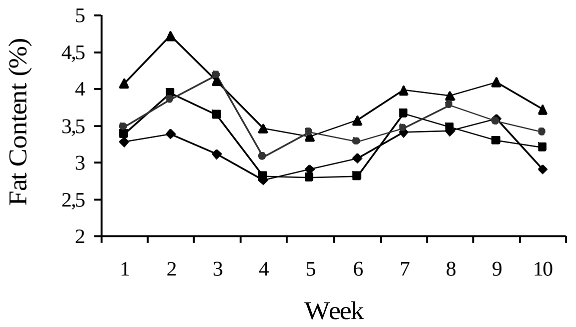

Figure 4. Average Milk Fat Content Produced From Each Group of Treatment During the Experiment Period. ◊: Control, ■: Pro.Woodii, ▲: Pro.Noterae, ●: CRM-Noterae

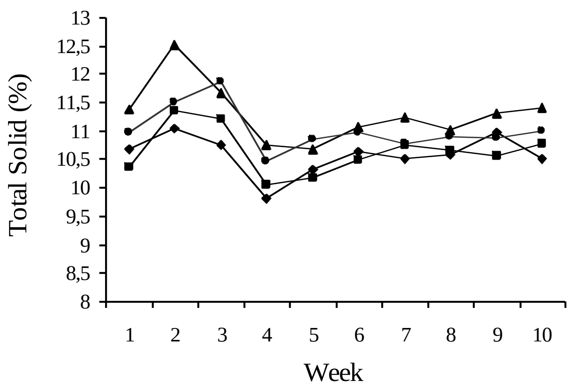

Figure 5. Average Milk Total Solid Content Produced from Each Group of Treatment During the Experiment Period. ◊: Control, ■: Pro.Woodii, ▲: Pro.Noterae, ●: CRM-Noterae

(June 2009) were increased compared to the values before the treatment was applied (May 2009).

There is no increase in milk production during the last two months of experiment period even tended to decrease. Milk production is start to decrease during this month because most of the animals used in the experiment were within 3- 6 months of lactation period, where the milk production has reach the peak and starting to decline. Due to low quality of grass, the average milk production in all treatment groups was less than 10 liters/head/day. The value is still far below the target rate of 13 liters/head/day.

The average fat, total solid and protein content of milk produced from each animals in all group of treatments measured every week during the 10 weeks of measurement period are shown in Table 2 and Figures 4-6. Fat and protein contents of milk during the 10 weeks of measurement period for all treatments seen fluctuated (Figure 4, and 6), but the total solid content was relatively stable (Figure 5).

The fluctuation of fat and protein content of milk during the 10 weeks of measurement period might be due to the inconsistency of quality grass offered to the animals. Protein content of milk produced by animals in Group I (Control) was below those the values recorded in the other three groups of treatments, with some points coincide with or slightly above the treatment II (Pro *woodii*). While, fat content of milk in Group III

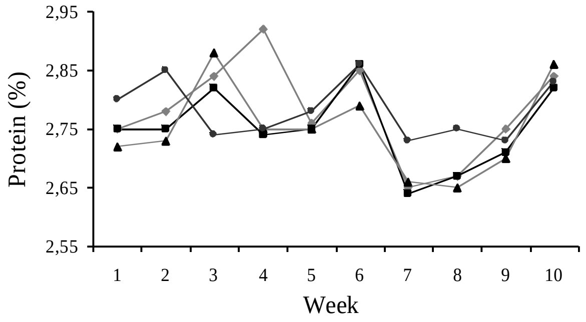

Figure 6. Average Milk Protein Content Produced from Each Group of Treatment During the Experiment Period. ◊ : Control; ■: Pro.Woodii, ▲ : Pro.Noterae, ●: CRM-Noterae

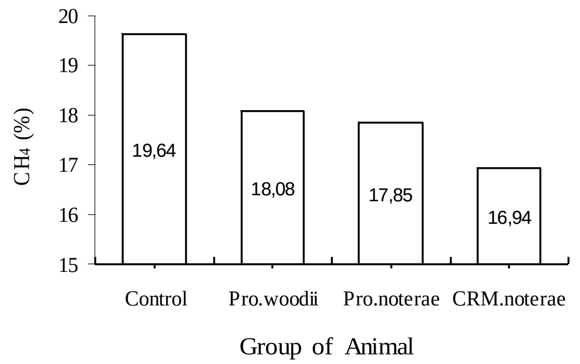

Figure 7. Percentage of CH_4 in Total Gas Resulted from Substrate Fermentation.

(Pro *noterae*) was above those values were observed in the three other groups (Figure 4). From these results it was assumed that milk fat content was mostly influenced by the composition of the acetic acid resulted from rumen fermentation in the digestive system.

Trend of total solid content (Figure 5) was similar with those of fat content (Figure 4) This result is as expected, because with the assumption that other component except fat were relatively stable, therefore increasing in fat content will be followed by increasing in total solid content. Protein content of milk produced from all the animals in all groups of treatments fluctuated week to week but within a narrow range and showed the high and low alternating positions between treatments (Figure 6).

The average contents of fat and total solid from 10 points of measurement show significant different values ($P<0.05$) between treatments with the highest levels observed in the treatment III. The higher content of milk fat in the treatment III and IV in comparison to the control is agree with the hypothesis that asetogenic bacteria (in this case was displayed by *A.noterae*) could reduce CO_2 to form acetic acid following the reaction path of the Wood - Ljungdahl, such as the following reactions:

$$2CO_2 + 4H_2 ===> CH_3COOH + 2H_2O$$

AG = - 25 kJ/mol. (Ljungdahl, 1986). Intervention of *A. noterae* in CRM is assumed to involve its action in lipogenic metabolism but it is not so with *A. woodii* where its ability to act in accordance with the reaction path of Wood–Ljungdahl may be low. This is probably because *A.woodii* unable to compete in the existence of microbial life in the rumen system. This is consistent with the assumption in previous studies (Thalib, 2008; Thalib and Widiawati, 2008).

Methane gas produced during *in vitro* fermentation of the substrate by using microbial inoculum extracted from animals faeces used in the experiment is presented in Figure 7. Methane produced from the three groups of treatment was lower than those produced from Control group. In Group II, III and IV, the production was 8% ($P>0.05$); 9% ($P>0.05$) and 14% ($P<0.05$) lower than those produced in Control Group, respectively. The results indicate that the treatment concentrates containing CRM-*noterae* can reduce enteric methane gas production by 14%.

In a previous study on sheep (Thalib *et al.*, 2010), CRM reduced enteric methane production up to 24%. The large difference of abated methane production (ie. 14% vs 24%) recorded in the current experiment and previous experiment are assumed not caused by different kind of animals used in the experiment. The difference is assumed due to differences in inoculum type used in both study. In previous experiment (Thalib *et al.*, 2010, the inoculums was taken out directly from rumen microbes, while in the current experiment the inoculum was collected from faeces of the animals.

CONCLUSION

Complete rumen modifier (CRM) containing *A.noterae* culture can be used to improve performance of dairy cow with lower enteric methane production. The CRM. a synergistic combination of the dual role of some additional components, is effective to improve productivity and reduce methane emissions of ruminants. So CRM will have a positive impact on ruminant production with healthy and friendly environment.

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