

Improvement of Rumen Degradability to Low-quality Tropical Forage with the Addition of a Complete Supplement

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Abstract. The low productivity of beef cattle is primarily due to the low rumen degradability of forage ration. This study aims to determine the level of addition complete supplement in improving rumen degradability to low quality tropical forages. The study was conducted *in vitro* using beef cattle rumen fluid treated with 4 levels of addition complete supplement (0, 5, 10 and 15% DM) in tropical forage was *paspalum conjugatum* containing CP 5.41%, NDF 56.47% and lignin 10.86%. Complete supplements are prepared from red sugar, bran, coconut meal, soybean meal, tapioca, urea, salt and mineral, with addition of 10% gambier pulp as source of condensed tannin. The addition of a complete supplement at level 10% significant ($P < 0.01$) increased rumen degradability of dry matter, organic matter, crude fiber and crude protein. The concentration of NH₃ in rumen fluid increased significantly ($P < 0.01$) at the supplement level of 10% while the TCA-soluble N increased significantly ($P < 0.01$) at the 5% supplement level. But the pH and total VFA were not significant effect ($P > 0.05$). Best level of complete supplement addition is 10% DM ration, while at level 15% gives negative tendency effect caused by negative effect of condensed tannin.

Keywords: complete supplement, beef cattle, tropical forage, rumen degradability, condensed tannin.

1 Introduction

In West Sumatera as well as in other parts of Indonesia, the development of beef cattle farm is was constrained in the provision of quality rations due to the limited source of quality feed and use competition with poultry farm resulting causes high prices so as not reached by the small farmers. This condition forces farmers to rely on beef cattle rations from native forages and is unable to provide concentrate feed. The low quality of tropical forage with low protein and rumen degradability [1] has led to lower rate of daily gain of beef cattle maintained on small farms [2].

Grass quality in tropical regions such as Indonesia is classified as low quality forage, has a protein content of less than 70 g / kg of dry matter [3] and unbalanced nutritional content [4]. The grasses grow in coconut, rubber and palm oil plantations without maintenance, resulting in low quantity and quality [5]. Tropical forages contain low rumen degradable protein because most of the nitrogen is bound to the cell wall, thereby reducing the degradation of the

forage crude protein which causes low ammonia (N-NH₃) concentrations in rumen fluid thereby limiting microbial activity, resulting in low rumen degradability [6].

Supplementation of nitrogen compounds in the form of urea, biuret, casein belonging to rumen degradable protein is reported to improve rumen degradability [7]. Similarly, supplementation of fermentable energy compounds such as starch and starch with protein combinations can enhance rumen degradability and has interaction effects increase the growth rate of rumen microbes that play a role in fermentative processes in the rumen [8]. Supplementation of urea with sucrose in the form of molasses or brown sugar with mineral addition in urea molasses block and saka block has successfully improved the digestibility of low quality tropical forages and increase livestock productivity [9][10].

Table 1. Composition of rations and complete supplements

| Item | | A | B | C | D |
|-------------------------|--------|----------------|-------|-------|-------|
| Forage, % | | 100 | 95 | 90 | 85 |
| Complete Supplement, % | | 0 | 5 | 10 | 15 |
| Supplement Composition | % DM | | | | |
| Red sugar | 15 | | | | |
| Bran | 27 | | | | |
| Coconut meal | 12 | | | | |
| Soybean meal | 15 | | | | |
| Tapioca | 15 | | | | |
| Urea | 5 | | | | |
| Salt | 3 | | | | |
| Minerals | 3 | | | | |
| gambier pulp | 5 | | | | |
| Chemical composition, % | |% DM..... | | | |
| Organic matter | 86,13 | 90,33 | 90,18 | 89,63 | 89,88 |
| Crude Protein | 29,36% | 5,41 | 6,10 | 8,46 | 9,46 |
| NDF | 42,50 | 56,47 | 54,86 | 52,22 | 51,67 |
| Lignin | 0,81 | 10,86 | 9,64 | 8,27 | 7,64 |
| Catechin | 0,49 | 0 | 0,025 | 0,049 | 0,074 |

In this study we will develop a complete feed supplement by combining block supplements that have evolved and understood the benefits with the addition of gambier pulp containing catechin as tannin condensation compounds to protect feed proteins. It is therefore desirable to have high rumen degradability by protecting quality protein to be available on post-rumen digestion.

2 Materials and methods

This study used a sample of low quality tropical forages from *Paspalum conjugatum* species taken on a smallholder farm in the Pariaman area of West Sumatra, Indonesia in the summer of March. This forage is a field grass that grows widely in the area of coconut plantations commonly used by farmers in this area as a source of forage in beef cattle farms. Complete supplements are prepared by formula Ramaiyulis et al [11] as shown in Table 1.

The treatment in this research is the level of complete supplement addition in ration that is 0, 5%, 10% and 15% (DM basis) in low quality tropical forage. The study was conducted in

in vitro method following the Tilley and Terry procedure [12], using cattle rumen fluid extracted from slaughterhouses from traditionally raised cattle with full-forage without concentrate. The rumen fluid taken from 4 different cattle then brought to the laboratory using a heated flask. The rumen fluid was mixed with buffer solution [13] at a ratio of 1:4. Then the mixture was added to the fermentation bottle containing 2.5 grams of ration sample and no sample as a blank

After that into the bottle exhaled CO₂ gas to create anaerobic conditions, then bottle closed and incubated at 39 °C using Shaker Waterbath. After 48 hours incubation the bottle soaked in ice water to stop the fermentation process. Then pH measurements using pH meters Hanna Hi9807-phep. The contents of the fermentor bottle were centrifuged at 3,000 rpm for 5 minutes to precipitate the remaining un-degraded feed and washed with aquadest 2 times with the same centrifuge and then filtered with Wathman 42 filter paper. Then the residue was dried in a 60 °C temperature oven for 24 hours, then determined dry matter, organic matter, crude protein and crude fiber following procedure of ICARDA [14].

The soluble rumen fluid nitrogen content in Trichloroacetic acids (TCA-soluble) was analyzed following the Shultz and Shultz procedure [15] using 10 ml of rumen fluid plus 10 ml of TCA 20% and 10 ml of sulfoacetic acid (SSA) was allowed to stand for 1 hour, then centrifuged 3,000 rpm for 20 minutes then the resulting sedimentation results analyzed protein content.

The total VFA in rumen fluid were determined on 5 ml supernatan with steam distillation, while NH₃ in rumen fluid was determined by analyzing 1 ml of supernatant mixed with saturated NaCO₃ in Conway cup, both following procedure of the General Laboratory Procedure [16].

Data were analyzed statistically using analysis of variance (ANOVA) with block randomized design and to test the real difference between treatments, Duncan's multiple range test (DMRT) [17]. The regression analysis were used to examine the relationship between factors of treatments. Data processing is done by computer using application of Statistica version 10 and Microsoft Excel 2010.

3 Result and Discussion

Rumen degradability

The results of the study in Table 2 showed that the addition of complete supplement was highly significant ($P < 0.01$) increasing the rumen degradability of dry matter, organic matter and crude protein of low-quality tropical forage rations. Increased rumen degradation occurs after the addition of supplements at the level of 10% of dry matter rations. The 5% supplement level did not significantly with the control, while the 15% level did not significantly with the 10% level. Means that the complete supplement level of 10% has optimally improved the rumen degradability of dry matter, organic matter and crude protein from low quality tropical forages.

The addition of complete supplements in ration of low-quality tropical forage caused an increase in crude protein content of the ration from 5.41 to 9.46% (table 1), this correlates closely with rumen degradability of dry matter ($P = 0.04$; $R^2 = 0.91$), organic matter ($P = 0.05$; $R^2 = 0.90$) and crude protein ($P = 0.05$; $R^2 = 0.90$). In this study we found that the crude protein level that gives optimal rumen degradability of dry matter, organic matter and crude protein is 8.46% ie in the addition of supplements at level 10% of dry matter rations. For

comparison Lazzarini et al. [18] reported that the optimal organic matter rumen degradability of low-quality forage was found at the crude protein level of 7.93% in ration.

Increased crude protein content in ration of low quality tropical forage due to the provision of adequate nitrogen for the formation of microbial enzymes that play a role in feed degradation [19]. Therefore increasing the rough protein of ration through the administration of easily degradable proteins with the addition of urea may stimulate rumen microbial activity and improve the degradation of organic matter, forage intake and livestock productivity in low quality tropical forage rations [7], [19].

If the supplement level is increased to the highest level (15%) in this study is not significant ($P > 0.05$) gives an increase effect compared to the level of 10%. This is due to the condensed tannin content in the gambier pulp which increases its concentration in the ration (Table 1). At the supplement level of 15% there is 0.067% catechin concentration in the ration which causes inhibition of dry matter digestibility, organic matter and crude protein. Catechin is a condensed tannin capable of forming complex bonds with proteins that are resistant to degradation at neutral pH in the rumen and one of the strategies in optimizing the use of nitrogen in ruminants [20]. Based on the results of meta analysis it was reported that in condensed tannins caused decreased digestibility of organic matter and crude protein in both in vitro and in vivo on certain level, but at low levels showed varying effects [21].

The effect of addition complete supplement on the rumen degradability of crude fiber of low quality tropical forage showed highly significant effect ($P < 0.01$). The lowest degradability occurs in the control without addition complete supplement that is only 35.76%. Addition of complete supplement at level 10% increased rumen degradability of crude fiber to 53.80%, but decreased again at a higher level on 15% to 46.78%. The addition of complete supplement to level 10% gives a positive influence on crude fiber degradability, this is due to the availability of nutrients needed by microbes that stimulate the activity of rumen microbes in degrading crude fiber of feed.

The decrease in the rumen degradability of crude fiber on addition complete supplement at level 15% occurs due to the content of the condensed tannin (catechin) compound in the gambier pulp. Tannins interact and inhibit the protein and fiber degradation in rumen [9], [22], [23] Wischer et al. [23] reported a significant decrease in fiber degradation by the tannin treatment of pelargonidine, catechin, cyanidin and sinapinic acid compounds, suggesting that fiber degradation was inhibited by condensed tannin treatment at level.

Rumen fluid Concentration

pH of rumen fluid influences rumen microbial activity especially cellulolytic bacteria which is expected to work optimally degrade high fiber rations of low quality forage. The addition of complete supplements did not show a significant effect on rumen pH ($P = 0.11$). The pH range obtained in this study was 6,90-6,97 which was at optimum pH for cellulolytic bacteria activity that is 6,9-7,0 [24]. Cellulolytic bacteria activity will be inhibited if the rumen fluid pH is below 6.0 [25].

The effect of addition complete supplement on low quality tropical forage on total VFA concentration in rumen fluid showed no significant difference ($P = 0.12$). VFA is derived from the fermentation of structural carbohydrates ie NDF and ADF fiber components in forage and non structural carbohydrates such as starch and sucrose contained in complete supplement. The process of carbohydrate degradation in the rumen occurs through two stages: breaking complex carbohydrates into simple sugars and simple sugar breakdowns into acetic acid, propionic acid, butyric acid, CO₂ and CH₄ [26]. In this study the total VFA concentrations ranged from 85.50 - 99.25 mM, the resulting VFA concentration was sufficient for livestock

survival because the VFA concentrations required for a livestock to grow normally ranged from 70-130 mM [27].

The NH₃ concentration in rumen fluid in this study was lowest 2.40 in the controls and the highest was found in the addition of 10% supplement 4.63 and significantly (P <0.01) influenced by the addition of complete supplements. NH₃ is the final product of crude protein degradation by rumen microbes through some of the previous products of polypeptide, amino acids and the last ammonia (NH₃). Several factors affecting NH₃ concentration in rumen fluid are feed protein level, protein source and its solubility and feed protein degradation rate [28].

The Complete supplement containing urea as crude protein and protected feed protein by condensed tannin from gambier pulp. At the complete supplement level of 10% there was an increase in crude protein degradation from control 39.29% to 53.68%. This is also reflected in the increased NH₃ concentration in rumen fluid from control to the 10% supplement level. However, at a higher supplement level of 15% there has been a protection of protein degradation because condensed tannins form a complex bond with proteins that are resistant to rumen degradation causing NH₃ concentrations that are not significantly different at that level.

The addition of a complete supplement significantly increased TCA-soluble N from the 5% level (P <0.01). The lowest values of these parameters were found in controls and highest in the addition of a complete supplement level of 10%. In control, the lowest score was 76.67 mg / dl of rumen fluid, significantly increased to 113.52 mg / dl after the addition of a complete supplement of 5% and 125.03 mg / dl at a complete supplement level of 10%. Apparently, if the supplement level is increased by more than 5% there is an increasing trend but not statistically significant.

TCA-soluble N contains proteins, peptides and amino acids derived from non-degraded feed proteins and proteins from rumen microbes, these are the values of proteins that will enter the post-rumen digestion. The increase of TCA-soluble N is a plus value of a complete supplement, in which the benefits of supplements are able to provide nutrients for optimal rumen microbial activity in degrading feed nutrients and capable of protecting high-quality feed protein so that it can be readily available in post-rumen. So the level addition of complete supplement should be limited to 10%, because the condensed tannin compound in the complete supplement has a negative effect on the higher supplement level.

Table 2. In vitro Rumen degradability and rumen fluid concentration to low quality tropical forage with addition complete supplement

| Parameter | Supplement level (% DM ration) | | | | SEM ¹ | P-value |
|---------------------------|--------------------------------|---------------------|---------------------|---------------------|------------------|---------|
| | 0 | 5 | 10 | 15 | | |
| Rumen Degradability, % | | | | | | |
| Dry matter | 49.01 ^b | 49.70 ^b | 51.97 ^a | 51.66 ^a | 0.01 | <0.01 |
| Organic matter | 43.80 ^b | 44.33 ^b | 46.59 ^a | 46.21 ^a | 0.01 | <0.01 |
| Crude protein | 39.29 ^b | 37.12 ^b | 53.68 ^a | 53.58 ^a | 0.02 | <0.01 |
| Crude fiber | 35.76 ^d | 42.50 ^c | 53.80 ^a | 46.78 ^b | 0.01 | <0.01 |
| Rumen fluid concentration | | | | | | |
| pH | 6.90 | 6.90 | 6.94 | 6.97 | 0.03 | 0.11 |
| VFA total (mM) | 99.25 | 85.50 | 91.25 | 95.00 | 4.54 | 0.12 |
| NH ₃ (mg/dl) | 2.40 ^c | 3.85 ^b | 4.63 ^a | 4.25 ^a | 0.16 | <0.01 |
| TCA-soluble N, mg/dl | 76.67 ^b | 113.52 ^a | 125.03 ^a | 122.12 ^a | 8.31 | <0.01 |

Different superscripts on the same line showed significantly different effects

4 Conclusion

The conclusions of the results of this study are the addition of complete supplements can improve the rumen degradability of dry matter, organic matter, crude fiber and crude protein of low quality tropical forage. The addition of the optimal complete supplement is 10% of ration dry matter for optimal rumen degradability and the rumen fluid concentration that supports the growth and activity of rumen microbes. The addition of a complete supplement increases TCA-soluble N that is the protein that will be available in the post-rumen digestion.

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