

# EFFECT OF VITAMIN - MINERAL SUPPLEMENTATION IN COMMERCIAL FEED ON THE DIGESTIBILITY COEFFICIENT AND RUMEN FERMENTATION OF BALI CATTLE

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## ABSTRACT

The aim of this study was to find out the influence of vitamin-mineral supplementation on digestibility and rumen fermentation in Bali cattle. The randomized block design with 4 treatments and 4 replications were used in the research. In this study was used 16 Bali cattle with body weight around  $295.31 \pm 23.07$  kg. Rations used in the treatments were Treatment A (control): rice straw *ad libitum* plus commercial feed; Treatment B: Treatment A ration plus 0.2% vitamin-mineral in commercial feed; Treatment C: Treatment A ration plus 0.3% vitamin-mineral in commercial feed, and Treatment D: Treatment A ration plus 0.4% vitamin-mineral in commercial feed. Parameters measured were nutrient digestibility, rumen metabolites and urinary allantoin. The results showed that supplementation of vitamin-mineral at 0.2 - 0.4% in commercial feed did not increase the digestibility of dry matter, organic matter, crude protein and crude fiber, except for dry matter and organic matter digestibilities at 0.2% supplementation ( $p < 0.05$ ). However, the vitamin-mineral supplementation increased concentrations of partial VFA and ammonia as well as for methane gas production, except for VFA and ammonia at 0.4% level. Vitamin-mineral supplementation at 0.2-0.4% level did not affected pH value of rumen fluid and urinary allantoin.

*Keywords: Bali cattle, Digestibility coefficient, Rumen fermentation, Urinary allantoin, Vitamin-mineral supplementation*

## INTRODUCTION

The high demand of beef is an opportunity and a challenge. The steps to anticipate the decreasing population of Bali cattle can be done by increasing its productivity through feeding improvement. Bali cattle's growth depends on nutrients quality contained in feedstuffs. High value forages may support the nutrient needed by the Bali cattle, but these availability are very limited especially in Bali. Rice straw is an agricultural waste and its availability is abundant, but up to now its utilization is still limited (Syamsu *et al.*, 2007). The rice straw production reached 5.53 ton dry matter per ha (BPS Bali Province, 2007). In terms of nutrients, rice straw contains crude protein 4.33% and crude fiber 30.85% (Utomo, 2005).

In fact, the rice straw is lack of nutrient and could be overcome by providing additional feed. The use of rice straw as the basal diet, even combined with commercial feed for Bali cattle, needs supplementation of vitamin-mineral mix to

enrich the nutrients such as vitamins A, E and minerals that are damaged during the manufacturing process, storage and the distribution of feed (Parakkasi, 1999). Multivitamin and mineral supplementation could improve the productivity especially on body weight gain as reported by Partama (2006) that Bali cattle given rice straw and commercial feed at 2.5% of body weight supplemented by 0.2 kg vitamin-mineral increased the body weight gain by 20%. However, the effect of multivitamin and mineral supplementation on microbial protein synthesis in Bali cattle is still lacking, and therefore need to be studied.

The objective of the study was to find out the influence of vitamin-mineral supplementation on digestibility and rumen fermentation in Bali cattle.

## MATERIALS AND METHODS

### Animals and Design

The research was conducted at the Beef

Cattle Experimental Station of Animal Husbandry, Fisheries and Maritime Affairs, Gianyar regency, Bali, for three months using sixteen Bali cattle (*Bos sondaicus*) with body weight (BW) around  $295.31 \pm 23.07$  kg. The cattle were grouped based on BW and were grouped into four groups for feeding treatments. The average of the BW on each group of A, B, C and D were 273.5, 294.0, 304.5 and 310.0 kg, respectively. Experimental design used in this study was Randomized Block Design with four treatments and four groups as replication, so there were 16 experimental units.

### Feeding Treatments

The cattle allowed the rations consisted of rice straw *ad libitum* and commercial feed at 2.5% of BW plus vitamin-mineral. The rations were formulated to fulfill or exceed the cattle requirement based on NRC standard (1976). The four feeding treatments were,

1. Treatment A: Rice straw *ad libitum* plus commercial feed, were given at 2.5%BW
2. Treatment B: Feeding Treatment A plus 0.2% vitamin-mineral in commercial feed
3. Treatment C: Feeding Treatment A plus 0.3% vitamin-mineral in commercial feed
4. Treatment D: Feeding Treatment A plus 0.4% vitamin-mineral in commercial feed

The chemical compositions of rice straw and commercial feeds as well as formulated rations for feeding treatments are shown in Table 1 and 2.

### Digestibility and Rumen Parameters

Total collection methods to determine nutrients digestibility and urinary Allantoin were carried out by collecting feeds, feces and urine for 7 days on week 11 of feeding treatments period. Nutrients digestibility was calculated according to AOAC (1990).

Nutrients digestibility coefficient (%) =

$$\frac{\text{Nutrients consumed} - \text{nutrients in feces}}{\text{nutrients consumed}} \times 100\%$$

Rumen parameters, such as volatile fatty acids (VFA) and ammonia were measured by collecting rumen's fluid which was performed on the day after total collections and at 4 hours after feeding time. The VFA concentration of rumen fluid partial (acetic, propionic and butyric acid) was calculated with formula below:

Partial VFA (mM) =

$$\frac{\text{High sample}}{\text{High standards}} \times \text{concentration of standards}$$

Ammonia concentration of rumen fluid was determined using Phenolphthoride (American Society of Limnology, 1969). This method was based on the color reaction which was determined by the amount of ammonia. Methane production was calculated using the formula of Orskov and Ryle (1990), as follow:

$$\text{Methane (mM)} = 0.5 \text{ Acetate} - 0.25 \text{ propionic} + 0.5 \text{ butyric}$$

The pH of rumen fluid was measured by a pH meter, while the protozoa population was measured by the method of Methylgreen Formalin Saline, (Ogimoto and Imai, 1981).

Amount of protozoa population (cell/ml) =

$$\frac{n \times p \times Fp}{A}$$

where

n = The number of protozoa in room count

p =  $10^4$

Fp = Dilution factor

A = The number of boxes counted

The level of allantoin in urine was measured by the method of Matsumoto *et al.* (1995), and was calculated using the following formula:

Level of allantoin =

$$\frac{\text{Allantoin standard}}{\text{Allantoin sample}} \times \frac{100}{5} \text{ (mg/100ml)}$$

### Statistical Analysis

All data were analyzed using an analysis of variance (ANOVA) and were tested using Duncan's New Multiple Range Test to compare the significant differences between treatment means (Steel and Torrie, 1991).

## RESULTS AND DISCUSSION

### Nutrient Digestibility Coefficients

The coefficients of nutrients digestibility in four feeding treatments are presented in Table 3. The results showed that vitamin-mineral supplementation at 0.2% in the basal ration containing commercial feed and rice straw increased dry matter digestibility ( $p < 0.05$ ), but no effect was found in other levels although numerically tended to increase. Similar results were found in organic matter digestibility. These phenomena indicated that digestibility can be maximized with the addition of precursor nutrients such as vitamins, minerals, amino acids,

Table 1. Nutrients Content of Commercial Feeds and Rice Straw

Nutrient Content	Commercial Feed	Rice Straw
Dry matter (%)	84.74	87.00
Organic matter (%)	80.53	75.00
Crude protein (%)	14.89	4.00
Crude fiber (%)	23.92	33.00

Table 2. Composition of Feedstuffs and Chemical Composition of Rations for Feeding Treatments

	Treatment			
	A	B	C	D
Ration Composition				
Commercial Feed (kg)	100.00	99.80	99.70	99.60
Vitamin-Mineral (kg)	0.00	0.20	0.30	0.40
Rice straw (kg)	<i>ad libitum</i>	<i>ad libitum</i>	<i>ad libitum</i>	<i>ad libitum</i>
Total (kg)	100.00	100.00	100.00	100.00
Nutrients content				
Dry matter (%)	85.87	85.87	85.87	85.87
Organic matter (%)	77.76	77.76	77.76	77.76
Crude protein (%)	9.45	9.45	9.45	9.45
Crude fiber (%)	25.46	25.46	25.46	25.46
Zn (ppm)	45.09	85.09	105.09	125.09
S (ppm)	685.50	02.09	711.10	719.64

and readily available energy (fermentable carbohydrates) in the rations. According to Cakra *et al.* (2008), the addition of minerals like Ca, P, S and Zn can improve digestibility coefficients of dry matter, organic matter and nutrient.

Crude protein digestibility coefficient (Table 3) showed not significant different ( $p > 0.05$ ) among the four treatments. This indicated that vitamin-mineral supplementation up to 0.4% in the commercial diet gave no significant influence to the proteolytic process in the rumen that digests proteins into the rumen. This findings was in contrast with the report of Karsil *et al.* (2001) that the concentration of vitamins (A and E), and minerals (Ca, P, S and Zn) contribute to the efficiency of protein synthesis. Similar result was found in crude fiber digestibility although numerically there was a tendency to increase with the provision of vitamin-mineral. The finding on crude fiber digestibility was slightly supporting the report of Bidura (2005) who claimed that

digestion rate of fiber in ruminant is linear to feed quality.

#### Rumen Metabolites and Allantoin Urine

The effect of vitamin-mineral supplementation on VFA and ammonia rumen is shown in Table 4. Acetic and butyric acids are the end product of the fiber fermentation in the rumen. In this study the concentration of acetic acid in treatment B, C and D was higher ( $p < 0.05$ ) than that in the treatment A, and this was thought that the level of vitamin-mineral supplementation in commercial rations have fulfilled all the needs of mineral such as Zn, S, vitamin A and E. This opinion is supported by Bal and Ozturk (2006) statement that the macro minerals (P, Ca and Mg), micro minerals (Cu, Co, Zn, Mn and S) and vitamins especially vitamins A and E played an important role in protein synthesis of rumen microbes, feed degradation and various microbial enzyme activator.

Table 3. Nutrients Digestibility Coefficients

Digestibility coefficients	Treatment			
	A	B	C	D
Dry matter digestibility (%)	60.44 <sup>a</sup>	79.08 <sup>b</sup>	66.92 <sup>a</sup>	65.74 <sup>a</sup>
Organic matter digestibility (%)	52.73 <sup>a</sup>	61.82 <sup>b</sup>	59.84 <sup>a</sup>	52.98 <sup>a</sup>
Crude protein digestibility (%)	57.99	68.39	67.33	67.22
Crude fiber digestibility (%)	66.39	67.40	67.96	66.64

Values with different superscript in the same row are significantly different ( $p < 0.05$ )

Table 4. Rumen Metabolites and Allantoin

Variables of partial VFA	Treatment			
	A	B	C	D
Acetic acid concentration (mM)	26.92 <sup>a</sup>	50.79 <sup>c</sup>	48.93 <sup>b</sup>	47.56 <sup>b</sup>
Propionic acid concentration (mM)	24.42 <sup>a</sup>	34.55 <sup>c</sup>	32.81 <sup>b</sup>	31.83 <sup>b</sup>
Butyric acid concentration (mM)	18.83 <sup>a</sup>	26.65 <sup>c</sup>	22.53 <sup>b</sup>	20.42 <sup>b</sup>
Partial VFA concentration (mM)	70.17 <sup>a</sup>	111.89 <sup>c</sup>	104.27 <sup>b</sup>	99.81 <sup>b</sup>
Ammonia concentration (mM)	3.21 <sup>a</sup>	9.46 <sup>c</sup>	4.39 <sup>b</sup>	3.39 <sup>a</sup>
Methane gas production (mM)	2.86 <sup>a</sup>	8.00 <sup>c</sup>	6.39 <sup>b</sup>	3.82 <sup>a</sup>
Rumen fluid pH value of	6.27	6.41	6.53	6.63
Population Protozoa ( $\times 10^5$ cell/ml)	3.67	4.41	4.42	4.75
Allantoin urine (mM)	4.43	5.83	4.90	4.73

Values with different superscript in the same row are significantly different ( $p < 0.05$ )

The propionic acid concentration obtained in treatment B, C, and D was higher ( $p < 0.05$ ) than that in treatment A, while the highest was found in treatment B. It showed that the level of supplementation of 0.2% has complied with all the nutrients precursor of rumen required for maximum microbial activity in digesting carbohydrates including fermentable carbohydrates (sugars and starches) entered the rumen. Propionic acid is the main result of carbohydrates (sugars and starches) fermentation in the rumen which important to rumen microbial growth and activity (Parakkasi, 1999).

VFA total concentration obtained (acetic, propionic, and butyric) on each treatment showed that supplementation with vitamin and mineral in commercial diet can improve rumen microbial

activity in the metabolism of carbohydrates and protein in the rumen. This was supported by the digestibility coefficient in treatment B, C and D which was tended to be higher than that in treatment A. According to the study of Witariadi *et al.* (2010), the high digestibility of dry matter causes higher rumen metabolism. This study showed the digestibility of dry matter in treatment B was the highest among those four treatments so that the rumen fermentation process would be more efficient. The VFA produced in the rumen will increase and in turn will lead more nutrient availability for microbes and animals.

The concentration of ammonia resulted in treatment B, and C was found higher ( $P < 0.05$ ) than that in treatment A (Table 4) while treatment B showed the highest among the treatments, being

9.46 mM. This study showed that giving vitamin-mineral could improve protein digestibility (Table 3) which was needed to provide ammonia for rumen microbial growth. Moreover, Khampa *et al.* (2006) stated that ammonia (N-NH<sub>3</sub>), carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) in the rumen are used to synthesize microbial cells. It has been explained also that the ammonia contained on the rumen fluid is an indicator of protein quality for the growth of livestock and rumen microbial.

The pH value obtained on each treatment showed no significant difference ( $P < 0.05$ ) with pH ranged of 6.27 - 6.63. The increment of pH on each treatment was caused by the presence of mineral through supplementation of vitamin-mineral. The presence of Zn in the feeding treatment may activate the carbonic anhydrase enzyme which one of its functions is to maintain acid-base balance of rumen fluid in normal pH ranged at 5.5-7.2, as stated by Owen and Goetsch (1998)

Protozoa population in all feeding treatments was found similar ( $p > 0.05$ ). It indicated that vitamin mineral supplementation has no effect on protozoa population, although numerically there was a tendency that vitamin-mineral supplementation in feeding B, C, and D give  $0.7-1.1 \times 10^5$  cell/ml higher than in feeding A. This tendency is presumably because of the influence of the vitamin-mineral addition especially Zn and S in the ration. The presence of Zn minerals in the rumen will increase microbial protein synthesis through the activation of microbial enzymes, whereas the presence of mineral S in the rumen can be used as a component of sulfur amino acid by rumen microbes that was in agree with the report of Karma (2005). The presence of Zn minerals in the rumen will also stimulate growth of rumen protozoa because Zn can easily penetrate protozoa and was utilized in the body for growth.

The excretion of urinary allantoin is shown in Table 4. Urinary allantoin was found similar among the treatments, indicated that vitamin-mineral supplementation has no effect on microbial synthesis. However, the vitamin-mineral supplementation tended to lift urinary allantoin by 0.3-1.4 mM, if compared to the control feeding. Total excretion of allantoin in urine is representation of bacteria's population growth in the rumen. Increasing excretion of allantoin is an indicator of the improving utilization of microbial protein by the animal, because allantoin is a derivative of the purine

nucleic acid which is mainly derived from microbes (Wanapat *et al.*, 2003). The higher allantoin levels, the higher crude protein digested as the result.

## CONCLUSION

The vitamin-mineral supplementation on rice straw and commercial feed increased the digestibility coefficient of dry matter and organic matter, partial VFA and ammonia concentration as well as methane gas production. However, the vitamin-mineral supplementation has no effect on digestibility coefficient of crude protein and crude fiber, and pH rumen. This study suggested that supplementation of vitamin-mineral at 0.2% is the best level to increase the feed utilization in Bali cattle.

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