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Rumen Mechanical Stimulation through Brush Administration: Its Influence on Performance of Beef Cattle Fed with Low Roughage Diet

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Abstract - In recent years concentrate feeding has been the main factor affecting production in feedlot cattle industry. The use of concentrate in feedlot is approximately 90% of the total feed consumed. Although such feeding practive is relevant in boosting animal performance within a short period of time, however, its application may induce a metabolic disorder in the rumen, i.e. acidosis. Acidosis occurs when lactic acid and volatile fatty acid production rate are above their clearance rate through absorption and passage to the subsequent gastro-intestinal tract. Rumen mechanical stimulation (RMS) is a technology that may reduce such incidence although the results so far are varied. Study just experimented in Indonesia with twenty Brahman crossbreed steers (ca. 267±4 kg) randomly allocated in four pens. fed in feedlot usual proportion and formulation (high proportion of grower and finisher concentrate, King Grass, rice straw, green cut corn as roughage with low proportion) on varies DM basis, following PT Mitra Catur Taruma feeding management. Ten experimental steers in two pens will be orally administered with three RMS into rumen of each animal using devices for administration as a treatment, and another as controls. Average feed intake and nutrients, body weight, average daily gain and carcass evaluation are compared. The results showed there were no significant differences ($p>0.05$) between two treatments (with or without RMS) in measured.

1. INTRODUCTION

In recent decades concentrate feeding has been the main factor affecting production in feedlot cattle industry. Although it has been suggested that a certain amount of roughage in the ration is necessary for maintenance of these rumen functions, the use of concentrate in feedlot is approximately 90% of the total feed consumed or even more. This feeding practice is relevant in boosting animal performance within a short period of time, but its application may induce a metabolic disorder in rumen, i.e. acidosis. Acidosis occurs when lactic acid and volatile fatty acid production rate are above their clearance rate through absorption and passage to the subsequent gastro-intestinal tract [1]. Varied grains as main composition of concentrate feeding may induce its tendency [2].

Rumen mechanical stimulation (RMS) is a technology that may reduce such incidence although the results so far are varied. The device has been developed since 1960th in same reasons at present with unsimilar design from its former study even unrecognized as an attractive study in all this time. This technology initially would act to stimulating rumen activity similar to stimulation by roughages [3] (*pseudo-fiber*), thus correcting some of feed problems and production encountered when feeding with high energy rations to ruminant. Later RMS developed as an artificial mechanical stimulating brush (commercially known as Rumenfibe: RF; Meiwa-Sangyo Co. Ltd, Kyoto, Japan) for stimulating the physical function of rumen mucosa and utilized as a medical device for animals [4].

Former data showed that RMS improved the proportion of propionic acid to total volatile fatty acid (VFA), although the total VFA itself was similar than that of control (without RMS administration) [5]. Feed intake, pH and rumination behavior of Holstein steers also improved due to RMS administered in individual treatment than ruminant under field flock [6]. However, administration of RMS on steers fed with concentrate and rice straw on 15-30% organic cell wall basis did not improve rumination, ruminal fluid passage time, digestibility and rumen characteristics, [7] [8] but might affect N-retention, passage rate and retention time on digestion and ruminal fermentation status if fed with high concentrate [9] [10]. Meanwhile, RMS administration reduced methane production released from methanogenic archaea which contained in rumen liquoir of Holstein steer, but did not improve on native Thai cattle [11]. The RMS also tended to increase rumen contraction and chewing activity that indicated rumination capacity of Holstein steer [12]. Through of all data, RMS can mitigate methane production by rumen fermentation status and made the best use of VFA nutrient into propionic acid [13] although significantly did not affect the ruminant performance and economically feasibility yet. In the present study, an experiment was conducted in Indonesia to evaluate the effect of RMS on the performance of beef cattle fed with low roughage diet.

2. METHOD

a. Experimental Animal and Treatment

The experimented was carried out at PT. Mitra Catur Taruma Feedlot, Bogor, Indonesia, between dry and rainy seasons at temperature about 30±4^{0}C and humidity around 67±18% in cooperation with Faculty of Animal Science, Bogor Agricultural University and Meiwa Sangyo Ltd, Japan, from October 2014 to January 2015 (93 days) with 7 days of adaptation period. Twenty Brahman cross bred steers (ca. 267±4 kg) were randomly divided into two treatments, allocated in four pens which five steers installed in each pen. Ten cattle in two pens as control treatment were not administered with Rumenfibes, and the other cattle in two pens as RF treatment were administered with three Rumenfibes (Figure 1) for each cattle into cattle's rumen using devices.

Figure 1. ***Rumenfibe® as RMS trough brush administration (Meiwa Sangyo. Ltd)***

b. Diet and Feeding

All animals were fed with 90% or more formulated concentrates (Starter, Grower and Finisher feed) and about 10% roughages (green cut King grass, rice straw, and green cut corn) depends on growing and fattening phase based on DM that presented in Table 1. Animals were monitored amounts of feed offered to animal two times a day at 8.00 and 15.00 with free access to water (*ad-libitum*).

Table 1. Chemical Composition of Feeds

Composition	Concentrate		Roughage		
	GR	FN	KG	CC	RS
	----------%----------				
Dry Matter	88,5	86,2	13,3	19,3	49,5
Organic Matter	85,3	90,4	88,4	92,5	89,5
Crude Fiber	18,2	16,8	20,1	27,5	27,4
Crude Protein	13,6	14,4	14,6	6,4	6,3
Ether Extract	4,1	4,7	2,5	1,4	2,1
Ash	14,7	9,5	11,6	7,4	10,5
NFE	49,3	54,5	51,2	57,2	53,6
TDN*	63,7	69,9	62,2	51,5	52,3

Note: GR= Growing Feed; FN=Finishing feed; KG=King grass; CC=Green cut corn; RS : Rice Straw NFE=Nitrogen free extract ;TDN=Total Digestible Nutrient.
*=National Research Council ,1966.

c. Data Collection and Statistical Analysis

Feed intake was monitored as total feed intake and individual daily feed intake was expressed as average daily feed intake. Bodyweight of each steer was weighed monthly (31 days/month). Consequently, average daily gain of individual steer calculated from monthly change of weight. Feed conversion efficiency of each animal was estimated from both body weight change in front and behind of experiment and total feed intake during experimental period. Then, carcasses weight and percentages of each steer were evaluated at the moment of slaughtering at animal slaughterhouse.

Nutrient composition of roughages and concentrates were analyzed (Laboratory of Biotechnology and Biological Resource Research Center of IPB; Institution of Seed Quality Testing And Feed Certification). Nutrient intake was calculated from the amount of nutrients in feed consumed, particularly TDN [14]. Then, all collected data statistically analized with Minitab 16. The statistical significance of differences between control and RF group was determined using Student's *t*-test at the level of $P<0.05$.

3. RESULT AND DISSCUSSION

The chemical composition of the concentrate and roughage used in this experiment are expressed as nutrient intake. The feed intake content of the concentrate and roughages on a dry matter (DM) basis with total dietary intake/steer during the experimental period was 887 kg (814 kg concentrate and 73 kg roughage) in the control group and 883 kg (811 kg concentrate and 72 kg roughage) in the RF group and have no differences between treatments. Thus, there were not significant differences between treatments in all measured parameters after all that were presented at Table 2.

Table 2. Feed Intake, Body weight Performance, Feed Convertion Ratio (FCR) and Carcass in cattle without (control) and with fiber brush administration (FB).

Item	Control			RF			P value
Feed intake							
Dry Matter (kg/day)	9,71	±	1,02	9,72	±	1,11	0,827
Organic Matter (kg/day)	8,55	±	0,14	8,56	±	0,14	0,830
Crude Fiber (g/day)	1768,56	±	187,69	1770,12	±	201,27	0,894
Crude Protein (g/day)	1313,07	±	137,16	1314,99	±	150,52	0,782
Ether Extract (g/day)	409,87	±	42,26	410,57	±	46,61	0,751
TDN (kg/day)	6,38	±	0,66	6,39	±	0,72	0,804
Final Body weigh (kg)	453,3	±	27,43	437,6	±	28,55	0,227
Average Daily Gain (kg/day)	1,98	±	0,28	1,84	±	0,30	0,296
Feed Conversion Ratio (kg DM/kg BW)	4,92	±	0,80	5,30	±	0,94	0,344
Carcass weight (kg)	231,70	±	13,82	226,80	±	14,53	0,445
Carcass percentage (%)	51,61%	±	3,98%	51,44%	±	4,14%	0,583

Values are mean ± SD of each cattle.

The RMS through brush administration had no effect on dry matter intake of steer and its nutrient (crude fiber, crude protein, extract ether, and TDN). Feed intake and nutrient intake did not show any significant difference between control and RF treatment on dry matter (DM) basis. It indicates that RF treatment was unable to improve feed intake of Brahman cross steer during the fattening phase. This result also supported by former experiment conducted to Thai native steers (*Bos indicuss*) [11] and Holstein steers that RF treatment had no differences than control treatment and its feed nutrient [15]. It was believed by high grain ration in feed composition containing high lactic acid that affect digestibility in rumen [16] although RF treatment can improve rumination time and fluid passage of rate in the rumen[10].

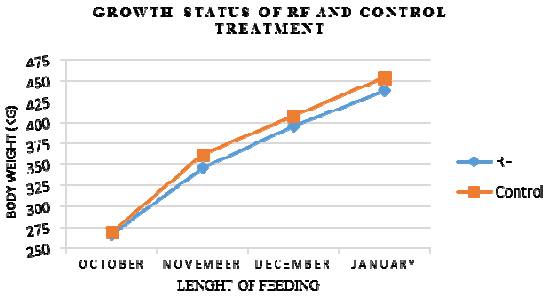

Figure 2. Growth Development of RF and Control treatment

RF treatment failed to boosting cattle performances such as body weight and average daily gain of Brahmancross steer (P>0,05). Its happened by early stressed which caused by installation of RF using devices that affect cattles phisiologies condition. This condition affect the length period of cattle adaptation and slowed the body weight gain caused of nutrient lost by stressed metabolism and in the other side compensatory feeding was not fullfill to maintain its requierment. Nutrient was directly related with the growth rate and the body composition during the development [17]. The energy was used to fulfill the requirement for maintaining, protein development and fat deposition.

Carcass quantity such as carcass weight and percentages were no differences between the control group and RF group. The percentage was similar in both groups. These appearence indicate that RF treatment had no effect on carcass quantity and its percentage on live weight. Similar result was reported that RF treatment were not affect carcass quatity, but the use of RF dosing for fattening beef cattle may produce beef of good eating quality by C18:1 fatty acid that compound in its [18].

4. CONCLUSIONS

Rumen Mechanical Stimulation trough brush administration ca. Rumenfibe did not affect on nutrients digestibility, body weight growth, Average daily gain and carcass quantity on dry matter basis feeding.

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