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The Formulation of Cattle's Rumen Content and Sludge Fermented with *Cellulomonas* sp. as Rabbit Feed

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Authors' Contribution
SAEM designed the study and wrote the manuscript. RAVT and IDRL participated in the data collection analysis. NLIMO interpreted the study results.

Key words
***Cellulomonas* sp., Fermentation, Rabbit, Rument content, Sludge**

ABSTRACT

This study aimed to determine the level of rumen content and sludge mixture fermented with *Cellulomonas* sp. in the complete feed composition to optimize the rabbit's performance, weight increment, and food conversion. The study used 30 calf male rabbits strain New Zealand White (8–11 weeks old, 435-1,037 g). The feed consisted of fermented rumen content sludge mixture (FRCSM), and other feed materials, such as corn, coconut cake, pollard, bran, sugar drops and minerals. Rabbits were given complete feed with following treatment: R_0 = feed without FRCSM, R_1 = feed with 10% FRCSM, R_2 = feed with 20% FRCSM, R_3 = feed with 30% FRCSM, and R_4 = feed with 40% FRCSM. The results showed that the highest feed consumption and weight increment were found in the R_3 group by 60.5 g/individual/day and 17.8 g/individual/day, respectively. However, the R3 group exhibited the lowest food conversion ($p<0.05$) compared to another group. It was indicated that the R_3 group was a more efficient feed. Feed with 30% *Cellulomonas* sp.-fermented rumen content and sludge mixture (FRCSM) was an ideal feed composition for the rabbit to increase consumption and body weight increment and reduce food conversion.

INTRODUCTION

A rapid increase in the meat demand due to a rapid rise in human population in the resource-limited developing countries has triggered growing research to exploit the potential of low-inputs animal production systems (Khan *et al*., 2017; Habib *et al*., 2016). However, the rabbit has many advantages such as high prolificacy, rapid growth and short generation interval. The availability of animal's feed is limited by decreased green field from land conversion to residences, industries, transportation, etc., resulting from population growth. To overcome problems of areal limitation for animal's food plants, lack of grass in the dry season, and reduce feed cost and environmental pollution, alternative food materials are needed (Habib *et al*., 2016).

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Rumen content and organic wastes of biogas (sludge) are large amounts of garbage and can disturb the environment if they are not well handled. Rumen content is collected from the slaughterhouse, while sludge is the mud of residual biogas production. This livestock waste is rich in essential amino acids and vitamins and potential to make the feed material of rabbit. Rumen content and sludge are cattle wastes that still contain good nutrition if used as livestock feed (Moningkey *et al*., 2016). Rumen content has digestive processes in the rumen mechanically or biologically and held rumen microbial cell biomass (Adeniji *et al*., 2015). Sludge comes from cattle's feces containing endogenous N and protein passing from rumen degradation and is not digested in the abomasum so that it is released as feces (Moningkey *et al*., 2016).

Biogas production uses feces as raw materials, and in the process, the feces will be fermented, in which the remaining solids wasted in the biogas process is called sludge. The major constraints of this waste utilization as rabbit's feed are high fiber and low protein content (Osak *et al*., 2015). To reduce the coarse fiber content and increase protein content of this alternative food source, microscopic organisms *Cellulomonas* sp. is used, since these cellulotic microbes are capable of digesting the cellulose. Yustanti

(2009) stated that *Cellulomonas* sp. is the cellulose-digesting microorganism that highly influences the degradation of sugar cane pulp (lignocellulose containing waste).

Efforts of utilizing the rumen content and the cattle's sludge through fermentation are expected to break down the complex organic compounds into more simple compounds to be well digested by rabbit livestock. This waste also has an essential and strategic benefit in economic and efficient livestock development. Therefore, the present study aimed to determine the level of rumen content and sludge mixture fermented with *Cellulomonas* sp. in the complete feed composition to optimize the rabbit's performance, weight increment and food conversion.

MATERIALS AND METHODS

Materials

This study used wastes of cattle's rumen content collected from the slaughterhouse and sludge from the biogas processing unit. These materials were mixed in 50:50 ratios and fermented for 8 days employing *Cellulomonas* sp. at the concentration of 10^7 CFU/g dry material. The feeding trial was used 30 male rabbits (8-11 weeks) of New Zealand white strains with a weight range of 435-1037 g. Rabbits were obtained from the public farm, rumen content and sludge mixture, and other feed materials, such as corn, coconut cake, pollard, bran, sugar drops, and other materials bought from animal's feed material shops. These feed materials were formulated to make complete feed without using green feed. Animal's cages (50 × 50 × 60 cm^3) were prepared and facilitated with feeding and drinking spots, balance, room thermometer, and other supporting equipment.

Experimental design

The study was experimental with group randomized design based upon the initial bodyweight of the rabbit. Variance coefficient (VC) was 23.77% (VC > 10%), meaning that the initial bodyweight of the rabbit was not homogenous. Rabbits were separated into three groups: a) rabbit group of low body weight, 435 g, 456 g, 471 g, 480 g, 497 g, 535 g, 556 g, 574 g, 584 g, and 590 g (VC = 9.07%), b) rabbit group of medium bodyweight, 612 g, 620 g, 694 g, 708 g, 712 g, 721 g, 736 g, 747 g, 781 g, and 780 g (VC= 8.13%), and c) rabbit group of high initial body weight, 787 g, 814 g, 818 g, 830 g, 860 g, 878 g, 888 g, 960 g, 1016 g, and 1037 g (VC = 9.82%).

Treatment feed

The treatment feed was separated into 5 levels of concentrations with 3 replications. There were 15 experimental units, and each experimental unit had 2 individuals, so 30 individuals of rabbits were used. The concentration levels of rumen content and sludge mixture fermented with *Cellulomonas* sp. in the complete feed made in pellet form were set as follows: R0 = Feed without fermented rumen content and sludge mixture (FRCSM); R_1 = Feed with 10% FRCSM; R_2 = Feed with 20% FRCSM; R_3 = Feed with 30% FRCSM; R_4 = Feed with 40% FRCSM

The feed nutrient content and composition in the complete feed are presented in Tables I and II.

Adaptation phase

Male rabbits of New Zealand White strain of 8–11 weeks old were selected, weighed, and separated into 3 groups as small, medium, and large initial weights. Using a battery system, the selected rabbits were put into a 50 × 50 × 60 cm metabolic cage. The experimental units were randomly set using random numbers with one individual per experimental unit. After the rabbits had been caged, they were adapted to experimental feed for 10 days. The need for each feed material was calculated following the treatment feed formulation.

Preliminary feeding adaptation

All experimental rabbits were fed 3 times a day at 07.00 am, 12.00, and 5.00 pm local time. This preliminary study was intended to eliminate the previous feed effect and determine the feed given. This activity was done for 5–10 days.

Table I. Feed material nutritive content (in dry matter).

Ingredients	Nutrient content						
	Dry matter (%)	Crude protein (%)	Crude fiber (%)	Ether extract (%)	Calcium (%)	Phosphorus (%)	Metabolizable energy (Kcal/kg)
FRCSM	86.04	12.45	26.12	1.30	0.27	0.19	3,062
Pollard	88.54	16.50	14.90	4.00	0.14	0.32	1,300
Yellow corn	88.76	8.60	2.70	3.90	0.02	0.10	3,400
Coconut cake	87.92	18.50	15.00	2.50	0.20	0.57	2,200
Bran	87.82	11.56	13.36	7.00	0.04	0.16	2,860
Concentrate	88.78	38.00	11.14	5.90	1.40	1.20	2,600
Molasses	87.50	3.00	0	0.10	0.90	0.10	1,960

Table II. Composition and nutrient content of treatment feed.

Materials	Treatment				
	R_0	R_1	R_2	R_3	R_4
FRCSM (%)	0	10.00	20.00	30.00	40.00
Pollard (%)	26.00	27.00	26.00	26.00	20.00
Corn (%)	22.00	19.00	16.00	10.00	8.00
Coconut cake (%)	15.00	8.00	7.00	6.00	5.00
Bran (%)	18.00	17.00	12.00	10.00	9.00
Concentrate (%)	17.00	17.00	17.00	16.00	16.00
Molasses (%)	2.00	2.00	2.00	2.00	2.00
Total (%)	100	100	100	100	100
Dry matter (%)	88.39	88.18	87.97	87.72	87.48
Crude protein (%)	17.56	17.30	17.36	17.29	17.07
Crude fibre (%)	11.02	12.51	14.08	16.00	17.38
Ether extract (%)	4.54	4.35	3.95	3.63	3.35
Calcium (%)	0.33	0.35	0.37	0.38	0.39
Phosphorus (%)	0.43	0.40	0.40	0.39	0.38
Metabolizable energy (Kcal/kg)	2,412	2,447	2,473	2,470	2,579

Notes: Processed feed nutrient content.

Data collection

The amount of the treatment feed was prepared a day before feeding. While weighing the remaining feed was carried out the next morning (at 06.30 – 07.30 am), and each unfed feed was placed in prepared buckets. The data were used to know the amount of feed consumed, and the feed was stocked for 3 – 5 days feed treatment. Data collection was conducted for 40 days. The daily feed consumption and body weight increment was calculated by the following Equations 1 and 2:

Daily feed consumption (g/individual) = amount of feed given – the amount of uneaten feed … (1)

Body weight increment (g/individual) = final lived body weight – initial body weight … (2)

Food conversion was obtained from the feed amount consumed and body weight increment in weight and time unit (Equation 3).

$$\text{Food Conversion} = \frac{\text{Amount of feed consumed}}{\text{Bodyweight increment}} \quad \ldots(3)$$

Statistical analysis

The study used randomized complete block design (RCBD) in the linear model as follows:

$$Y_{ij} = \mu + T_i + B_j + €_{ij} \quad \ldots(4)$$

W here Yij is the response of ith treatment in jh block, μ is the overall mean, Ti is the effect of ith treatment, Bj is effect of jth block; €ij is the experimental error.

The observed values obtained by the model above were analyzed with ANOVA and then continued with Duncan's Multiple Range test if there was a significant effect to know the difference between treatments (Sudjana, 2002). All statistical analysis were performed using IBM SPSS Statistics version 23 for Windows.

RESULTS AND DISCUSSION

Effect of FRCSM in the complete feed on feed consumption

Table III demonstrated the effect of *Cellulomonas* sp. fermented rumen content and sludge mixtures (FRCSM) in the complete feed on the rabbit livestock performance. The growth of rabbit, like other animals, depends on consumption and utilization of the feed. Feed consumption is crucial in rabbit livestock productivity determination (Fadare, 2015; Maidala *et al*., 2016). Results showed that the highest feed consumption occurred in treatment R_3 (60.5 g/individual/day). Treatment R_3 was statistically higher than that of R_0, R_1, and R_4 (P<0.05) but not different from that of R_2 (Table III).

Feeding of FRCSM could increase the consumption level at 30% FRCSM (R_3) administration and then reduce the consumption level at 40% FRCSM (R_4) administration. It means that the use of FRCSM in the complete feed could trigger the rabbit's appetite up to 30% FRCSM because the fermented product contains a synthesis of the vitamin B complex that could increase the appetite. Decreased appetite in treatment R_4 could result from higher CIRSF administration with high metabolic energy, 3,062 kcal/kg so that the cattle are quickly total. The R4 rations also hold higher coarse fiber than other treatments, making it difficult to digest. The palatability could also be an influencing factor, in which the rabbit does not like feed aroma or flavor. According to Church and Pond (1980), feed palatability is related to the feed's texture, color, flavor, and aroma. Nurhayati *et al*. (2006) found that fermentation's benefits raised feed quality and palatability. According to Khan *et al*. (2017), several internal or external factors affect the consumption level of the livestock, environmental temperature, palatability, taste, physiological status, nutrient concentration, feed shape, and livestock body weight.

Effect of FRCSM in the complete feed on daily weight increment

The FRCSM administration in the complete feed significantly affected the body weight increment of the rabbit (P<0.01). The mean weight increment is shown in Table III. The highest weight increment was found in

Table III. Mean feed consumption, weight increment, and food conversion.

Variables	Treatments				
	R_0	R_1	R_2	R_3	R_4
Feed consumption (g/individual/ day)	50.5±9.85^{b}	48.7±13.28^{b}	52.8±14.74^{ab}	60.5±8.18^{a}	43.8±2.81^{b}
Weight increment (g/individual/ day)	14.6±2.07^{b}	13.5±0.94^{b}	15.3±3.87^{b}	17.8±1.68^{a}	10.0±1.83^{c}
Conversion	3.5±0.52	3.6±0.95	3.4±0.88	3.4±0.25	4.4±0.79

Notes: different alphabets indicate highly significant difference (P<0.01).

treatment R_3 (17.8 g/individual/day) and the lowest in treatment R_4 (10.0 g/individual/day). Thus, treatment R_3 is the best treatment since it reflects the highest feed consumption during the study and gives the highest weight increment. Increased feed consumption does not always yield a high body weight increment in a certain condition.

Bhatt *et al*. (2017) stated that one factor influencing the bodyweight increment is feed consumption. High feed consumption and digestibility will yield higher weight increment. It could result from increasingly numerous nutrients absorbed by the livestock's body. This is supported by Pascual *et al*. (2014) that the livestock body weight is directly proportional to the feed consumption level. It means that feed consumption will demonstrate the nutrients taken by the livestock affecting the livestock's weight increment. According to Bhatt *et al*. (2017), there is a close correlation between growth and food consumption. Increasingly higher feed consumption will increase protein consumption, increase livestock growth, and raise meat production. The nutrients taken by the rabbit are utilized to fulfil the major living needs and growth (Bhatt *et al*., 2017).

Effect of FRCSM in the complete feed on food conversion

Food conversion is the ratio of feed amount consumed by the livestock and body weight increment. Food conversion is inversely proportional to feed efficiency, in which the lower the food conversion is, the higher the feed efficiency so that it will affect the production costs (Belabbas *et al*., 2019).

Based on Table III, it is apparent that means food conversion to be 3.5 (R_0), 3.6 (R_1), 3.4 (R_2), 3.4 (R_3), and 4.4 (R_4). Treatments R_3 and R_2 reflect the lowest food conversion despite statistically not being significantly different (P>0.05) compared with R_0, R_1, and R_4. Lower food conversion reflects better food quality. It is in agreement with Oonincx *et al*. (2015) that low food conversion indicates high food efficiency. Increased protein content and decreased coarse fiber will raise the feed quality. Higher feed quality will impact growth and feed efficiency. Treatments R_3 and R_2 showed the lowest food conversion in this study, indicating that those treatments are more efficient than other treatments. The mean food conversion of the rabbit in the present study is higher than that of the previous research (2.62 – 3.46) (Aritonang *et al*., 2004), with the mean value of 3.00, that employs feed containing 16% PK, DE of 2,500 kcal/kg and 0.1% biovet. Rabbits are an efficient converter of forage into good quality animal protein compared to other livestock (Pasupathi *et al*., 2015).

Food conversion could also be influenced by several factors, such as gene, feed shape, temperature, environment, feed consumption, fresh weight, and sex. Basuki (2002) stated that food conversion is affected by consumption of dry matter and daily weight increment, which increase the body weight and improve the efficiency of feed. Until now, there has been limited study regarding the use of the mixture of rumen content and sludge fermented with *Cellulomonas* sp. to improve the feed consumption, body weight, dan food conversion of rabbits. This study gives new insight into the alternative feed to increase the performance of rabbits.

CONCLUSION

Feed with 30% *Cellulomonas* sp. fermented rumen content and sludge mixture (FRCSM) in the complete feed was the ideal feed composition for rabbit livestock to increase consumption and body weight increment and reduce food conversion. The use of rumen content and sludge could be one of the important and strategic efforts to benefit waste in rabbit livestock development.

Statement of conflict of interest

The authors have declared no conflict of interest.

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