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Performance and Meat Quality of Local Sheep Administered with Feed Additive Containing Probiotic and Organic Mineral Complex

H. Herdian*, A. Sofyan, A. A. Sakti, H. Julendra, M. F. Karimy, A. E. Suryani, E. Damayanti, & L. Istiqomah
Division of Animal Feed & Nutrition, Center for Processes Development & Chemical Engineering (BPPTK), Indonesian Institute of Sciences (LIPI)
Jln. Yogya-Wonosari Km. 31.5, Gading, Playen, Gunungkidul, D.I. Yogyakarta 55861, Indonesia
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ABSTRACT

The experiment was conducted to evaluate the effect of probiotic and organic mineral complex (POMC) administration on performance and meat quality of local sheep. In this study, 6 sheep with an average initial body weight of 12.67±0.81 kg were arranged in a completely randomized design with 2 treatments and 3 replications. The treatments were T0: basal diet (control) and T1: basal diet + POMC. The basal diet consisted of forage and concentrate (60:40) with dry matter of feed intake as much as 5% of body weight. Dose of POMC used in this study was 15 g/d/head. The POMC contained lactic acid bacteria, i.e. *Lactobacillus* sp. ($1x10^8$ cfu/g) and *S. cereviseae* incorporated with micromineral Co (2 ppm), Cu (100 ppm), Fe (2.5 ppm), I (110 ppm) and Mn (100 ppm). The experimental period lasted for 11 wk (1 wk for adaptation and 10 wk for data collection). Data were analyzed using t-Student statistical test to compare the treatments. The results showed that POMC administration did not affect the body weight gain (BWG) (7.46 kg) compared to control (7.13 kg) while concentrate consumption (26.9 kg) of POMC was lower than the control (28.6 kg). Meanwhile POMC administration did not affect the meat quality (pH, moisture, cooking loss and tenderness), whereas the meat cholesterol was lower (34.25 mg/100g) than the control (38.87 mg/100g). It is concluded that administration of probiotic lactic acid bacteria combined with organic minerals decreases concentrate consumption and thereby potentially increases the animals energy utilization efficiency. In addition, the treatment also decreases the meat cholesterol content of local sheep.

Key words: meat quality, lactic acid bacteria, organic mineral, sheep performance

ABSTRAK

Penelitian dilakukan untuk mengevaluasi pengaruh pemberian kombinasi probiotik dan mineral organik kompleks (POMC) terhadap performa dan kualitas daging domba lokal. Sebanyak enam ekor domba jantan dengan rataan bobot awal 12,67±0,81 kg dibagi secara acak ke dalam 2 perlakuan. Tiap perlakuan terdiri atas 3 ulangan dalam rancangan acak lengkap yang dianalisis menggunakan uji t-Student. Perlakuan terdiri atas T0: ransum basal (kontrol) dan T1: ransum basal + POMC. Hijauan dan konsentrat (60:40) diformulasi sebagai pakan basal, dengan proyeksi konsumsi bahan kering sebanyak 5% dari berat badan. Dosis POMC yang diberikan sebanyak 15 g/hari/ekor. POMC mengandung bakteri asam laktat *Lactobacillus* sp. ($1 x 10^8$ cfu/g) dan *S. cerevisiae* terkorporasi mikromineral Co (2 ppm), Cu (100 ppm), Fe (2.5 ppm), I (110 ppm) dan Mn (100 ppm). Percobaan dilakukan selama selama 11 minggu (1 minggu periode adaptasi dan 10 minggu periode koleksi data). Hasil penelitian menunjukkan bahwa pemberian POMC tidak mempengaruhi pertambahan berat badan domba (7,46 kg) dibandingkan kontrol (7,13 kg), namun menghasilkan konsumsi konsentrat yang lebih rendah ($P<0,05$) (26,9 kg) dibandingkan kontrol (28,6 kg). Pemberian POMC tidak mempengaruhi kualitas daging (pH, kadar air, susut masak dan keempukan), tetapi menghasilkan kadar kolesterol daging yang lebih rendah (34,25 mg/100g) dibandingkan kontrol (38,87 mg/100g). Dapat disimpulkan bahwa pemberian probiotik bakteri asam laktat yang dikombinasikan dengan mineral organik menurunkan konsumsi konsentrat yang berpotensi meningkatkan efisiensi pengggunaan energi dan juga menurunkan kadar kolesterol daging domba.

Kata kunci: bakteri asam laktat, kualitas daging, mineral organik, performa domba

*Corresponding author:
E-mail: hendra.herdian@lipi.go.id / hendravit@yahoo.com

INTRODUCTION

Administration of feed additives to ruminants has variety of interests with the main objective to improve the productivity of livestock. Microorganism or direct-fed microbial (DFM) as probiotics is one of natural feed additive that can be used for this purpose. Previous studies reported that the administration of DFM was beneficial to improve performance and production of livestock. Administration of *Enterococcus faecium* (10^9 cfu/g) in cattle decreased CO_2 levels of blood, thereby reduced the risk of acidosis (Ghorbani *et al.,* 2002). Research conducted by Adams *et al.* (2008) showed that the use of *Propionibacterium jensenii* 702 (1.1×10^8 and 1.2×10^9 cfu/kg BW/day) increased calf body weight. Stephens *et al.* (2010) reported that the administration of 8×10^9 cfu of *S. cerevisiae* strain BP-31702; 5×10^8 cfu of *Lactobacillus lacidophilus* strains BT-1386/head /day was able to improve feed conversion of cattle. In dairy cows the administration of *S. cerevisiae* at level 2550 ppm (DM basis) increased postpartum ruminal propionate concentration and decreased the ratio of acetate:propionate (Erasmus *et al.,* 2005). Fermented rice straw with probiotic as goat feed could substituted the use of elephant grass (Novita *et al*., 2006).

There is a global interest in using lactic acid bacteria (LAB) as feed additive for ruminants. LAB improved ensiling processes (Contreras-Govea *et al.,* 2013; Lee *et al*., 2008), could be used as probiotic in calf, increased the blood glucose levels and energy efficiency (Mwenya *et al*., 2004; Bayatkouhsar *et al*., 2013), and also potential as anti-diarrhea in ruminant (Signorini *et al.,* 2012).

Minerals are needed in relatively small quantities compared with other feed substances; however its deficiency is very influential on livestock performance. In ruminants, the mineral absorption in body is relatively less compared to non-ruminant due to differences of ruminants feed types which tend to be more fibrous so that the minerals could be bound when it pass the digestive tract and causes a lot of insoluble mineral (Spears, 2003). A number of studies had shown that the administration of minerals in organic form increased its bioavailability and improved the performance of livestock. The administration of organic mineral (Zn, Mn, Cu, and Co) increased milk production of dairy cows in mid-lactation (Hackbart *et al.,* 2010). Muehlenbein *et al.* (2001) reported that organic Cu administration for 30 days of calving period improved pregnancy rates in dairy cows. Administration of organic Se (Se-yeast) by orally drenching, could led to more efficient in the transfer of Se in sheep compared to inorganic (Na-selenite) (Stewart *et al.,* 2012).

The administration of probiotic maintains the balance of rumen microbiota increasing the production of enzymes as cellulose, amylase, urease, protease consequently increasing improving the use fibrous foods (Rigobelo & deÁvila, 2012). The consumption of more fibrous food reduced bioavailability of mineral as mentioned before by Spears (2003). Limitation of studies about administration of feed additive containing combination of lactic acid bacteria (LAB) and organic mineral on sheep encourages researcher to conduct a study about the effect of combination of both. This study focused on evaluating the effect of LAB and organic mineral complex administration on body weigth gain, feed conversion, feed consumption and meat quality of local sheep.

MATERIALS AND METHODS

Research Animal

Six local sheep (rams) with an average body weight of 12.67±0.81 kg were used in this study. The sheep were obtained from a commercial farm in Kaliurang, Yogyakarta. Before treatments, sheep were given anti-helminthic and antibiotics to eliminate the influence of parasites and disease during the experimental period (1 wk for adaptation period). The sheep were randomly distributed into a number of individual cages (1.5 x 1.5 x 0.6 m). The sheep were weighed every week and final body weight was assessed basis from initial day to the final day of the experiment. Feed intake was recorded daily by subtracting the amount of offered feed with the residual feed for each replicate. Feed conversion ratio (FCR) was calculated as total feed intake divided by body weight gain of sheep.

Preparation and Feeding of Experiment Feed

Basal diet composed of forages and concentrates (60:40) with dry matter of feed intake as much as 5% of body weight. Tebon (a whole corn crops part taken from the entire growing on land) was used as forages with composition as follows: 7.9% of crude protein, 30.5% of crude fiber and 19% dry matter (Hartadi *et al*., 2005). Concentrates was a mixture of feed ingredients as listed in the Table 1. Administration of concentrates and forages were given separately. The residual of forages and concentrates that were not consumed were weighted daily. Diet treatment was as mixture of probiotic contained of *Lactobacillus* sp. (1×10^8 cfu/g) and *S. cereviseae* incorporated with micromineral Co (2 ppm), Cu (100 ppm), Fe (2.5 ppm), I (110 ppm), Mn (100 ppm) called POMC. Dose of POMC applied was 15 g/day/head. Water were provided *ad libitum* all over the experimental period.

Meat Quality

At the end of experiment (11 wk), one ram per treatment were slaughtered for meat quality analysis (pH, moisture, cooking loss, water holding capacity, tenderness, and cholesterol content). The main back muscle of sheep i.e. Longissimus Dorsi (LD) part was used for meat quality analysis.

The meat pH was measured according to Faucitano *et al.* (2008). The LD muscle at the interface between the 12th and 13th ribs on the 6th day postmortem using an Oakton Instruments Model pH 100 Series pH meter fitted with a spear-type electrode and an automatic temperature compensation probe.

Cooking loss was determined according to Nikmaram *et al*. (2011). The LD samples (20 g) were

Table 1. Concentrate composition and nutrient content (dry matter basis)

Feed ingridients		(%)
Rice bran		31.00
Pollard		66.65
Urea		0.35
$CaCO_3$		1.00
NaCl		0.50
Molasses		0.50
Total		100.00
Nutrient composition		Amount
Crude protein	(%)	15.000
Ether extract	(%)	6.030
Crude fiber	(%)	8.330
Total digestible nutrients (TDN)	(%)	70.280
Calcium	(%)	0.486
Total phosporus	(%)	0.830
Natrium	(%)	0.013
Chlorine	(%)	0.057
Kalium	(%)	1.148
Sulfur	(%)	0.131
Cobalt	(ppm)	0.067
Cuprum	(ppm)	4.056
Magnesium	(ppm)	0.440
Selenium	(ppm)	0.280
Zincum	(ppm)	0.404
Ferrum	(ppm)	0.650
Manganese	(ppm)	0.025

Note: Nutrient composition was calculated referred to Hartadi *et al*. (2005)

placed in polyethylene plastic, then sealed with vacuum pack, and heated in a water bath at 80 °C for 30 min. After cooked, samples were cooled at room temperature, dried surface with filter paper, reweighed using an analytical balance (Metler AE100-0.001), and the cooking loss calculated from differences of raw and cooked weight.

Water holding capacity was determined according to O'Fallons (2007). The LD samples (0.3 g) were placed on Whatman 41 filter paper between two metal plates with a pressure load of 35 kg for 5 min until wet area formed on the filter paper. Wet area was calculated by subtracting the area covered meat samples (in the area ofa circle) of the total area (wide outer ring).

Tenderness was measured according to Soeparno *et al*. (2005). The LD samples were sealed in polypropylene plastic, then heated in a water bath at 80 °C for 30 min. After cold, samples were made with a size of 1.5 x 0.67 cm or tubular shape, and placed on Wanner-Blaztser Shear Force, Model Salter 235. Samples were cut parallel to the muscle fiber direction and measurement result was noted.

The meat cholesterol content was determined by Liebermann-Burchad reaction (Xiong *et al*., 2007) using a spectrophotometer at a wave length of 420 nm. Coloring reagent used were acetic acid anhydride and concentrated sulfuric acid in different solvents such as chloroform or ether.

The remainder of the fresh LD muscle was ground, vacuum-packed, and frozen (−20 °C) before proximate analysis. Dry matter content was determined by the air-drying method (AOAC, 2005) at temperatures of 100 to 102 °C.

Experimental Design and Data Analysis

The experiment was arranged in a completely randomized design (Gomez & Gomez, 2007) consisted of 2 treatments, each in 3 replications. The treatments were T0: basal diet (control) and T1: basal diet + POMC. The effect of treatments on sheep performance BWG, feed consumption and feed conversion ratio was evaluated using t-Student analysis which operated by CoStat® Statistical Software (LIPI License). Data of meat quality (pH, moisture, cooking loss, water holding capacity, tenderness, and cholesterol content) was evaluated by descriptive analysis.

RESULTS AND DISCUSSION

Animal Performance

Body weight of sheep in control treatment (T0) and probiotic-organic mineral complex/POMC treatment (T1) increased during the experimental period (Figure 1). This suggested that in this study the metabolism of sheep was uninterrupted by POMC administration. The performance of sheep is performed in Table 2. The initial live body weight of experimental sheep were almost alike with a little bit difference indicating the well randomization way for distributing sheep within the experimental treatments. The body weight gain, forage consumption (Figure 2), total consumption (Figure 4) and feed conversion ratio of sheep administered with POMC were not significantly different (P>0.05) from control.

Table 2. Performances of control and treated sheep by probiotic-organic mineral complex (POMC)

Variables	Treatments		S.E.M	P-value
	Control	POMC		
Initial body weight (kg)	12.67±0.58	12.67±1.15		
Body weight gain (kg)	7.13±0.76	7.46±0.64	0.204	0.378
Forage consumption (kg)	51.61±3.80	54.64±0.98	0.021	0.196
Concentrate consumption (kg)	28.60±0.59*	26.99±0.90	0.006	0.037
Total consumption (kg)	80.01±4.01	81.30±1.82	0.025	0.641
FCR	11.65±0.92	10.94±0.99	0.352	0.181

Note: *Means in the same row with different superscripts differs significantly. FCR= feed convertion ratio.

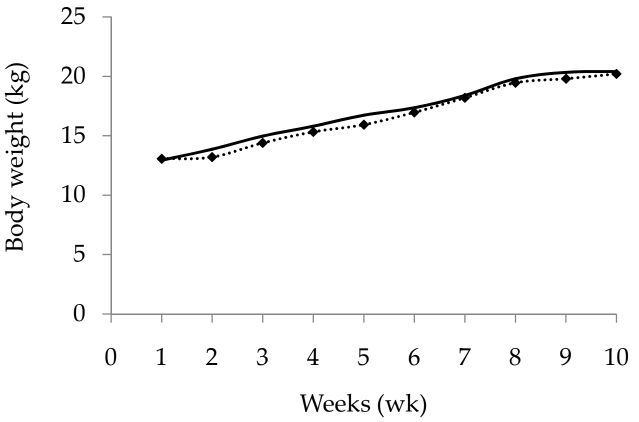

Figure 1. Response of control (T0= ···♦···) and probiotic-organic mineral complex/POMC (T1= —) treatments on body weight gain (kg/wk)

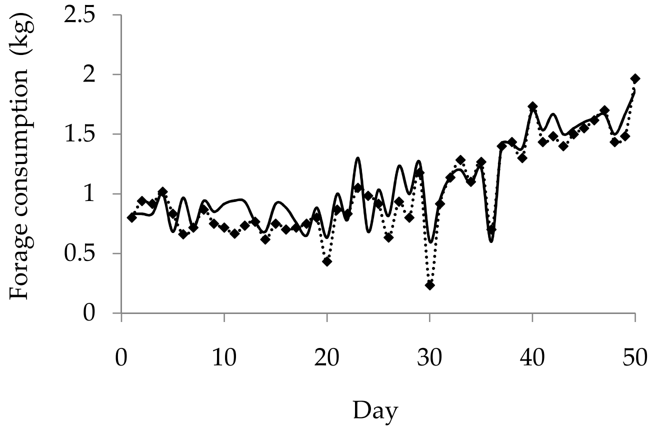

Figure 2. Response of control (T0= ···♦···) and probiotic-organic mineral complex/POMC (T1= —) treatments on forages intake (kg/d)

From the data in Table 2, the POMC treatment had the potential to improve FCR (10.89) compared to control (11.22) and had higher BWG (7.46±0.64 kg) than control (7.13±0.76 kg). Improving feed efficiency closely related to concentrate consumption from sheep supplemented by POMC compared with control. Control sheep constantly consumed higher concentrate after 20 d period of treatment (Figure 3).

The increased of feed efficiency through FCR reduction in probiotic treatments shown by Stephensa *et al.* (2010) who reported that there was an improvement of feed conversion in feedlot steers fed probiotic contained 8×10^9 cfu of *S. cerevisiae* strain BP-31702 and *L. acidophilus* strain BT-1386 compared to control. Musa *et al*. (2009) also stated that lactic acid bacteria as probiotic could enhance the growth of animals. The other study, Baah *et al*. (2009) stated that supplementing diets with $12\text{x}10^7$ cfu of the mixed culture of lactobacilli could improve ruminal fermentation and average daily gain (ADG) through promoted cellulolytic activities and improved microbial digestion of fibrous components.

Effect of probiotic administration on molar proportion of ruminal propionate, was reported by Lima *et al.* (2010) who mentioned that the administration of molasses and *Lactobacillus* on silage decreased the production of acetate and increased propionate production in the rumen fluid during *in vitro* fermentation. Propionate (in the proportion of at least 50%) would be metabolized by the rumen epithelium cells and absorbed into the blood vessels in L-lactate form then further converted into glucose in the liver (Van Houtert, 1993) and in the context of energy supply for livestock it was to be better. Similar results mentioned that administration of lactic acid bacteria (2 g/d) increased the blood glucose levels of calf (Bayatkouhsar *et al.*, 2013). Mwenya *et al.* (2003) reported that administration of lactic acid bacteria can reduce methane emissions and increase energy retention in sheep.

Meat Quality

Value of pH, moisture, cooking los and tenderness of the LD either in control and POMC treatments was

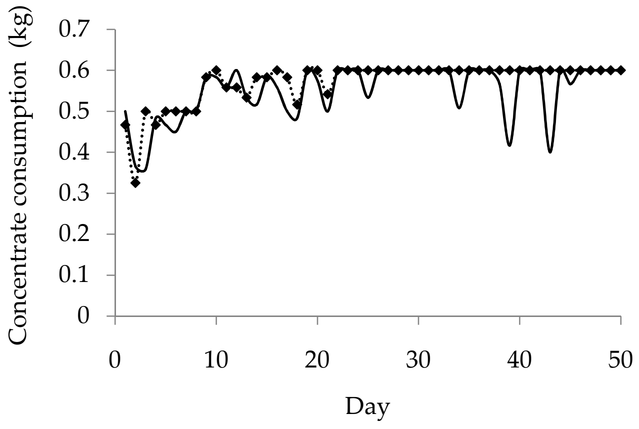

Figure 3. The response of control (T0= ···♦···) and probiotic-organic mineral complex/POMC (T1= —) treatments on concentrate intake of local sheep (kg/d/head)

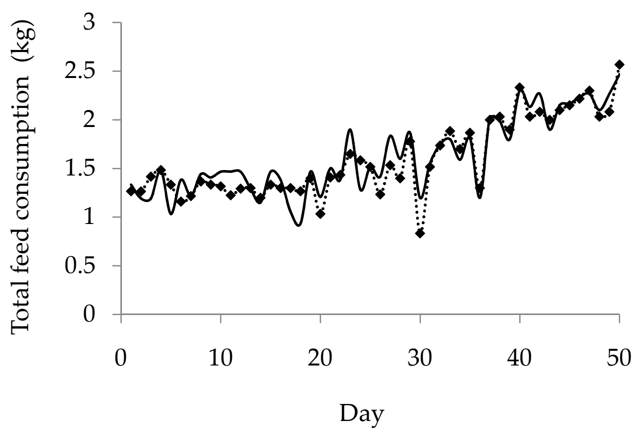

Figure 4. The response of control (T0= ···♦···) and probiotic-organic mineral complex/POMC (T1= —) treatments on total feed intake (kg/d/head)

not significantly different. In contrast, Whitley *et al*. (2009) revealed that quality of meat goat consisting of leg circumference, loin eye area, and backfat were not influenced by probiotic administration. However, the use of probiotics consisted of *Bacillus subtilis*, *B. licheniformis* and *S. cerevisiae* had no effect on broiler meat quality of cooking loss and water holding capacity (Pelicano *et al*., 2003).

The POMC treatment (T1) reduced meat cholesterol content and increased water-holding capacity (Table 3). Hassanein *et al*. (2013) reported that probiotic from lactic acid bacteria *L. lactis* KF147 reduced meat cholesterol. Lactic acid bacteria could affect total cholesterol by directly binding with dietary cholesterol or deconjugation of bile salt (Pato *et al.,* 2005) or some others reason (Lay *et al.,* 2010), since these mechanism generally took place in gastro intestinal system, it could be estimated that microbial viabilty of POMC could reach the post ruminal digestion system and conduct such mechanism. Since the small amount of data, these meat quality analysis should be explored with more extend data.

Table 3. Meat quality of sheep offered control diet and probiotic-organic mineral complex (POMC) treatments

Observed variables	Treatments	
	Control	POMC
Value of pH	6.07	6.23
Moisture (%)	76.58	77.72
Cooking loss (%)	43.97	41.66
Water-holding capacity (%)	24.69	33.15
Tenderness (kg.cm²)	9.96	9.15
Cholesterol (mg/100g)	38.87	34.25

CONCLUSION

Administration of probiotics (15 g/head) containing lactic acid bacteria (1x10^8 cfu/g) combined with organic mineral consisted of Co (2 ppm), Cu (100 ppm), Fe (2.5 ppm), I (110 ppm), Mn (100 ppm) incorporated with *S. cerevisiae* decreases concentrate consumption and meat cholesterol content of local sheep.

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