Performance of Local Lambs Fed Total Mixed Rations Based on Forages with Different Sorghum Cultivars

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ABSTRACT

Total mixed rations (TMR) containing conventional forage sorghum (Pahat), brown mid rib (BMR) forage sorghum (G5), or green midrib (GMR) forage sorghum (G8) were fed to local lambs to determine the effect on digestibility, performance and ruminal fermentation. Fifteen ewe lambs (aged < 1 year) with average live weight of 15±0.50 kg were assigned to three diets in completely randomized design with 4-wk periods (21-d adaptation and 7-d sample collection). Total mixed rations consisted of 60% sorghum forage and 40% concentrate mix (dry basis). Results demonstrated that the difference in sorghum cultivars did not affect the digestibility, growth performance and ruminal fermentation of local lambs. Organic matter digestibility (OMD) ranged from 63.73 – 65.45%. Daily weight gain of lambs fed TMR based on Pahat tended to be higher than G5 and G8 (97.86 vs 89.29 and 75.00 g/h/d). Total mixed rations based on sorghum forage produced optimal ruminal fermentation for lambs growth. In conclusion, the difference in sorghum cultivars on total mixed rations formulation did not affect the performance of local lambs.

Keywords: *Local lambs, Performance, Total mixed rations, Sorghum.*

1. INTRODUCTION

Sheep industry plays an important role in the business ecosystem in rural areas. Indonesia had 17,834,000 of sheep populations in 2019. During three years (from 2016 to 2019), it was about 223,000 to 1,425,000 populations which increased about 13.47% [1]. According to the aspects of development and opportunities, sheep farming has obtained great market position. However, animal productivity needs to be increased through feed quality and feeding systems improvement [2]. Wijaya *et al*. [3] reported that the low productivity of sheep in Indonesia is caused by the feeding systems. The sheep feeding system on smallholder scale farms has not been adapted to the level of production needs.

Total mixed rations (TMR) form is more effective for increasing sheep production. Kishore *et al*. [4] stated that TMR has several advantages, including: 1) increased feed consumption; 2) increased feed palatability; and 3) assisted the formulation pattern in determining forage and concentrate ratios. Total mixed rations based on hay or silage provides higher growth performance than traditional feeding systems [5]. Sorghum forage is one of the quality roughages that can be used as a source of fiber for sheep [6], [7]. Based on the color of leaf midrib, sorghum could be categorized into three types: 1. White midrib (WMR); 2) green midrib (GMR); and 3) brown midrib (BMR) [7], [8]. The National Nuclear Energy Agency of Indonesia (BATAN) has developed three sorghum cultivars, namely Pahat, G5 and G8. Based on leaf midrib color types, Pahat, G5 and G8 are within the WMR, BMR and GMR types, respectively [7]. The three sorghum cultivars have potential to be developed as an ingredient in TMR for sheep.

Previous studies related to the use of different sorghum cultivars on sheep diets have been studied by Yosef *et al*. [9], Babu *et al*. [10] and Pinho *et al*. [11]. However, there is a lack of information about the effect of different sorghum cultivars on TMR formulation on the productivity of local sheep in Indonesia. Thus, the objective of this study is to determine the effect of TMR with different sorghum forage cultivars on performance of local lambs.

2. MATERIALS AND METHODS

2.1. Ethical Approval

The experiment was approved by National Nuclear Energy Agency of Indonesia animal ethics committee.

2.2. Experiment Location

This experiment was conducted in Animal Integrated Laboratory, Center for Isotope and Radiation Application, National Nuclear Energy Agency of Indonesia, South Jakarta, Indonesia. This experiment was conducted from May to August 2019.

2.3. Experimental Design, Diets and Animal

The three experimental total mixed rations were prepared using different sorghum cultivars i.e., Pahat forage (TMR P), G5 forage (TMR G5) and G8 forage (TMR G8) at 600 g kg^{-1} level as roughage source along with other concentrate ingredients and processed into mash size. The experimental diets were formulated according to the energy and protein requirements of Jayanegara *et al*. [12] for local sheep. Composition of experimental diets were presented in Table 1.

The animals used were 15 local ewe lambs aged 6-7 months with a mean body weight of 15±0.5 kg. Animals were divided randomly into three groups of five animals each in completely randomized design. The experimental diets were offered in a restricted feeding, fixed at 3% of the live weight of each lambs per day. The respective feeding was offered twice a day, at 08.00 and 16.00. The animals were kept in metabolism cages during 21 days, including 14 days for diet adaptation and seven days for the data collection of performance and rumen fermentation.

Residues, if any, were weighed in the next morning before offering diets. Fresh water was offered *adlibitum*. The refusals and faeces were collected daily, weighed and taken to an oven (60^{o}C for 48h). The materials were ground until 1 mm particle size.

On day 7 of the faecal collection, rumen fluid samples were taken using an oral stomach tube (OST) vacuum fluid extractor of Ramos-Morales *et al*. [13]. An amount of 20 ml of rumen fluid from each lamb was collected to determine rumen fermentation products.

2.4. Chemical Analysis

Feed, residuals and faeces were analysed for dry matter (DM) and organic matter (OM) by AOAC [14]. Crude protein (CP) and ether extract (EE) on feed sample was also determined based on AOAC [14]. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent fiber were determined by following Van Soest et al. [15] procedures. Non fiber carbohydrates (NFC) (%) was estimated as %OM – %CP – %NDF – %EE. Total digestible nutrients (TDN) value was calculated using Jayanegara et al. [16] procedure, as follows: (0.417x%NDF) + (0.776x%NFC) + (1.688x%EE) + (0.782xCP). Ca and P contents were determined by Talapatra et al. [17] and Ward and

Table 1. Composition of the experimental diets: total mixed rations (TMR) with three sorghum cultivars (Pahat, G5 and G8)

Ingredients	TMR P (g kg^{-1} DM)	TMR G5 (g kg^{-1} DM)	TMR G8 (g kg^{-1} DM)
Sorghum Pahat	600	-	-
Sorghum G5	-	600	-
Sorghum G8	-	-	600
Soybean meal	80	80	60
Wheat bran	100	80	110
Rice bran	100	120	110
Bakery waste	60	60	60
Mineral mix	20	20	20
Urea	10	10	10
$CaCO_3$	10	10	10
Molasses	20	20	20

Table 2. Nutrient composition of the experimental diets

Nutrient composition (g kg^{-1} DM)	TMR P	TMR G5	TMR G8
Dry matter	906.8	919.3	902.2
Organic matter	875.9	875.4	888.8
Crude protein	144.9	145.5	144.8
Ether extract	73.4	70.8	87.1
Non fiber carbohydrate	161.5	175.9	168.6
Neutral detergent fiber	495.9	483.1	488.3
Acid detergent fiber	276.1	267.6	272.8
Acid detergent lignin	54.6	51.9	47.3
Ca	39.0	56.2	57.3
P	9.2	6.2	6.0
Total digestible nutrient	569.3	571.2	594.7

Johnston [18], respectively.

Rumen fluid from each lamb was collected to determine total volatile fatty acids (TVFA) production and ammonia concentration (Conway *et al.* 1951).

2.5. Statistical Analysis

A one-way ANOVA was used to analyze the data. Differences among treatments were separated using duncan multiple range test [19]. All statistical procedures were carried out using SPSS 22.0 program.

3. RESULTS AND DISCUSSION

Nutrient composition of TMR based on sorghum forages are listed in Table 2. Diets formulation is based on the iso energy and iso protein requirements of local sheep [12]. No differences were showed between all TMR treatments on nutrient contents, fiber compounds and TDN. The CP content of TMR ranges from 14.48-14.55%. The NDF and ADF contents range from 48.31-49.59% and 26.76-27.61%, respectively. The NFC fraction which represents the non-structural carbohydrate group ranges from 16.15-17.59%. Variation in nutrient contents will influence the digestibility value and rumen fermentation profile [20].

The performance and rumen fermentation products of local lambs are shown in Table 3. No differences ($p > 0.05$) were observed between all treatments on consumption, digestibility, daily weight gain, feed efficiency and rumen fermentation products of lambs.

Using different sorghum cultivar does not have effect on DM consumption, OM consumption, DM digestibility and OM digestibility which ranging from 457.32 – 466.50 g day^{-1}, 352.36 – 410.32 g day^{-1}, 57.98 – 59.94% and 63.73 – 65.45%, respectively. Average daily gain and feed efficiency in experimental ewe lambs range from 750.0 – 978.6 g h^{-1} d^{-1} and 16.92 – 19.74, respectively.

Similar results are reported by previous studies. The use of different sorghum cultivars in diets provide similar nutrient intake, digestibility and performance of sheep [11]. Ledgerwood *et al.* [21] also reported that different sudangrass type (BMR vs conventional) on TMR were too small to impact animal performance at a commercially practical level. In our study, DM consumption ranges from 2.53 – 2.60% of body weight or less than 3 %. This finding can reduce feed efficiency which makes the daily weight gain less than optimal. This is represented by the daily gain value of the three treatments which is less than initial calculation (100 g h^{-1} d^{-1}). Winarti *et al.* [22] reported that the DM consumption of lambs for growth can reach 4.41 – 5.12% of weight. Feed consumption represents the palatability of TMR. Dry matter and OM consumption in our finding is quite lower than previous studies by Falahudin and Imanudin [23], Wijaya *et al.* [3] and Al Khalasi *et al.* [24]. Apparently, the rough texture of sorghum stems and leaves in this study could reduce the feed consumption. Variations in results between studies can be caused by differences in the average body weight, age, breed, digestive track capacity and sex. Worku *et al.* [25] reported that non-genetic factors have a role in determining the performance of local sheep.

The absence of differences in DM and OM digestibility is due to the similar nutrient content between all treatments (Table 2). This finding is in agreement with Pinho *et al.* [11] and Babu *et al.* [10], who observe similar DM and OM digestibility among different sorghum cultivars based complete diets. In contrary, Ledgerwood *et al.* [21] demonstrated that diets based on BMR plants produce higher digestibility than conventional plants. This contradiction can be caused by the difference in nutrients composition between experiments. In our experiment, the DM and OM

Table 3. Performance and rumen fermentation products of local lambs fed total mixed rations based on forages with different sorghum cultivars

Parameter	TMR P	TMR G5	TMR G8	SEM
Performance				
DM consumption (g day^{-1})	466.5	457.3	459.1	18.616
OM consumption (g day^{-1})	402.4	410.3	352.4	15.509
DM digestibility (g kg^{-1})	599.4	593.5	579.8	0.427
OM digestibility (g kg^{-1})	646.3	654.5	637.3	0.499
Daily weight gain (g h^{-1} d^{-1})	978.6	892.9	750.0	5.013
Feed efficiency	19.74	17.62	16.92	1.178
Rumen Fermentation				
pH	7.14	7.12	7.16	0.024
Total volatile fatty acids (mM)	135	155	135	3.944
Ammonia (mg L^{-1})	6.98	6.41	6.41	0.308

digestibility tend to be in accordance with several previous studies that used sorghum forages as diets ingredient. Pinho *et al*. [11] demonstrated that the DM and OM digestibility from sheep fed diets based on sorghum forages range between 54.59 – 60.98% and 57.62 – 63.21%, respectively. Babu *et al*. [10] reported that OM digestibility from TMR based on sorghum ranges from 61.01 – 64.08%.

The average daily gain from all treatments is not significantly different due to the similar results from nutrient consumption and digestibility. The similarity of the nutrient profiles from treatments tends to produce the same performance. Pinho *et al*. [11] stated that there are no statistical differences in performance between sheep fed the diets with different new sorghum cultivars and those fed control cultivars. Babu *et al*. [10] reported that the same nutrient profiles in rations will affect the same level in energy intake for animal. It is interesting to note that the average daily gain of lambs in present study is quite low. Falahudin and Imanudin [23] stated that rams fed a combination of grass and vegetable by products is only able to produce a maximum daily gain of 88.18 g h^{-1} d^{-1}. This explains that there is a distribution of nutrient responses for growth and reproductive physiology in lambs. The low gain responses may be replaced by the hormonal readiness for the ewes for mating. However, this opinion needs further investigation. Astigarraga *et al*. [26] reported that milk production of cows fed TMR based on BMR sorghum was higher than conventional sorghum, even though the DM intake was similar.

No significant difference was found among three rations in the pH value, NH_3 concentration and TVFA production which ranged from 7.06 – 7.14, 6.41 – 6.98 mg 100 ml^{-1} and 130.40 – 149.40 mM. The pH value in this study is in the neutral range. The neutral pH value is an indicator that TMR based on sorghum forage can support the performance of cellulolytic bacteria. Nocek *et al*. [27] reported that a neutral pH (5.80 – 7.00) was a good environment for cellulolytic growth. Yahaghi *et al*. [28] stated that neutral pH conditions have a correlation with the efficiency of rumen fermentation. In our findings, the concentration of NH_3 is quite high. Yahaghi *et al*. [28] stated that sheep fed high concentrate rations based on maize, sorghum and barley produced NH_3 ranged from 3.50 – 3.90 mg 100 ml^{-1}. This result may be due to high CP content in rations (Table 2). Our results in TVFA concentration were in consistent with the findings of Ledgerwood *et al*. [21] who observed no difference in the TVFA value in sheep by replacing the conventional sorghum with BMR type.

4. CONCLUSION

The difference in sorghum cultivars on total mixed rations formulation did not affect the performance of local lambs. However, further studies are needed to evaluate the effect of different sorghum cultivars on health, carcass characteristics and meat quality of lambs.

AUTHORS' CONTRIBUTIONS

Teguh Wahyono and Wijaya Murti Indriatama designed the study, did the experiment, analysed the data and drafted the manuscript. Dewi Apri Astuti, Anuraga Jayanegara and Komang Gede Wiryawan supervised the study and revised the manuscript. Widhi Kurniawan revised and approved the final manuscript. Irawan Sugoro designed the experiment.

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