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Feed protein utilization and nitrogen emission of young and mature Kejobong goats fed different ratios of concentrate and forage

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ABSTRACT: This study aimed to evaluate feed protein utilization and nitrogen emission of young and mature Kejobong goats fed different concentrations of concentrate and forage. Sixteen heads of male Kejobong goats consisted of eight heads young goats (5 months old) and eight heads mature goats (9 months old) with initial body weight (BW) of 14 ± 1.46 kg, and 22.3 ± 1.99 kg, respectively were arranged in a nested design. All goats were fed with two different rations of concentrate and forage (C30 = 30% concentrate: 70% forage and C70 = 70% concentrate: 30% forage). The data were analyzed using ANOVA procedure. This study showed that the average daily gain (ADG) did not differ ($p>0.05$) in both ages, but it differed ($p<0.05$) in concentrate levels. The ADG of goats fed C70 was significantly higher ($p<0.05$) than those of goats fed C30 in both ages. The digestible crude protein (DCP) of young and mature goats was similar ($p>0.05$), while there was a significantly difference ($p<0.05$) between the treatments. There were no effects of different ages of goats and concentrate levels on feed conversion ratio (FCR) ($p>0.05$). The different ages of goats and concentrate levels affected N retention (g/day) and total N_2O emission (g/day). It was concluded that ADG, DCP and FCR did not differ in mature and young Kejobong goats, while young goats had less N_2O emissions than mature goats. Goats fed 70% of concentrate improved their ADG, DCP, N retention (g/day) and produced less N_2O emission.

Keywords: Feed efficiency; Growth production; Protein partition

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INTRODUCTION

Kejobong goat is one of Indonesia's domestic goats selected for its black color by crossbreeding between Kacang and Ettawa goat. Local farmers still raise their goats in the traditional feeding system depending on forages containing low nutritional quality. This condition causes low productivity on Kejobong goats. Until now, there is still limited study about the potential productivity of Kejobong goats.

Therefore, it is needed to improve Kejobong goat's productivity by improving protein level in feed as the main nutrition source for growth. Increasing crude protein levels in feed improved the average daily gain of goats (Zhu et al., 2020), however over feeding of protein will result in excessive ammonia and then excreted in the urine. Some studies reported that higher crude protein intake resulted in higher nitrogen excreted in feces (Gusha et al., 2015; Rashid et al., 2016) and urine (Zhu et al., 2020). In order to make protein used efficiently in goats and improve their productivity, it is necessary to give appropriate ratios of concentrate and forage in the diet.

The addition of concentrate in feed could improve the goat's productivity. Goats fed with *ad libitum* concentrate resulted in greater carcass weight than those fed 2.5% of concentrate with *ad libitum* rice straw (Kim et al., 2014). However, giving 60% of concentrate in feed resulted in lower rumen pH (5.96) than 30% of concentrate (6.28) on goats (Giger-Reverdin et al., 2014). The decrease of rumen pH could lead to reducing the rumen microbial activity. Another side effect of feeding high concentrate level to goats (70%) resulted in higher N excretion than those fed 30% concentrate (Cantalapiedra-Hijar et al., 2011). These results indicate that different concentrations of concentrate and forage may differ in protein utilization, but it has not yet been known on Kejobong goats. On the other hand, it is known that fattening young animals can promote growth as well. A previous study reported that lambs fed 14 - 18% of crude protein resulted in a high average daily gain of up to 141 g with no significant value on N and N_2O emissions (Prima et al., 2019).

That study did not compare with mature sheep. Besides, goats are known to have better efficiency in utilizing protein than sheep (Kearl, 1982). There is a lack of information that compares the protein utilization between young and mature goats and its nitrogen emissions. Mature goats with greater body size will consume more than young goats, so it potentially has different protein utilization depending on feed consumed.

Therefore, this study aimed to evaluate protein utilization and nitrogen emission in young and mature Kejobong black goats fed different concentrations of concentrate and forage.

MATERIALS AND METHODS

This study was conducted at the Research Farm of Meat and Dairy Production Laboratory, Department of Animal Science, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang, Indonesia, from October 2018 to March 2019.

Sixteen heads of male Kejobong goats consisted of eight heads young goats (5 months old) and eight heads mature goats (9 months old) with initial body weight (BW) of 14 ± 1.46 kg and 22.3 ± 1.99 kg, respectively were housed in individual pen. All goats were randomly grouped and fed two different rations of concentrate and forage (C30 = 30% concentrate: 70% forage and C70 = 70% concentrate: 30% forage). *Panicum muticum* as forage and concentrate that was composed of 6% cassava meal, 45% soybean meal, 42% rice bran, 6% molasses and 1% mixed mineral on DM basis were mixed and made into the pelleted ration. The diets and drinking water were given *ad libitum*. The nutrient composition of the experimental diets are presented in Table 1.

The experimental period lasted for 98 days and feed intake were calculated daily. Samples of feed were analyzed for nutrient composition following the methods of AOAC (2012). Goats were weighed individually at the beginning of the experiment in the morning before feeding to know the initial body weight. The final body weight was taken at the end of the experimental period.

Average daily gain (ADG) was calculated by subtracting final body weight to initial body weight, and then it was divided by the experimental period (day). Feed conversion ratio (FCR) was calculated by dividing dry matter intake (DMI) to ADG. Protein conversion ratio (PCR) was calculated by dividing crude protein intake (CPI) to ADG. At the 13th week of the experimental period, total daily feces and urine were separately collected for 7 days to measure the digestibility. The feces were collected and sprayed with 10% H_2SO_4, while the urine was streamed down using a filter funnel connected to a container containing 200 ml of 10% H_2SO_4. The feces and urine of each goat were weighed, frozen, stored and sampled for proximate analysis. Nitrous oxide (N_2O g/day) excreted in feces and urine was calculated using IPCC guidelines (IPCC 2006), where 2% of the N excreted in livestock manure (feces and urine) was the emission factor that was adopted to find the amount of N_2O emitted.

Table 1. Ingredients and chemical composition of the diets.

Composition	Treatments (Forage: concentrate ratio)	
	T1	T2
Ingredients composition, %		
Forage	70	30
Cassava meal	1.8	4.2
Soybean meal	13.5	31.5
Rice bran	12.6	29.4
Molasses	1.8	4.2
Mineral mix	0.3	0.7
Chemical composition, %		
Dry Matter	79.1	71.4
Ash	11.7	12.7
Ether extract	1.65	2.14
Crude fiber	29.9	25.7
Crude Protein	10	14.7
Nitrogen free extract	46.7	44.8
Total Digestible Nutrients	64	69.7

The data were analyzed using analysis of variance (ANOVA) nested design based on Sastrosupadi (2000). If there were differences between the treatments, then it was analyzed by t-test.

RESULT AND DISCUSSION

ADG, nutrients' intake and digestibility and feed efficiency

The data of growth performance, DMI, CPI, DDM, DCP, FCR and PCR on Kejobong goats are presented in Table 2. The difference of age in Kejobong goats did not affect ADG, DDM and DCP (%) ($p>0.05$), except for DMI and CPI ($p<0.05$). The ADG, CPI, DDM and DCP of goats fed C70 was significantly higher ($p<0.05$) than those of goats fed C30. The different levels of concentrate resulted in the same DMI in mature goats ($p>0.05$), however, it was significantly different from those in young goats ($p<0.05$). There were no effects of different ages of goats and concentrate levels on FCR and PCR ($p>0.05$).

Table 2. Effect of different ages and concentrate levels on growth performance, nutrient intake, digestibility and efficiency of Kejobong goats.

	Age	C30	C70	Average
Performance of goats				
Initial live weight, kg	Mature	21.6	23.2	22.4
	Young	12.7	15.1	13.9
Final live weight, kg	Mature	28.4	32.3	30.4[x]
	Young	18[a]	24.6[b]	21.3[y]
ADG, g	Mature	68.6[a]	93.2[b]	80.9
	Young	54.2[a]	97[b]	75.6
Nutrient intake and digestibility				
DMI, g/day	Mature	888	960	924[x]
	Young	601[a]	791[b]	696[y]
CPI, g/day	Mature	89[a]	141[b]	115[x]
	Young	60.3[a]	116[b]	88[y]
DDM, %	Mature	64[a]	73[b]	68.5
	Young	66.5[a]	71.1[b]	68.8
DDM, g/day	Mature	567[a]	701[b]	634[x]
	Young	399[a]	562[b]	481[y]
DCP, %	Mature	75.9[a]	87.4[b]	81.7
	Young	75.9[a]	86.4[b]	81.2
DCP, g/day	Mature	67.5[a]	123[b]	95.3[x]
	Young	45.7[a]	100[b]	72.9[y]
Nutrient efficiency				
FCR	Mature	13.2	10.8	12
	Young	11.6	8.26	9.93
PCR	Mature	1.32	1.59	1.46
	Young	1.17	1.21	1.19

[a,b ; x,y] *Means in the same row or column with different superscripts differ ($p<0.05$)*

The similar ADG between mature and young Kejobong goats was because the young goats had an accelerated growth rate, while the growth rate of mature goats started to slow down. Goats fed C70 had a significantly higher ($p<0.05$) ADG than goats fed C30 in both ages. The ADG increased with the increase of DMI (Kustantinah et al., 2017). The DMI of Kejobong in mature goats (924 g/day) was higher ($p<0.05$) than those in young goats (696 g/day). It indicated that the greater the live weight of mature goats, the greater maintenance requirements were needed. An increase in feed intake was associated with increased goat's live weight (Brand et al., 2017). A non-significant difference in DMI in mature goats was because there was no significant difference in their final live weight. The DMI of young goats fed C70 (791 g/day) was higher ($p<0.05$) than those fed C30 (601 g/day). It was because C70 contained more protein, which was good for microbial growth, so it improved the degradation rate (Tadesse et al., 2016) and finally increased feed intake.

The CPI in mature goats (115 g/day) was higher than those in young goats (88 g/day), which was correlated with DMI. The higher CPI of goats fed C70 compared to those fed C30 was due to the CPI that was affected by the DMI. The different ages of goats did not significantly affect ($p>0.05$) DDM and DCP (%). It was expected that Kejobong young goats had the same digestive tract ability as mature goats to digest feed. Jiao et al. (2015) stated that functional and anatomic development of rumen in goat were achieved started at 2 months. The DDM (%) in goats fed C70 was higher ($p<0.05$) than those fed C30 both in mature and young Kejobong goats. Higher crude protein (CP) and lower crude fiber (CF) content in C70 (Table 1) could be attributed to the high DDM (%). The higher DCP (%) in goats fed C70 was due to the increased CP content of C70 (14.7 versus 10%) that made the diet easier to digest. The increase of CP level in diet could stimulate microbial fermentation activity and microbial protein synthesis (Pirzado et al., 2016). The similar FCR and PCR were due to the same growth rate of young and mature Kejobong goats. These results indicated that the ability of young and mature goats to convert feed intake for ADG was totally the same. Thus young Kejobong goat was potentially reared using C70 ration to improve growth performance and shorten the rearing period.

Nitrogen balance

The data of N balance on Kejobong goats are shown in Table 3. Nitrogen intake in mature goats was higher ($p<0.05$) than that in young goats. The different goats' ages did not significantly affect ($p>0.05$) on the total excreted N and N retention percentage. The different concentrate levels significantly affected ($p<0.05$) N intake and fecal nitrogen percentage, but it had a similar effect ($p>0.05$) on N percentage in urine.

Table 3. Effect of different ages of goats and concentrate levels in diet on N balance of goats.

	Age	C30	C70	Average
Nitrogen intake, g/day	Mature	14.2^a	22.5^b	18.4^x
	Young	9.64^a	18.6^b	14.1^y
N excretion				
Feces, g/day	Mature	4.53^a	3.58^b	4.06^x
	Young	3.35	3.37	3.36^y
Feces, % of N intake	Mature	24.1^a	12.6^b	18.4
	Young	24.1^a	13.6^b	18.8
Urine, g/day	Mature	7.06^a	10.8^b	8.93^x
	Young	4.23^a	9.8^b	7.02^y
Urine, % of N intake	Mature	37.5	38.2	37.8
	Young	30.4	39.4	34.9
Total, g/day	Mature	11.6^a	14.4^b	13^x
	Young	7.58^a	13.2^b	10.4^y
Total, % of N intake	Mature	61.5^a	50.9^b	56.2
	Young	54.5^a	53^b	53.7
N retention, g/day	Mature	5.48^a	11.1^b	8.29^x
	Young	4.34^a	8.72^b	6.53^y
N retention, %	Mature	38.5^a	49.2^b	43.8
	Young	45.5	47	46.3

$^{a,b\,;\,x,y}$ *Means in the same row or column with different superscripts differ ($p<0.05$)*

The percentage of N retention in mature goats fed C70 was higher ($p<0.05$) than that fed C30, while those in young goats fed C70 and C30 were similar ($p>0.05$). As mention above, the different goats' ages and concentrate levels affected

N intake. These results were linearly due to the higher CPI in mature goats and goats fed C70 diet. The different ages of a goat did not affect ($p>0.05$) the percentage of N excreted in feces and urine. The same percent of N excreted in feces was due to the same amount of DCP (%) in mature and young Kejobong goats. The same ability of rumen to degrade feed in mature and young goats may lead to the same percentage of excreted N in urine. The percentage of N in feces of goats fed C70 was lower than those fed C30. However, the different levels of concentrate did not affect the percentage of N in urine. The higher DCP (%) in goats fed C70 was confirmed with a lower percentage N in feces.

There was no significant difference ($p>0.05$) between mature and young Kejobong goats on N retention percentage. It was due to the value of DCP percentage that did not differ in both ages of goat. The different levels of concentrate affected N retention percentage in mature goats, but it did not affect in young goats. These results were caused by the fecal N excreted by mature goats fed C70 was less than those fed C30. On the other hand, there was no difference on the percentage of N in urine, thus N retention percentage in mature goats fed C70 was higher. Paengkoum (2011) stated that the increase of N intake might increase N retention of goats. It can be concluded that the effect of different ages of goats and concentrate levels affected N retention (g/day).

Nitrous oxide emission

The data of N_2O emission is presented in Table 4. The different ages of goats and concentrate levels in diet affected ($p<0.05$) fecal N_2O, urinary N_2O and total N_2O. Mature Kejobong goats produced higher ($p<0.05$) nitrous oxide emissions than young goats. It was caused by the N excreted through feces and urine of mature goats was also higher ($p<0.05$) than those of young goats (Table 3).

The results of nitrous oxide emissions could be explained by the total N excreted through feces and urine (Prima et al., 2019). The N_2O emissions in feces of mature goats fed C70 (0.09 g/day) were higher ($p<0.05$) than those fed C30 (0.07 g/day), while different concentrate levels did not affect significantly ($p>0.05$) on fecal N_2O emission of young goats. Kejobong goats fed C70 had higher ($p<0.05$) urinary and total N_2O emissions than that fed C30. These results were in line with the data of N excreted in feces and urine.

Table 4. Effect of different ages of goats and concentrate levels in diet on N_2O of goats.

	Age	C30	C70	Average
Fecal N_2O, g/day	Mature	0.09^a	0.07^b	0.08^x
	Young	0.07	0.07	0.07^y
Urinary N_2O, g/day	Mature	0.14^a	0.22^b	0.18^x
	Young	0.08^a	0.20^b	0.14^y
Total N_2O, g/day	Mature	0.23^a	0.29^b	0.26^x
	Young	0.15^a	0.26^b	0.21^y

$^{a,b\ ;\ x,y}$ *Means in the same row or column with different superscripts differ ($p<0.05$)*

CONCLUSIONS

It was concluded that ADG, DDM and DCP (%), FCR, N excreted through feces and urine (%) and N retention (%) did not differ both in mature and young Kejobong goats, while young goats produced less N_2O emission than mature goats. Goats fed concentrate 70% in diets improved ADG, DDM, DCP, N retention (g/day) and produced less N_2O emission.

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