The Concentrations of Rumen Fluid Volatile Fatty Acids and Ammonia, and Rumen Microbial Protein Production in Sheep Given Feed During the Day and Night Time

D. A. K. W. Gumilar[1], E. Rianto[1*] and M. Arifin[1]

[1]Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang, Central Java, Indonesia.

*Corresponding E-mail: erianto05@yahoo.com

Abstract

An experimental study was carried out to investigate the concentrations of volatile (VFA), ammonia and microbial protein production of rumen fluid in sheep given fedd during the day and at night. This study used 12 fat-tailed rams aged 12-18 months and weighed 24,12 ± 25 kg (CV= 10,51%). The rams were fed a complete feed containing 16.64% protein and 68,33% total digestible nutrients (TDN). The rams were allocated into a completely randomised design with 3 treatments and 4 replications. The treatments applied were: T1: day time feeding (6.00 hrs – 18.00 hrs); T2: night time feeding (18.00 hrs – 6.00 hrs); and T3: day and night time feedings (6.00 hrs – 6.00 hrs). The parameters observed were dry matter intake (DMI), rumen VFA concentration, rumen ammonia concentration, rumen rmicrobial protein production and the efficiency of rumen microbial protein production. The results showed that feeding time did not significantly affect (P>0.05) all the parameters observed. Dry matter intake, VFA concentration, ammonia concentration, the microbial protein production of rumen fluid and the efficiency of microbial protein production were 1,073g/d, 49.69 mmol; 4.77 mg N/100 ml, 12,111 g/d and 19.96 g per kg digestible organic matter intake (DOMI), respectively. It is concluded that feeding time did not affect DMI, condition of rumen fluid and rumen microbial protein production in sheep.

1. Introduction

The environmental temperature is one of the external factors that have a big influence on livestock productivity, especially related to feed intake and efficiency of feed utilization [1] [2] [3]. The timing strategy of feeding on livestock is one way to increase livestock productivity. A proper timing of feeding is considered necessary to be one of the strategies for the feed given to livestock can be utilised optimally.

The time difference between day and night feeding probably result in different thermoregulations in livestock. Livestock ruminants in the tropics face challenges with high external heat intakes, especially during the day due to higher ambient temperatures [2]. Animals fed during the day receive a high heat load derived from feed metabolism and environmental temperature. Sheep reduce the amount of feed intake when ambient the temperature increases. Animals under heat stress attempt to reduce body heat production by reducing feed intake [3], therefore a new strategy of timely feeding is needed to improve the efficiency of feed utilisation.

Feeding animal at night should be considered to avoid the animal from heat stress that is likely to happen during the day. The time difference between day and night feeding is considered to result in different thermoregulations in livestock. Ruminants in the tropics face challenges with high external

heat exposure, especially during the day due to higher ambient temperatures [4]. The purpose of this study was to examine the comparison of feed digestion efficiency in terms of volatile fatty acids (VFA) concentration, rumen fluid ammonia and production of microbial protein in sheep treated with day and night feeding. The results of this study were expected to be used as a guide in managing feeding strategies.

2. Materials and Methods

This study used 12 fat tailed rams of 12-18 months old and 20.65 ± 1.88 kg body weight. The rams were fed a complete feed containing 16.64% protein and 66%total digestible nutrients (TDN).

The experimental design used was a complete randomized design (CRD), consisting of 3 treatments and 4 replications. The treatments applied were: T1: feeding at noon (06.00-18.00); T2: feeding at night (18.00-06.00); and T3: feeding on day and night at (06.00-06.00).

Parameters observed in this study were feed intake, live weight gain (LWG), rumen VFA concentration, rumen ammonia concentration and rumen microbial protein production. Calculation of feed intake was conducted by subtracting the feed offered with refusals. The LWG was calculation by subtracting the final live weight (kg) with the initial live weight (kg) divided by the length of observation (day). Measurements of VFA concentrations were measured by gas chromatographic techniques. Measurement of ammonia concentration was done by Connway method.

3. Results and Discussion

3.1. Dry Matter Intake

The data obtained showed the feeding time during day and night had no significant effect ($P>0.05$) on the dry matter (DM) intake (average 1,073 g/d). This is probably caused by the fact that there was only a small difference in ambient temperature between the day and night time, which were 27.7ºC and 25.2ºC, respectively. Such a difference was not big enough to alter DM intake. This was in accordance with the findings of [5] that sheep did not reduce feed intake when ambient temperature increased from 24º to 34ºC. A study by [2] also showed that DM intake of the lamb decreased when the ambient temperature increased from 20 to 30^{o}C.

The DM intake of the sheep in this study was comparable with the findings of [6], that thin tailed sheep with 18 kg body weight had 0.75 DMI. The difference can be attributed to the body weight of the animals; animals with higher body weight need and consume more feed that those with lower body weight [7].

3.2. Concentration of Rumen Fluid Volatile Fatty Acids

Day and night feeding did not significantly affect ($P>0.05$) VFA concentrations, except at 21.00 hrs ($P<0.05$; Table 2). It was attributed to the fact that DM intake in rams T1 and T2 was not significantly different. A study by [8] showed that rumen VFA concentration was influenced by rumen microbial population and DM intake.

The concentration of rumen VFA in this study (49.69 mM) was relatively lower than the normal limits to support the growth of rumen microbes. The range of normal rumen fluid VFA products that support microbial growth is 70–150 mM [7]. The VFA concentrations of this study were also lower when compared with studies conducted by [9] showing that the rumen VFA concentration in sheep that received grass and concentrate in the at 0, 4 and 8 hrs after feeding were 84.1, 101.1 and 97.2 mM, respectively. Such the differences can be attributed to the different composition of feed offered to the animals [10]. It is also suggested that feed digestion with non-structural carbohydrate content would result in higher VFA production [11].

Table 1. Concentration of Rumen Fluid Volatile Fatty Acids

Parameter	Treatment			Average
	T1	T2	T3	
Total VFA (mM)				
• 06.00 hrs	38.95	46.65	44.95	43.52
• 09.00 hrs	62.61	71.84	47.95	60.80
• 18.00 hrs	39.43	36.75	58.03	44.74
• 21.00 hrs	46.05[a]	51.15[a]	74.84[b]	-

Legend: different superscripts on the same row indicate significant difference (P<0.05)

3.3. Ammonia Concentrations of Rumen Fluid

The results of this study indicate that feeding time day and night have no significant effect (P>0.05) on rumen fluid ammonia concentration (Table 3). The condition was suspected to occur because the intake of dietary protein was not significantly different. One of the factors that influence the low concentration of ammonia in the ruminant is the amount of feed protein entering the rumen. High dietary protein content with high degradability will result in an increased rumen fluid ammonia concentration [7].

The mean rumen ammonia concentration in this study was 4.7 mg/100 ml. The condition is slightly lower than that required for normal rumen microbial growth. The minimum concentration of rumen fluid ammonia for rumen microbes to grow well is 5.0 mg per 100 ml rumen fluid, and the optimum concentration of rumen fluid ammonia ranges between 8.5 and 30.0 mg/100 ml [7]. Meanwhile, according to [12] the minimum ammonia concentration was 40 -240 mg/L**.**

Table 2. Rumen Fluid Ammonia Concentration

Parameter	Treatment			Average
	T1	T2	T3	
NH_3 (mg N/L)				
• 06.00 hrs	46.40	39.74	48.70	44.95
• 09.00 hrs	47.06	43.36	63.53	51.32
• 18.00 hrs	45.97	39.16	47.31	44.15
• 21.00 hrs	46.56	42.64	62.24	50.48

Notes: there is no significant difference (P>5%) among treatments.

The ammonia concentration in this study was lower than that of [13], who found N-ammonia concentration was 90.3 and 98.3 at ambient temperature of 20 and 40^{o}C, respectively. It is suggested that the minimum rumen N-ammonia concentration is 50 mg/L [7]. The difference is due to the fact that the dietary protein content of in the study by [13]was higher, i.e. 17.89%, while the content of dietary protein in the current study was 16.64%. The rumen fluid ammonia concentration is influenced by the level of dietary protein intake, the degree of degradability, feed duration in the rumen and the acidity (pH) of rumen fluid [73].

3.4. Production of Microbial Protein

Feeding on day and night had no significant effect (P>0.05) on microbial protein production and its efficiency (P> 0.05; Table 4) with an average of 12.11 g/d and 19.96 g microbial protein/kg DOMI. This condition can be attributed to the fact that DM intake, dietary protein concentration and rumen fluid concentration in the animal were not significantly different (P>0.05) between the treatments. The synthesis of rumen microbial protein depends on protein and other nitrogen source intake, the speed of dietary protein degradation into ammonia, and the need of the microbes for amino acids [7] [10].

The rumen microbial protein production in this study (12.11 g/d) was lower than the finding of [13] which was 19.0 g/d. That was because the types of feed and animals used in this study were different. According to [7] and [10], the factors affecting microbial protein synthesis are fermentation types based on the type of feed and microbial requirements of amino acids.

Table 3. Microbial Protein Production

Parameter	Treatment			Average
	T1	T2	T3	
DOMI (kg/d)	0.735	0.559	0.689	0.661
Microbial protein production (g/d)	9.240	13.92	13.122	12.111
Efficiency of microbial protein production (g microbial protein/kg DOMI)	14.23	26.99	18.23	19.96

Legend: DOMI = digestible organic matter intake

The treatment of day and night in this study had no significant effect (P>0.05) on the efficiency of microbial protein production, it is suspected that the feeding of day and night had no significant effect on the production of microbial protein and the consumption of feed PK. The production of rumen microbial proteins is also inseparable from the use of dietary protein that is reorganized by the rumen microbes through degradation process. It is claimed by [14]) that such efficiency is affected by dietary protein content that is degraded into ammonia. The efficiency of rumen microbial protein production in this study was comparable with the finding of [13], i.e.19.0 g/kg DOMI. The differences in data from both studies are probably due to the use of different feed ingredients and different nutritional content of the feed.

4. Conclusion

Based on the results of this study. it can be concluded that the feeding time during the day or night does not affect the DM intake and the digestion process of feed in the rumen in sheep.

References

[1] Bhattacharya A N and F Hussain 1974 Intake and utilization of nutrients in sheep fed different levels of roughage under heat stress *J. Anim Sci* 38: 877

[2] Rianto E, M K Hill dan J V Nolan 2001 The Effect of Quality of Diet on Carcass and Meat Characteristics of Lambs at Ambient Temperatures of 20 and 30 °C *Bulletin Anim. Sci* **25**(3): 127

[3] Baumgard L H and R P Rhoads 2012 Ruminant Nutrition Symposium: ruminant production and metabolic responses to heat stress *J. Anim Sc*i. 90:1855

[4] Al-Tamimi H J 2007 Thermoregulatory response of goat kids subjected to heat stress *Small Ruminant Res.* 71:280

[5] Susiloningsih 2009 Pemanfaatan Protein pada Domba Lokal Akibat Perbedaan Suhu Lingkungan. Program Pasca Sarjana Universitas Diponegoro Semarang (Tesis Magister Ilmu Ternak).

[6] Prakoso, F Mulia, F A Setyawatue, S Dartosukarno, S Mawati, E Rianto, R Adiwinarti and Soedarsono 2009 Prosiding Seminar Nasional Teknologi Peternakan dan Veterine*r*. Bogor 13-14 Agustus 2009 456

[7] McDonald P, R A Edwards, J F D Greenhalgh, C A Morgan, L A Sinclair and R G Wilkinson 2012 Animal Nutrition Seventh Edition. Prentice Hall, Harlow, England

[8] Yurleni, R Priyanto, E Gurnadi and K G Wiryawan 2013 Efektivitas minyak ikan lemuru terproteksi terhadap populasi mikrob rumen dan fermentasinya pada kerbau dan sapi *Jurnal Veteriner* 14(3) 285

[9] Giraldo L A, M. L Tejido, M J Ranilla, S Ramos and M D Carro 2008 Influence of direct-fed fibrolytic enzymes on diet digestibility and ruminal activity in sheep fed a grass hay-based diet *J. Anim. Sci.* 86 1617

[10] Bondi A A 1987 *Animal Nutrition*. John Wilay & Sons,Chichester

[11] Van Soest P J 1994 *Nutritional Ecology of the Ruminant.* 2nd Ed. Comstock Publishing Associates A division of Cornell University Press Ithaca

[12]Satter L D and L L Slyter 1974 Effect of ammonia concentration on rumen microbial protein production in vitro *British J. Nut.* 32 199

[13] Rianto E, C J Thwaites and J V Nolan 2005 Pengaruh Suhu Lingkungan dan Ketersediaan Air Minum terhadap Kecernaan Pakan, Protein Nitrogen Mikroba Rumen dan Kondisi Rumen pada Domba *Bulletin Anim. Sci.* **29**(1)10

[14] Yulianti A 2006 Kinetika Volatile Fatty Acid Cairan Rumen dan Estimasi Sintesis Protein Mikrobia pada Sapi Perah Dara Peranakan Friesian Holstein yang Diberi Pakan Basal Rumput Raja, Jerami Jagung, dan Jerami Padi yang Disuplementasi Konsentrat Protein Tinggi *Jurnal Teknologi Pertanian* **6**(1)25