Jurnal Sain Veteriner, Vol. 36. No. 2. Desember 2018, Hal. 191 - 199
DOI : 10.22146/jsv.41149
ISSN 0126-0421 (Print), ISSN 2407-3733 (Online)
Tersedia online di https://jurnal.ugm.ac.id/jsv

Perubahan Bobot Badan, Status Fisiologis dan *Volatile Fatty Acid* Darah pada Kambing Kacang dan Peranakan Etawah dengan Pengurangan dan Pemenuhan Kembali Pakan

Body Weight, Physiological Status and Volatile Fatty Acid on Kacang and Etawah Crossbreed Goat by Reduction and Refeeding of Feed Quantity

Bambang Suwignyo'*, Panjono', Aryanto[2], Sarmin°, I. Widiyono'

'Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna 3, Bulaksumur, Yogyakarta, 55281
Center for Assessment of Agricultural Technology (BPTP) Sulawesi Utara, J1. Kampus Pertanian, Desa Kalasey I Dusun IV, Kecamatan Mandolang, Kabupaten Minahasa, 95013
[3]Faculty of Veterinary Medicine, Universitas Gadjah Mada, Jl. Fauna 2, Karangmalang, Yogyakarta, 55281
*Email: bsuwignyo@ugm.ac.id

Naskah diterima 21 November 2018, direvisi 27 November 2018, disetujui 1 Desember 2018

Abstrak

Penelitian bertujuan untuk mengetahui efek pengurangan dan pemenuhan kembali pakan terhadap perubahan bobot badan, status fisiologis dan *volatile fatty acid* (VFA) darah pada kambing Kacang dan Peranakan Etawah. Delapan ekor kambing jantan yang terdiri atas 4 ekor kambing Kacang dan 4 ekor kambing Peranakan Etawah digunakan dalam penelitian ini. Kedua jenis kambing tersebut diberikan perlakuan yang sama dalam tiga fase dimana masing masing fase selama satu bulan. Pertama adaptasi, fase kedua, pakan dikurangi dengan pemberian bahan kering 1,7% berat badan untuk masing-masing ternak. Fase ketiga, ternak diberi pakan secara *ad libitum.* Variabel yang diamati adalah perubahan bobot badan, status fisiologis dan VFA darah. Data yang diperoleh dianalisis dengan uji Sidik Ragam menggunakan Rancangan Acak Lengkap (RAL) pola faktorial 2x2. Uji Jarak Berganda Duncan digunakan untuk menguji perlakuan yang berbeda nyata. Hasil penelitian menunjukkan bahwa pola perubahan bobot badan kedua bangsa kambing relatif sama. Status fisiologis (pulsus, tempetarur *rectal* dan respirasi) kedua bangsa kambing tidak berbeda nyata. Akan tetapi penurunan pakan menurunkan temperatur tubuh, pulsus dan respirasi walaupun masih dalam kisaran normal. Hal serupa juga terjadi pada kadar VFA darah. Berdasarkan hasil penelitian dapat disimpulkan bahwa perbedaan bangsa tidak berpengaruh terhadap kondisi fisiologi ternak kambing. Perbedaan jumlah pakan berpengaruh terhadap kondisi fisiologi dan kinerja produksi ternak kambing.

Kata kunci: Bobot badan; kambing; pengurangan pakan; pemenuhan kembali; status fisologi

Abstract

The aimed of this study was to observe the effect of feed restriction and refeeding on body weight, physiological status and blood VFA on Kacang and Etawah Crossbreed Goat. Eight male goats consisting of4 Kacang Goats and 4 Etawah Crossbred goats were used as experiment objects in this study. Both types of goats were subjected to the same treatment (three phases). First was adaptation, feed was given gradualy until reach the intended amount. Secondly, the feed was reduced by giving as much as 1.7% dry matter of body weight for each; thirdly, both goats were fed on *ad libitum* (refeeding phase). The variables observed were body weight changes, physiological status and blood VFA. The data obtained were analyzed by Various Random Test using Completely Randomized Design (RAL) on 2x2 factorial patterns. Duncan Multiple Range Test was used to test treatments that significantly different. The results showed that the pattern of changes in body weight on both goats breeds were relatively similar. Physiological status (pulse, rectal and respiratory temperature) on both breed of goats were not significantly different. However, decrease in the amount of feed impacted in the decrease in body temperature, pulsus and respiration, although it was still within normal range. The same also happened on blood VFA levels. Based on the results of the study, it can be concluded that breed differences breed of goat did not affect the physiological condition of goat. Differences in the amount of feed affect the physiological conditions and the performance of goat production.

Keywords: Body weight; goat;feed restriction; refeeding; physiological status

Introduction

Goat is a ruminant that quite popular among Indonesia. Goats are able to adapt themselves with the environment, higher economic value, faster in reproduction (number of goat kid per series of birth is more than one) and does not require extensive land in its maintenance. The population of domestic goat in Indonesia as reported by BPS *(Center Statistical Agency)* in 2010 was 16.821.000 goats. The Indonesian domestic goat is quite diverse, but the dominant one and commonly known among Indonesia is *Kacang* and Etawah Crossbred Goat (PE goat). Etawah Crossbred (PE) Goat is a crossbred goat between Etawah Goat and *Kacang* Goat to serve dual purpose as meat and milk producer.

Physiological conditions and livestock production performance are influenced by genetic and environmental factors. According to Bintara *et al.* (2008), the environment plays greater role than the genotype, which the genotyping effect will not appear without the existence optimal environment. Feed is an enormous environmental factor.

Nutritional needs for domestic goats are used in their growth, production, reproduction, and movement. Therefore, feeding should consider these needs. Tomaszewska *et al.* (1991) stated that feed and feeding systems play a vital role in livestock production. The changes of season certainly causes fluctuation in the availability of feed; abundant in the rainy season, while limited in the dry season. Thus, livestock feeding will also follow the feed availability pattern at the seasonal change. Feed fulfillment as mentioned above will directly affect the performance of the existing livestock.

In connection with the above descriptions, it is necessary to conduct research simulated to see the response *o Kacang* and Etawah Crossbred Goat when the forage is abundant and limited, as a result of the seasonal changes from rainy to dry season.

Materials and Methods

This study was used in this experiment, 8 male goats with an average 1 year old, consisted of four (4) *Kacang* goats (average initial weight of 26.47+2.54 kg) and 4 PE goats (average initial weight of 34.05 + 1.46 kg). Goats were placed in the the individual cage-shaped stage (1.5 m x 75 cm per individu) with additional feed and drinking water buckets placed outside but adhered to the cage. Individual partitions were made of iron, while the cage floors are made of wood in such away for an easier cleaning purpose.

The equipments were used in this experiment were digital scales with a capacity 10 kg and 25 g accuracy for weighing the feed, camry analytical scale 3 kg capacity with 1 g accuracy for weighing the stool samples, chopper, machete, bucket, feces collection circuit, and other laboratory equipments.

The feed used in this experiment consists of forage in the form of groundnut straw *(rendeng)* purchased from farmers in Bantul. The concentrate feed used is pelletized commercial concentrate with the name *Gemuk* AR produced by PT. Japfa Comfeed Indonesia. Total feed offered was determined based on 3% dy matter of the body weight of the goat in the early week (goat was weekly weighed). The proportion of forages and concentrates was adjusted according to the treatment in each study period. The results of proximate analysis of the feed ingredients can be seen in Table 1.

The study was conducted at the experimental cage of the Faculty of Animal Science, Universitas Gadjah Mada (UGM) during month of August to November. The analysis was conducted at the Laboratory of Forage and Pasture Science, Faculty of AnimalScience UGM.

Table 1. Result of feed proximate analysis was used in the study

Feed ingredients	Nutrient Content *)					
	DM (%)	ah (%)	Fat (%)	Crude Protein (%)	Crude Fiber (%)	BETN (%)
Groundnut straw *(rendeng)*	29.23	11.84	15.47	2.14	24.40	53.87
Pellet	89.38	9.11	7.05	15.47	10.90	57.46

*) Analysis in Laboratory of Forage and Pasture Science, Faculty of Animal Science, UGM.

Adaptation

Adaptation was conducted for one month, intended to familiarize the animals to the new environment(feed and cage were used).

***Azperimeiifaf* design**

Completely Randomized Design Factorial pattern (Hanafia, 2010) was used in this research. The treatment consisted of two factors i.e, breed of goat Kacang Goat (K1) and PE Goat (K2)) and the amount of feed feed reduction 1.7% dry matter weight(R1) and ad libitum feed(R2). Each treatment was repeated for 4 times.

Research Phases

The study was conducted in three periode. The first periode is 30 days (adaptation). Both group of goats were offered groundnut straw *(rendeng)* in *ad-libitum* while the concentrate was offered 40% of dry matter need for basic living. The second periode lasted for 32 days. The amount of feed will be limited by giving 1.7% dry matter of body weight to each goat. The comparison of forage feed+concentrate feed was 60%+40%. The third periode lasted for 30 days. *Rendeng* were given by *ad-libitum* while concentrate was given by 40% of dry matter need for basic living (equivalent to 1.2% of body weight).

Feeding and drinking water

Animal was fed twice per day, in the morning and in the afternoon. Feeding in the morning was done after the collection of the remaining feed and the measurements of the remaining drinking water from the previous day. Concentrate was given earlier, at7:30 AM. After the concentrate runs out, *rendeng* was given at around 08.00-08.30 AM. Half of the feed was given in the afternoon i.e concentrate at 15.00 and *rendeng* around 15.30-16.00. Drinking water was provided on an *ad-libitum* (free but noted).

Data collection

The data taken in this study were body weight changes, body temperature, heart rate (pulsus), respiration frequency, blood VFA concentration (acetic acid, propionic acid, butyric acid).

Body weight measurement

Weighing of livestock was done at the beginning of the research to know the initial weight and to compute the feed requirement (dry matter based) for each goat. The next weighing was done weekly during the research in the morning before the animals were fed.

Body weight changes

Pattern of body weight changes in the animals was measured by the weekly weighing, while daily body weight changes were calculated based on the differences between final body weight and initial body weight at each study period divided by the number of days in each study period.

Body temperature(Pulse)

It was measured by inserting a rectal thermometer (clinical thermometer) into *rectum* of animal. The measurement was carried out until the indicator on the thermometer was respond.

Heart Rate

(Pulse). It can be measured by touching the groin *ifemoral artery)* until the pulse detected. The calculation of the heart rate was done by counting the number of beat in one minute. Counting was repeated three times on each data collection and then averaged.

Respiration Frequency

The respiration frequency was measured by counting the breath on the back of the hand placed in front of the object's nose for 1 minute. Counting was repeated three times in each data collection and then averaged.

Volatile Fatty Acid (VFA) concentration in blood

It can be determined by taken 10 ml of blood by using *syringe* through a *jugular vein* in the third week of each period. Blood samples are then put in a tube (vacutainer tube). To obtain serum, blood samples centrified by 3000-4000 rpm. The blood serum obtained was put into an *eppeDdor/* tube, and then analyzed by using chromatography gas method to determine its VFA concentration. VFA was measured by chromatography gas technique (GC Chrompack CP 9002) equipped with computer. A 1 ml of blood serum put into *eppefldor/* tube and then added by 0.003g of *sulfo-5-salicylic acid dihydrate,* then centrifuged at 12,000 rpm for 10 minutes. The clear liquid obtained was injected with standard VFA solution. As much as 0.4 Jil then injected into chromatography and the results can be seen on the screen.

Data analysis

The parameter data includes body weight changes, body temperature, heart rate (pulse), respiration frequency, blood VFA concentration (acetic acid, propionic acid, butyric acid) analyzed by variance according to completely randomized design with factorial pattern (Hanafia, 2010). If the variance shows any real differences, it was then tested by Duncan Multiple Range Test.

Results and Discussion

Body Weight Changes

Changes in goat's body weight was strongly influenced by the amount of feed offered (consumed). As seen in Figure 2, both breed of goats, *Kacang* Goat and *PE Goat* shows similar pattern in body weight changes at the time of feed restriction and in *ad-libitum.* During six weeks of feed restriction, both of goats were gradually losing weight. The average *Kacang goat* loss was 63,71 grams per day (0.22 % per day) while *PE goats'* weight decreased by an average of 69.07 grams per day (0.18 % per day). The decrease in body weight during feed restriction shows that the supply of nutritional needs expected from the feed offered was not sufficient for various activities purposes of domestic goat.

In the smallholder farmers, decreasing of body weight was an unavoidable fact. This condition is often occurring during the transition from the rainy season to the dry season as stated by Yuwono *et al.* (2000) that in the dry season domestic animal will lose weight. Surely it can be understood that in the dry season fodder crops can not growth properly or even depressed and eventually die. This causes the need for forage feed in the dry season was not fulfilled so that ruminants like goats that are traditionally domesticated will lose their weight.

Local goats experiencing compensation growth after the feed is replenished (after the 6° week), even in this study the changes are quite large. During the four

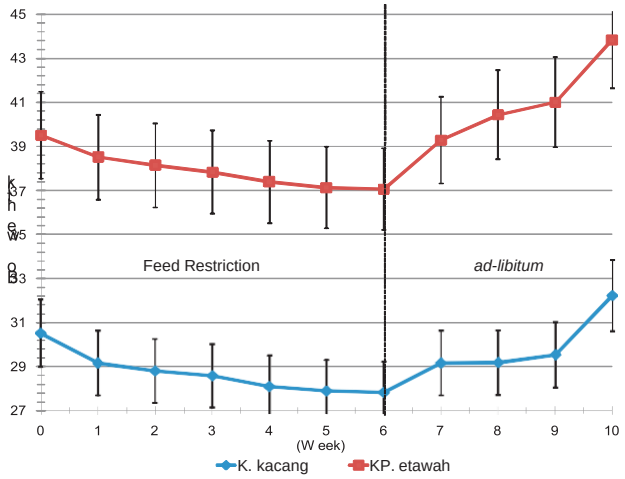

Figure 2. Pattern of body weight changes of Kacang and PE goats during the restriction and *ad-libitum* (refeeding) phase

weeks of *ad-libitum* feeding, the average daily gained (ADG) of Kacang goats about 129.31 grams per day (0,44% per day) while PE goats about 199,84 grams per day (0,50% per day). Similar research has been conducted by Aboelmaaty *et al.* (2008) with a 50% decrease in feeding of goats from the previous average consumption resulted in significant weight loss and after return to the normal amount of feed there was a weight gain compensation,as reported by Bambang Suwignyo *et al.* (2016) with male Bligon goat ; Bambang Suwignyo *et al.* (2017) with 60% restriction in Kacang Goat.

Body Temperature, Heart Rate and Respiration Frequency

Variance Analysis showed significant effect ($P<0.05$) from the treatment on body temperature and heart rate, but there was not significanty effect on respiration frequency. The average value of the body temperature, heart rate (pulse) and the respiration frequency of the goats as a result of the treatment can be seen in Table 2.

Table 2. Body temperatures, heart rate and respiration frequency of Kacang and PE Goat *)

Variables	Breed of Goats	Feeding phase		Average
		Restrictions	Refeeding	
Body Temp. (^{O}C)	Kacang	38.44±0.26^{a}	38.91±0.14^{b}	38.67±0.33
	PE	38.63±0.21	38.73±0.15	38.68±0.07
	Average	38.53±0.13^{a}	38.82±0.12^{b}	
Pulse (x/minutes)	Kacang	75.00±4.10^{a}	87.00±8.11^{b}	81.00±8.48
	PE	73.66±2.52^{a}	83.90±2.90^{b}	78.78±7.24
	Average	74.33±0.94^{a}	85.45±2.19^{b}	
Respiration Freq. (x/ minutes)	Kacang	22.66±1.96	24.10±1.32	23.38±1.02
	PE	21.66±2.27	23.00±3.02	22.33±0.95
	Average	22.16±0.71	23.55±0.77	

*)The value is written as deviation standard ± average
$^{a, b}$ Different Superscript in the same line shows significant differences ($P < 0.05$)
ns = Non-significant

The results of the analysis show that there was no interaction between breed of goats and the amount of feed given, either to body temperature, heart rate or respiration frequency. The absence of interactions gave information that the body temperature, heart rate and the respiration frequency are not determined by the linkage between breed of goat and the amount of feed offered. If there will be any differences, it was due to a single influence, and in this study the factors that significantly affect was the amount of feed given.

Body temperature

Kacang Goat was known as original Indonesian goat so they are expected of having better physiological

performance than the Etawah Crossbred. The results of the study did not show any significant difference. In this study, both breed of goat had normal body temperature, range from 38.67 'C to 38.68 ^{o}C, so it is assumed that both breed of goat was equal in responding the environmental changes. This is possibly because the two breed of goats come from local goats. Pamungkas *et al*. (2009) as the results of exploration activities, characterization and evaluation of plasma nutfah conducted by Center for Livestock Research and Development stated that the characteristics of PE goat based on its genetical potential and its adaptability to the environment are classified as Indonesian indigenous goat.

The goat's body temperature during feed restrictions was slightly below the normal temperature range which is 38.53° C. The normal body temperature of goat as reported by Triakoso (2011) is 38.6° C until 40.20° C with an average temperature 39.40° C. Although it is only 0.070° C below the normal range, it still indicates that with inadequate feeding, the condition of local goat based on body temperature is in a physiologically uncomfortable condition. The condition of goats during feed restriction was significantly different (P<0.05) with the one during refeeding. The balance of body temperature can be influenced by internal and external condition of the body. The internal condition of the body is the physiological process inside the body, including metabolism process.

The body temperature changed during feed restriction and refeeding mainly caused by the mechanical and chemical performance increase in the digestive process, in line with increasing feed intake. Similarly, Isroli *et al*. (2004) stated that changes in the body temperature of domestic goat are affected by the thermal generated from the amount of feed consumed.

Heart rate (pulse)

Statistically, there was no significant difference between Kacang Goat and PE Goat on heart rate frequency in responding the given treatment. When the amount of feed was reduced, the heart rate decreases and when the feed was given by *ad-libitum* the heart rate increase (Table 2).

A significant difference of heart rate (P<0.05) occurs during feed restriction and *ad-libitum* (Table 2) but it still within normal range. Normal range for goat's heart rate according to Dawson *et al*. (2011) is 70 to 90 times/minute. The increased of the heart rate caused by the increased activity of food digestion process as stated by Frandson (1992), that the activity of the digestive system is one of the factors that affect the heart rate in animals. In line with those statements, according to Isroli *et al.* (2004) in addition to being influenced by the quality of feed, the increase in heart rate is also influenced by the increase in feed consumption i.e the increase in feed consumption will increase the body metabolism and eventually will increase the heart rate. The increase in heart rate will stream the blood to the surface of the skin to keep the body's heat in balance (Isroli *et al.,* 2004). In connection to that, Marai *et al*. (2007) stated that heart rate is a major reflection of homeostatic process of blood circulation along the metabolic status.

Respiration Frequency

The respiration frequency of Kacang goat and PE goat in this study was not significantly different so it can be assumed that the ability of both goats to turn food into energy was relatively the same. According to Soeharsono *et al*. (2010) oxygen is needed in the process of turning food into energy. Cattle get oxygen from the respiration.

The range of goats' respiration frequency as the effect of the treatment is still within the normal range.

The normal frequency of domestic goat respiration according to Triakoso (2011) is 20 - 30 times per minute. Similar finding also reported by Bambang Suwignyo *et al.* (2016) with male Bligon goat; Bambang Suwignyo *et al.* (2017) with 60% restriction in Kacang Goat.

Concentration of Acetic, Propionic and Butyric Acid

Variance Analysis showed significant effect (P<0.01) from the treatment on acetic acid concentration but showed no significant affect on the propionic and butyric acid. The analysis also shows that there was no interaction between breed of goats and the amount of feed given, either to the concentration of acetic, propionic or butyric acid. The average values of the concentrations of acetic, propionic and butyric acid in goats' blood as a resulted of treatment can be seen in Table 3

Acetic acid

The concentration of acetic acid found in Kacang goat's blood was not significantly different from PE goats. The absence of significant differences between acetic acid concentrations in both breed of goats suggests that the microbial activity in the rumen on both breed of goats was relatively similar. As it is known that the nutrients fermentation process to produce VFA and other products is highly dependent on microbial activity in the *rumen.* The VFA concentration generated depends on the volume and the ease of feed to enter the *rumen* for fermentation process. The same of feed and feeding system give equal opportunity for Kacang goat and PE goat to utilize the feed to perform metabolism.

Acetic acid is an end product of crude fiber fermentation. When the feed was given by *ad-libitum*, the consumption of crude fiber will also become higher. It was proven by the significant increasing of acetic acid concentrations (P<0.01) when the feed is limited i.e 1,575 ml Mol, and it become 5,325 m1 Mol when feed was given by *ad-libitum.* Due to its high concentration in the *rumen*, acetic acid was most prevalent in the blood, followed by propionic acid and then butyric acid(Anonymous, 2012).

Propionic acid

There was no significant difference between the concentration of propionic acid in Kacang and PE goat. The absence of significant differences in all treatments suggests that the concentrations of propionate produced in the rumen and absorbed into the blood in both breed of goats were relatively similar, either in feed restriction and *ad-libitum.* The reduction of feed offered to the animal did not affet to the performance of rumen microbia, which responsible to covert feed entered to the rumen become acetic, propionic an butiric acid called VFA. Goats not only offered with concentrate (grain) that usually conotated with propionic production, but also groudnut straw is legume that has high crude protein content (more that 15%). Legume also has indirect effect to the propionic acid production. The consentration of propionate produced in the rumen (later on goes to the blood vesels) has close relationship with feed offered especially grain and forages with high crude protein as if legume (Suwignyo *et al.*, 2016). Furthermore, Suwignyo *et al.* (2016) stated that in cattle and buffalo that offered with feed supplemented with legume *(Leucaena leucocephala)* enhanced the population of *F.succinogenes* in the rumen. In rumen fermentation, *F. succinogenes* produces succinate, an intermediate compound for the production of propionate, while only *F.succinogenes* that can produce succinate in the fermentation processes, will turn to be propionate.

Table 3. The concentration of acetic, propionic, and butyric acid in the blood of Kacang and PE Goat *'

Variables	Breed of Goats	Feed				Average	
		Restriction		Ad-libitum			
Acetic Acid (ml Mol)	Kacang	2.25	1.45°	6.45	3.55[b]	4.35	2.96
	PE	0.90	0.42°	4.20	2.39[b]	2.55	2.33
	Average	i.s7	0.95	5.32	1.59[b]		
Propionic Acid (ml Mol)	Kacang	0.91	0.81	1.35	0.97	1.13	0.31
	PE	0.16	0.04	0.77	0.97	0.46	0.43
	Average	0.54	0.53	1.06	0.41		
Butyric Acid (ml Mol)	Kacang	0.25	0.31	0.22	0.31	0.235 z0.02	
	PE	0.03	0.02	0.45	0.71	0.240 z0.29	
	Average	0.14	0.15	0.33	0.16		

*.) The value is written as deviation standard + average
" Different Superscript on the same line shows significant differences (P < 0,05)
ns = Non-significant

\Butyric acid

Statistical analysis showed no significant differences between the concentration of butyric acid in the Kacang goat and PE goat's blood. The amount of feeding also did not show any significant effect on the concentration of butyric acid in goat's blood. Although it was not statistically different, but from Table 3. it can be seen that there was an increase in the concentration of butyric acid in goat's blood when feed was administered by *ad-libitum.* That means the concentration of butyric acid also depends on the amount of feed consumed by goat. However, butiric acid always the smalest amout compared with another VFA components. Wulandari (2006) stated that production of butyric acid is only about 10% from total VFA in the rumen. It caused the detection of VFA in the blood of goat also small, either during restriction or refeeding phase.

Conclusion

Based on the results of this study, it can be concluded that different breed of goats did not affect the physiological condition. Differences in the amount of feed affected in the physiological condition and the production performance of goat. During feed restriction, the body temperature dropped, heart rate and respiration also dropped but still within the normal range. The concentration of VFA in the blood also decreases, the daily body weight changes on both breed of goats tends to decrease and will increase again when feed was offered by *ad-libitum.*

References

Aboelmaaty, A.M., M.M. Mansour, O.H. Ezzo, A.M. Hamam, 2008. Some Reproductive and Metabolic Responses to Food Restriction and Re-Feeding in Egyptian Native Goats. Global Veterinaria 2 (5): 225-232.

An onym ous, 2012. P enyerapan VFA. http://sites.goog1e.com/site/nutrisiternakruminansia/karbohidrat. Diakses, 8 maret20l2.

Bambang Suwignyo, Zein Ahmad Baihaqi, Ristianto Utomo, Sarminand Irkham Widiyono. 2017. Effects of Different Feed Restrictions on Kacang Goats. Pak. J. Nutr. 16 (4): 236-241, March 15, 2017. ISSN 1680-5194

Bambang Suwignyo, Ulil Amri Wijaya, Rieska Indriani, Asih Kurniawati, Irkham Widiyono, Sarmin. 2016. Konsumsi, Kecernaan Nutrien, Perubahan Berat Badan, dan Status Fisiologis Kambing Bligon Jantan Dengan Pembatasan Paka. Jurnal Sain Veteriner Vol 34 (2) : 210-219, Desember 2016

Bintara, S., Kustono, Ismaya, D.T. Widayati, 2008. Ilmu Lingkungan Ternak. Fakutas Peternakan, Universitas Gadjah Mada, Yogyakarta.

BPS, 2010. Populasi Ternak di Indonesia. Badan Pusat Statistik Republik Indonesia, Jakarta.

Dawson, L., J. Allen, B. Olcott, 2011. Meat Goat Herd Health - Procedures and Prevention. http://www.1uresext.edu/goats/training/herdhea1thI.html. diakses, 5 Agustus 2011.

Frandson, R.D., 1992. Anatomi dan Fisiologi Ternak. Cetakan ke-4. Gadjah Mada University Press, Yogyakarta.

Hanafia, K.A., 2010. Rancangan Percobaan, Teori dan Aplikasi. Rajawali Pers, Jakarta.

Isroli, S.A.B. Santoso dan N. Haryati, 2004. Respons Termoregulasi dan Kadar Urea Darah Domba Garut Betina Dewasa yang Dipelihara di Dataran Tinggi Terhadap Pencukuran Woll. Jurnal Pengembangan Peternakan Tropis, 2: 110 — 114.

Marai, I.F.M., A.A. El-Darawany, A. Fadiel and M.A.M. Abdel-Hafez, 2007. Physiological Traits as Affected by Heat Stress in

Pamungkas, F.A., A. Batubara, M. Doloksaribu dan E. Sihite, 2009. Potensi Beberapa Plasma Nutfah Kambing Lokal Indonesia. Pusat Penelitian dan Pengembangan Peternakan, Badan Litbang Pertanian, Bogor.

Soeharsono, L. Adriani, E. Hernawan, K.A. Kamil, A. Mushawwir. 2010. Fisiologi Ternak; Fenomena dan Nomena Dasar dari Fungsi Serta Interaksi Organ pada Hewan. Widya Padjadjaran, Bandung.

Suwignyo, B., B. Suhartanto, N. Umami, N. Suseno, and Z. Bachruddin. 2016. Feeding Strategy of Ruminants and its Potential Effect on Methane Emission Reduction. Journal of Agricultural Science Vo18 (9) : 199-204, August, 2016

Tomaszewska, M.W., I.K. Sutama, I.G. Putu, T.D. Chaniago, 1991. Reproduksi, Tingkah Laku, dan Produksi Ternak di Indonesia. PT. Gramedia Pustaka Utama, Jakarta.

Triakoso, N., 2011. Petunjuk Pemeriksaan Fisik. Ilmu Penyakit Dalam, Departemen Klinik Veteriner, Fakultas Kedokteran Hewan, Universitas Airlangga, Surabaya.

Wulandari, C.A., 2006. Tampilan Konsumsi Serat Kasar Pakan, VFA Rumen, Glukosa Darah, Laktosa dan Kadar Air dalam Susu Akibat Suplementasi *Sauropus androgynus* (L.) Merr. (Katu) pada Ransum Sapi Perah. Tesis. Program Studi Magister Ilmu Ternak, Program Pascasarjana-Fakultas Peternakan Universitas Diponegoro, Semarang.

Yuwono, P., B. Hartoyo, A. Priyono, H. Soeprapto, 2000. Intik Pakan dan Pertumbuhan Domba yang Diberi Pakan Rumput Lapangan Setelah Pembatasan Pakan Selama 6 Minggu. Fakultas Peternakan UNSOED Purwokerto, *Animal Production*, Vol. 2 (2) : 47-52, November 2000.