

ISSN 1411-2027 e-ISSN 2541-5875

# ***ANIMAL PRODUCTION***

Accredited by

Dirjen Penguatan Riset dan Pengembangan Kemenristek Dikti No 32a/E/KPT/2017



Sinta Score

Indexed by



**FACULTY OF ANIMAL SCIENCE JENDERAL SOEDIRMAN UNIVERSITY**

**in collaboration with**

**INDONESIAN SOCIETY OF ANIMAL SCIENCE**

## Table of Contents

### Articles

<b>The Influence of Breed and Type of Extender on the Quality of Bull Semen</b>  Iman Sukirman, Eros Sukmawati, Siti Darajah Rasad, Nurcholidah Solihati	PDF 64-70
<b>Estrus Performance and Pregnancy Rate in Types of Local Cows on Different Estrus Synchronization Protocols</b>  Yendraliza Yendraliza, Lia Lia, Jully Handoko, Anwar Efendi Harahap	PDF 71-80
<b>The Internal Organs Weight of 6-Weeks Old Native Chickens after Supplement Addition With L-threonine and L-tryptophan in the Feed</b>  Charles Venirius Lisnahan, Oktavianus Rafael Nahak	PDF 81-86
<b>Rumination Time and Frequency of Goat Supplemented with Garlic Powder and Organic Chromium</b>  Munasik Munasik, Bahrin Bahrin, Ihsan Yosinanda Sigar, Agustinah Setyaningrum, Caribu Hadi Prayitno	PDF 87-92
<b>Content of Prussic Acid and Production of Sorghum Brown Midrib by Adding Urea Fertilizer and Extending Harvesting Time</b>  Nafiatul Umami, Nofi Isnaini, Bambang Suhartanto	PDF 93-97
<b>The Characteristics and Quality of Egg from Commercial Laying Hens Fed with Garlic (Allium Sativum) Supplemented Ration</b>  Jein Rinny Leke, Erwin Wantasen, Florencia Sompie, Femy Hadidjah Elly, Ratna Siahian	PDF 98-103
<b>Entrepreneur Behavior of Broiler Farmers in Banyumas</b>  Yusmi Nur Wakhidati, Mochamad Sugiarto, Hudri Aunurrohman	PDF 104-109
<b>Socio Demographic Factors Influencing the Income of Native Chicken Farming in Rural Area of Ciamis Regency</b>  Lucie Setiana, Mochamad Sugiarto, Oentoeng Edy Djatmiko	PDF 110-115

### Animal Production Indexed In





## ANIMAL PRODUCTION : INDONESIAN JOURNAL OF ANIMAL PRODUCTION

FAKULTAS PETERNAKAN UNSOED BEKERJASAMA DENGAN ISPI

P-ISSN : 14112027 <> E-ISSN : 25415875 Subject Area : Education



1.12

Impact Factor



884

Google Citations



Sinta 2

Current Accreditation

[Google Scholar](#) [Garuda](#) [Website](#) [Editor URL](#)

### History Accreditation

2017

2018

2019

2020

2021

2022

2023

2024

2025

Garuda

Google Scholar

Search...

Results for "Rumination Time and Frequency of Goat Supplemented with Garlic Powder and Organic Chromium"

clear search

Rumination Time and Frequency of Goat Supplemented with Garlic Powder and Organic Chromium

Universitas Jenderal Soedirman, Faculty of Animal Science, Purwokerto-Indonesia

ANIMAL PRODUCTION Vol 21, No 2 (2019)

87-92

2019

DOI: 10.20884/1.jap.2019.21.2.763

Accred : Sinta 2

## Rumination Time and Frequency of Goat Supplemented with Garlic Powder and Organic Chromium

Munasik\*, Bahrin, Ihsan Yosinanda Sigar, Agustinah Setyaningrum and Caribu Hadi Prayitno

Faculty of Animal Science, Jenderal Soedirman University, Purwokerto, Indonesia

\*Corresponding author email: munasik2011@gmail.com

**Abstract.** This research investigated the effect of supplementing garlic powder and organic micromineral Cr in feed on rumination time and frequency in Ettawah goat (PE). The research was conducted in Gunung Tugel Farm in Patikraja and the Laboratory of Feed Technology in Faculty of Animal Science, Universitas Jenderal Soedirman, Purwokerto, Central Java. This study used 18 male PE aged 1-1.5 years and weighed 18.62 – 22.69 kg. The feed consisted of 60% concentrate and 40% forage (field grass). Other materials included drinking water, 250 ppm garlic powder (*Allium sativum*), 1.5 ppm organic chromium mineral and eight CCTV camera. The observed parameters were rumination time and frequency. An in vivo experiment in a Completely Randomised Design (CRD) administered three treatments and six replicates, namely R0: control (basal feed); R1: basal feed + 250 ppm garlic powder; and R2: basal feed + 250 ppm garlic powder + 1.5 ppm organic Cr. The result demonstrated a significantly different effect of garlic powder and organic Cr micromineral supplement on rumination time across treatments, i.e.  $404 \pm 19.6$ ;  $382 \pm 19.04$  and  $351 \pm 13.87$  min/day, respectively, or 379 min/day on average. Rumination frequency was not significantly different across R0, R1, and R2 namely  $360 \pm 24.03$ ;  $359 \pm 30.13$  and  $342 \pm 21.10$  times/day, respectively. Conclusively, garlic powder and organic Cr micromineral significantly affected rumination time, but not significantly affected rumination frequency of PE goat.

**Keywords:** garlic powder, *Allium sativum*, organic Cr, feeding behaviour, rumination, Ettawah goat

**Abstrak.** Penelitian ini bertujuan untuk mengetahui pengaruh penambahan tepung bawang putih dan mikromineral Cr organik dalam pakan terhadap lama dan frekuensi ruminasi kambing PE (Peranakan Etawa). Penelitian dilaksanakan di Gunung Tugel Farm, Patikraja, Banyumas dan Laboratorium Ilmu Bahan Makanan Ternak, Fakultas Peternakan, Universitas Jenderal Soedirman, Purwokerto, Jawa Tengah. Materi penelitian menggunakan 18 ekor kambing PE jantan dengan umur 1–1,5 tahun dan kisaran bobot 18,62 - 22,69 kg. Pakan yang diberikan yaitu konsentrat sebanyak 60% dan hijauan berupa rumput lapang sebanyak 40%, air minum, tepung bawang putih (*Allium sativum*) 250 ppm, mineral chromium organik 1,5 ppm, 8 buah kamera CCTV, 1 unit. Parameter yang diamati adalah lama waktu ruminasi dan frekuensi ruminasi. Metode penelitian yang digunakan adalah eksperimen secara *in vivo* dengan Rancangan Acak Lengkap (RAL) menggunakan 3 perlakuan dan 6 ulangan. Perlakuan terdiri atas R0 : kontrol (pakan basal) ; R1 : pakan basal + 250 ppm tepung bawang putih ; R2 : pakan basal + 250 ppm tepung bawang putih + 1,5 ppm Cr organik. Hasil penelitian menunjukkan bahwa penambahan tepung bawang putih dan Cr mikromineral organik terhadap waktu ruminasi berbeda nyata yaitu  $404 \pm 19,6$ ;  $382 \pm 19,04$  dan  $351 \pm 13,87$  menit/hari dengan rata-rata 379 menit/hari dan frekuensi ruminasi tidak berbeda nyata dengan jumlah ruminasi perlakuan R0, R1 dan R2 :  $360 \pm 24,03$ ;  $359 \pm 30,13$  dan  $342 \pm 21,10$  kali/hari. Simpulan yang diperoleh adalah penambahan tepung bawang putih dan mikromineral Cr organik dalam ransum berpengaruh nyata terhadap lama ruminasi, namun tidak memberikan pengaruh nyata terhadap frekuensi ruminasi kambing PE.

**Kata kunci :** tepung bawang putih, *Allium sativum*, Cr organik, tingkah laku makan, ruminasi, kambing Peranakan Etawa

### Introduction

Goat is a livestock commodity that significantly meets the demand of animal protein besides beef and poultry. PE goat is widely bred, but the development is hampered by insufficient nutrients and low energy intake, which lead to low daily weight gain. One of the

solutions is improving feed quality to enhance cattle productivity. Feed is a crucial factor in breeding management, taking up 60-70% of production. Therefore, improving feed quality needs to consider the economic aspect and feed availability. Dry matter intake and requirement for goat is calculated from body

weight the bigger the cattle, the higher the feed intake.

Supplementing garlic powder and Cr micromineral into ration is one alternative to improve feed quality and efficiency. Garlic contains allicin with antiprotozoal and anti-methanogenic properties that could minimize the wasted feed energy in form of methane. Meanwhile, Cr micromineral improves cattle's body metabolism. Therefore, supplementing garlic powder enriched with allicin and Cr micromineral aims to inhibit protozoa growth and improve body metabolism. It was expected to prevent feed energy loss and optimize feed digestibility.

Rumination process starts when the cattle regurgitate the swallowed feed from the rumen in the form of bolus, then reswallow and passed it onto reticulum. The purpose of rumination is to reduce the size of feed particle, to improve feed area to ease microbe in degrading forage, and to stabilize ruminal pH. Rumination time and frequency are affected by the type of feed, feed digestibility, feed composition, physiological status and cattle measurement. Observing the behaviour of ruminants is an indicator to measure feed quality and efficiency.

## Materials and Methods

The observed parameters in this study were rumination time and frequency of male PE goat. This experimental study was conducted in a Completely Randomized Design with three treatments and eight replicates each. Feed concentrate plus garlic powder, and micromineral Cr supplement was rationed into four treatments, namely R0: control (basal feed), R1: basal feed + 250 ppm garlic powder,

and R2: basal feed + 250 ppm garlic powder + 1.5 ppm organic Cr. A CCTV was used for 2x24 hour observation, and the manual observation kit included observatory sheet, a hand counter and a stopwatch. An analysis of variance in a Completely Randomized Design (CRD) investigated the treatment effects on rumination time and frequency. Any significant difference was further tested using Duncant-test. The goats were under treatment for 8 weeks, including 2-week adaptation, 2-week preliminary, and 4-week feeding trial and observing feeding behavior. The goats were placed in individual cages, measuring 1 X 1.25 meters. Feed was given 4% of body weight, 2 times a day (morning and evening).

The feed was made of 40% forage (field grass) and 60% concentrate consisted of 1% salt, 1% mineral mix, 1% soybean meal, 7% palm waste, 11.5% groats, 12.5% soybean husk, 15% CGF (Corn Gluten Feed) and 48% pollard.

## Result and Discussion

### Dry Matter and Organic Intake

The results showed that supplementing 250 ppm garlic powder in goat feed increased feed consumption (DMI or OMI), but when compared with body weight there was a significant decrease. It demonstrated that garlic powder supplemented into goat feed increased feed efficiency although the combined garlic powder + organic Cr minerals produced non-significant effect. Also, garlic powder supplementation increased feed flow rates in the digestive tract and improved feed consumption. This condition was due to the enhanced digestive process of feed in the rumen (ruminal bacteria activity) and an improved feed utilization.

Table 1. Nutrient content

Feed	DM (%)	CP (%)	CF(%)	Fat (%)	TDN (%)
Concentrate	88.7	18.24	11.54	7.48	39.79
Forage	34.31	7.05	32.42	0.38	26.53



Table 2. Dry matter intake (DMI), organic matter intake (OMI) and rumination time

Parameters	R 0	R 1	R 2	Mean
.....(g/day).....				
Dry matter intake	820.34	902.21	916.37	897.64
DMI /Body weight (%)	4.02	3.57	3.57	3.72
Organic matter intake	495.83	560.87	566.87	541.19
DMO/Body weight (%)	2.77	2.51	2.46	2.58
.....(min/day).....				
Rumination time				
Day	144	133	120	132.3
Night	260	249	231	246.6
Total	404 ± 19.6 <sup>a</sup>	382 ± 19.04 <sup>b</sup>	351 ± 13.87 <sup>b</sup>	379

Note: \*R0 = control ration; R1 = control ration + 250 ppm garlic powder (CP: 14.36, TDN: 66.32 %); R2 = control ration + 250 ppm garlic powder + 1.50 ppm Organic Cr. \*values bearing superscript within rows show significant difference (P<0.05).

### Rumination Time

Rumination time is the duration for cattle to ruminate which depends on factors such as crude fibre content, feed type and feed shape. Rumination behavior is the process of discharging feed from the rumen to mouth (regurgitation) signified by the moving bolus from rumen to the throat. Measuring rumination time is one method to estimate feed efficiency and ruminant metabolism. The result of supplementing garlic powder and organic Cr mineral into feed is presented in Table 2.

The result showed that daily rumination time in R0, R1 and R2 was 404 ± 19.6, 382 ± 19.04 and 351 ± 13.87 minute per day, respectively, or 379 minutes per day on average. Supplementing garlic powder and organic Cr micromineral significantly affected rumination time (P<0.05). Rumination time in this study was below 391 minutes of male Kacang goat weighed 8.77-13.87 kg and fed on high protein and high energy (Pembayun et al., 2013). Therefore, garlic powder and Cr micromineral supplemented into feed resulted in a better metabolism because the rumination frequency was shorter despite the higher body weight and higher feed intake.

Table 2 shows that cattle ruminated more frequently during the night than day, averagely 246 vs 132.3 minutes, respectively (46% gap). This result confirmed Pembayun et al., (2013) that daylight rumination was shorter than the

night, i.e. 165 and 226 minutes, respectively. Additionally, the extended rumination at night was because cattle generally feed during the day and ruminate at night (Rook, 2000). Day time rumination in this study was 29% shorter than Garut sheep with 100,6 minutes per 12 hours rumination (Oetami et al., 2015). This gap may due to different types of cattle in the study.

Garlic powder and organic Cr micromineral supplementation in Table 2 show significant effect (P<0,05) on rumination time, where the shortest time was found in R2, i.e. 351 ± 13,87 minute per day, and the longest was 404 ± 19,6 minute per day. It indicated that goats offered with garlic powder and organic Cr micromineral supplementation in feed performed a more efficient body metabolism than those in control feed. Allicin in garlic could improve feed efficiency by inhibiting methanogenesis process, and organic Cr improves insulin activity which advances metabolism and progresses the efficiency of energy feed absorption. Prayitno et al. (2014) reported that Allicin in garlic is powerful to inhibit HMG-CoA reductase and methanogenesis process in the rumen. Supplementing organic Cr aimed to improve body metabolism. According to Adawiah et al. (2006), Cr micromineral contributes to protein metabolism, particularly incorporating amino acid to improve protein synthesis. Also, Cr physiological properties improves insulin

activity a crucial hormone to increase glucose and amino acid uptake in cells (Suryadi et al., 2011).

Supplementing garlic powder and organic Cr in the ration was aimed to increase the efficiency of energy feed absorption and metabolism in cattle. Garlic powder functions as a defaunation agent and inhibits methanogenesis process in the rumen. Kongmun et al. (2010) reported that extract garlic powder for in vitro fermentation was effective against protozoa host and decreased total protozoa. Furthermore, supplementing basal feed with raw garlic or garlic oil was sufficient to reduce total protozoa in sheep (Anassori et al., 2011). Table 2 shows that supplementing garlic powder in feed resulted in a shorter rumination time compared to goat offered with control feed. Similarly, the tannin-fortified feed was reported to perform 30 g/kg DM defaunation in feed and reduce rumination time up to 5%.

Supplementing 250 organic Cr in feed could improve body metabolism without obstructing cattle activity and reducing ruminal microbe population. Pechov and Pavlata (2007) informed that Cr supplementation in an in vitro animal tissue improved glucose oxidation, resulting in  $\text{CO}_2 + \text{H}_2\text{O}$  formation, improving glycogenesis, and converting glucose to lipid which improved glucose utilization. Dallago et al. (2011) stated that supplementing 250-375 ppm chromium per day did not affect total ruminal protozoa (15–16 unit/mm<sup>3</sup> ruminal fluid) and normal ruminal pH ( $6.49 \pm 0.28$ ). However, supplementing 500 ppm chromium per day could significantly decrease total ruminal protozoa 21-day post-treatment into 6-9 unit/mm<sup>3</sup> ruminal fluid.

The average one-day rumination time in Table 2 is 379 minutes per day or 48.3% lower than the previous studies. Male kacang goat fed on low-protein feed ruminated for 613.96 minutes a day (Riyanto et al., 2016), while goats fed with different levels of protein performed

391-minute rumination a day (Pembayun et al., 2013). The discrepancy may due to different feed types and quality and environmental factors. The contributing factors to cattle ruminating behavior may include, but not limited to, feed type and quality, environment and cattle age. The result in Table 2 shows shorter rumination time than that of Riyanto et al. (2016) and Pembayun et al. (2013); therefore, garlic powder supplementation could improve feed digestibility to perform shorter rumination. Yang et al. (2007) stated that garlic improves ruminant digestibility score - a higher digestibility resulted in higher efficiency.

Content in feed is a contributing factor to feed digestibility and ruminating behavior. The higher the crude fiber in feed, the lower feed digestibility; consequently, it extends rumination time. According to Oliveira et al. (2017) 3-month male Boer goats offered with 21% palm kernel biscuit in feed with high fibre and cellulose showed an extended rumination time by 13,8% from 339 to 393 minutes per day compared to basal feed. Galvao et al., (2019) reported that five-month male Boer goat offered with 14% tamarind waste supplement in high-fibre ration showed 12.6% extended rumination time compared to non-supplemented feed.

### Rumination Frequency

Cattle feeding behavior started from prehension, mastication (feed particle reduction), ensalivation (saliva secretion) before swallowing, and rumination. Measuring rumination frequency is a method to investigate feed efficiency and cattle metabolism (Pembayun et al., 2013). The result of garlic powder and mineral organic Cr supplementation in feed is presented in Table 3. The result showed that daily rumination frequency in PE goats offered with R0, R1 and R2 was  $359 \pm 24.03$ ,  $360 \pm 30.13$  and  $342 \pm 21.10$ , respectively. Table 3 shows that supplementing garlic powder in ration did not

Table 3. Dry matter intake feed and rumination frequency

Parameter	R 0	R 1	R 2	Average
	.....(g/day).....			
Dry matter intake	820.34	902.21	916.37	879.64
	.....(time/day) <sup>ns</sup> .....			
Rumination frequency				
Day time	128	118	115	120.3
Nighttime	225	238	226	229.6
Total	359 ± 24.03	360 ± 30.13	342 ± 21.10	353.6

Note: R0 = control ration; R1 = control ration + 250 ppm garlic powder; R2 = control ration + 250 ppm garlic powder + 1.50 ppm Organic Cr; ns = non-significant effect.

significantly affect rumination frequency ( $P>0.05$ ). R2 showed the lowest frequency, i.e.  $342 \pm 14.58$  times/day compared to R0 and R1 with a similar result,  $354 \pm 17.24$  and  $356 \pm 19.23$  times/day, respectively. It was per garlic powder and organic Cr micromineral supplement that improved digestibility. According to Prayitno et al. (2014), supplementing garlic powder and organic mineral in concentrate could improve digestibility score. Also, improving feed digestibility would enhance the effectiveness of rumination activity. Pembayun et al., (2013) stated that Kacang goats fed with high crude protein and low crude fiber would ruminate in a shorter time than those fed with low crude protein and high crude fibre.

The highest feed intake (1,028 kg) and rumination frequency ( $360 \pm 30.13$  times/day) in this study were observed in R1. High rumination frequency in R1 was followed by high feed intake; therefore, high feed intake was positively correlated with rumination frequency. It was in line Oetami et al. (2015) that feed intake was related to rumination. Feed intake occurs due to hunger generated by stomach movement that induces a more frequent feeding and rumination.

Garlic powder supplementation in R1 (Table 3) resulted in similar rumination frequency to that in R0 despite higher feed intake in R1. Total rumination frequency was  $360 \pm 30.13$  (R1) and  $359 \pm 24.03$  (R0), while total feed intake was 1.028 kg/day (R1) and 0.997 kg/day (R0). It indicated that goat offered with garlic powder supplement in feed performed higher body

metabolism than non-supplemented feed. R0 and R1 shared similar rumination frequency, but feed intake in R1 was 4% higher than that in R0.

According to Hernawa and Ahmad (2003), allicin in garlic had hypoglycemic properties to lower blood glucose level. Furthermore, Oetami et al. (2015) stated that hypoglycemic condition could stimulate vagus nerve center in medulla oblongata to induce cholinergic that triggers stomach contraction, hence hunger. It stimulated higher feed intake and a more efficient metabolism in goats fed with garlic powder-fortified feed than the control group; therefore, rumination frequency was not significantly different despite higher feed intake.

Supplementing garlic powder and Organic Cr in feed was aimed to improve body metabolism. Garlic powder functions as methanogen inhibitor to minimize energy feed wasted in the form of methane. Table 3 shows that the lowest rumination frequency ( $342 \pm 21.10$  times/day) was observed in R2 with garlic powder and organic Cr supplement. According to Taoma (2016), allicin supplementation in female sheep could lower methanogenesis by 47.07% and protozoa population by 15.19%. Substituting hay with 10% garlic leaves into the ration could improve digestibility. Also, the chromium-fortified feed could improve amino acid and glucose absorption in the muscle (Amata, 2013), improve lipid synthesis in adipose tissue, and affect cholesterol and triglyceride metabolism. However, further investigation has not been conducted.



## Conclusion

Observation on ruminating behaviour to PE goat offered with garlic powder and organic chromium supplement in feed showed the fastest rumination time ( $351 \pm 13.87$  minute per day) and the lowest rumination frequency ( $342 \pm 21.10$  times/day). Male PE goat ruminated for 379 minutes/day on average for 353.6 times/day.

## Acknowledgement

The authors are grateful to Rector and Chief of LPPM UNSOED for the Applied Research grant No: P/793/UN23/14/PN/2019.

## References

- Adawiah T. S., T. Toto, M. Wasmen and Nahrowi. 2006. Respons Kualitas Susu pada Suplementasi Kacang Kedelai Sangrai and Sabun Kalsium serta Mineral Organik dalam Ransum Sapi Perah. JIV. 11: 28 -287.
- Anassori E., N. B. Dalir, R. Pirmohammadi, A. S. Taghizadeh and M. Maham. 2011. Garlic: a potential alternative for monensin as a rumen modifier. Livestock Sci. 14 : 276–87.
- Amata I. A. 2013. Chromium in Livestock Nutrition: A Review. J. of Agri.Sci. 2 : 289 – 306.
- Dallago B. S. L., C. M. McManus, D. F. Caldeira, A. Lopes. C. T. P. Franco, B. O. Borges, P. H. F. Teles, P. S. Correa and Louvandini. 2011. Performance and ruminal protozoa in lambs with chromium supplementation. Res. in Vet. Sci. 90 : 253–256.
- Galvao J. M., T. M. Silva, W. P. Silva, P. R. S. Pimentel, A. M. Barbosa, T. V. C. Nascimento and A. G. V. O. Lima. 2019. Intake, digestibility, ingestive behavior and nitrogen balance of goats fed with diets containing residue from Tamarind fruit. Trop. Anim Health Prod.
- Hernawan U. E and D. S. Ahmad. 2003. Senyawa Organosulfur Garlic (*Allium sativum* L.) and Aktivitas Biologinya. Biofarmasi. 66 : 65 – 76.
- Kongmun, P., W. Mita, P. Pakdee and C. Navanukraw. 2011. Effect of coconut oil and garlic powder on in vitro fermentation using gas production technique. J.Livestock Sci.. 12 : 38 – 44.
- Oetami, N., H. Dennie and C.B Dwi. 2015. Tingkah Laku Deglutisi, Regurgitasi, and Redeglutisi Serta Lama Rumination pada Domba Garut yang dikandangkan. Students e- Journal. 4(3):18-28.
- Oliveira, R. L., G. G. P. Carvalho, M. S. L. Tosto, M. Santos, R. B. X. Ribeiro, T. M. Saliva and L. M. A. Rufino. 2017. Palm Kernel Cake Obtained from Biodiesel Production in Diets for Goats: Feeding Behavior and Physiological Parameters. Trop Animal Health Prod. 49 : 1401-1407.
- Pembayun, I. H., A. Purnomoadi and S. Dartosukarno. 2013. Tingkah Laku Makan Kambing Kacang Yang Diberi Feed Dengan Level Protein-Energi Berbeda. Anim. Agric. J. 2 : 31-36.
- Pechova, A. and L. Pavlata. 2007. Chromium as an essential nutrient: a review. Veterinarni Medicina. 52 : 1–18.
- Prayitno. C. H., T. R. Sutardi and Suwarno., 2014. Supplementation effect of herbal and organic minerals in beef cattle feed on consumption, digestibility, efficiency and daily gain. J. Anim. Prod. 16: 88-94.
- Riyanto, Agung, Dartosukarno, Sularno and Purnomoadi. 2016. Tingkah Laku Makan dan Rumination Kambing Kacang Yang Diberi Feed Dengan Sumber Protein Yang Berbeda. Thesis undergraduate.Fakultas Peternakan and pertanian. Universitas Diponegoro. Semarang.
- Rook J. A. 2000. Principles of Foraging and Grazing Behaviour. Page 229 in Grass: its production and utilization. A. Hopkins, ed. Blackwell Science.
- Suryadi, U., U. Santosa and U. H. Tanuwiria. 2011. Strategi Eliminasi Stres Transportasi pada Kambing Potong Menggunakan Kromium Organik. Unpad Press, Bandung.
- Taoma, D. Chen, Y. Tu, N. Zhang, B. Si, K. Deng and Q. Diao. 2016. Effect of supplementation of allicin on methanogenesis and ruminal microbial flora in Dorper crossbred ewes. J. of Anim. Sci. and Bio. 1-7.
- Yang, W. Z., C. Benchaar, B. N. Ametaj, A. V. Chaves, M. L. He and T. A. McAllister. 2007. Effects of garlic and juniper berry essential oils on ruminal fermentation and on the site and extent of digestion in lactating cows. J. Dairy Sci. 90: 5671 – 5681.