

ISSN 1819-1878

Asian Journal of
Animal
Sciences



Research Article

Improving the Performance of Local Kacang Goats Using Ruminally Undegradable Protein Feeds

R. Adiwintarti, Kustantinah, I. Gede S. Budisatria, Rusman and E. Indarto

Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta, Indonesia

Abstract

Objective: This study was set up to increase the productivity of Kacang goats using fish meal and soybean meal (containing relatively high ruminally undegradable protein) in the ration. **Materials and Methods:** Twelve kacang goats, 1-1.5-year-old, 17.84±1.57 kg were used in this study. A completely randomized design was used with 3 different rations: NG (control) = Natural grass, FM = Total Mixed Ration (TMR) containing fish meal and SBM = Total mixed ration containing soybean meal. The rations contained 15% of crude protein and 1% of the mineral mix, except for NG. Water and feed were provided *ad libitum*. Data were analyzed by analysis of variance using the SPSS statistics software version 19. **Results:** The growth of FM goats (ADG = 59.03 g) and SBM goats (ADG = 80.06 g) were higher than that of NG goats (ADG = 27.22 g). However, the slaughter weight, carcass weight and dressing percentage of goats fed TMR containing soybean meal (SBM) were the highest among all of the treatments with having the lowest of non-carcass (%). The meat, bone and fat of SBM carcass are also the highest among others. The chevon fat content of goats fed Natural Grass (NG) was the highest, while other physical and chemical properties of chevon were relatively the same. **Conclusion:** It can be concluded that the use of fish meal and soybean meal in the ration improved the performance of local kacang goats. In fact, soybean meal in the ration can improve the productivity and carcass products of kacang goats better than fish meal.

Key words: Carcass traits, fish meal, growth, indigenous goat, meat quality, meat-bone ratio, performance, soybean meal

Received: July 15, 2016

Accepted: July 30, 2016

Published: August 15, 2016

Citation: R. Adiwintarti, Kustantinah, I. Gede S. Budisatria, Rusman and E. Indarto, 2016. Improving the performance of local kacang goats using ruminally undegradable protein feeds. *Asian J. Anim. Sci.*, 10: 262-267.

Corresponding Author: R. Adiwintarti, Faculty of Animal Agriculture, Diponegoro University, Semarang, Indonesia

Copyright: © 2016 R. Adiwintarti *et al.* This is an open access article distributed under the terms of the creative commons attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The numbers of goats slaughtered in Central Java, Indonesia were more than sheep, namely 764,645 goats and 333,318 sheep¹. This is because chevon is preferable meat for health conscious people because of the nutritious and healthy product. It has low fat and low cholesterol content², containing 19.6-20.7% of meat protein³. These conditions have stimulated people to raise goats. The number of goats reared by farmers in Central Java, Indonesia as much as 3,461,409 heads, whereas sheep were only 533,616 heads⁴.

Kacang goat is one of animal genetic resources of goats in Indonesia⁵ which can adapt to the environmental conditions, especially well adapted to traditional management⁶ and prolific⁷. Elieser *et al.*⁸ stated that most farmers in the rural area of Indonesia raise kacang goats. Farmers raise goats traditionally (grazed during the day and housed at night fed roughage without concentrate) so that the productivity is low. Adiwiniarti *et al.*⁹ reported low productivity of grazing kacang goat that produced only 5.66 kg of carcass weight (38.79% of the slaughter weight). The average daily gain of grazing kacang goats was only 3.20 g¹⁰. Therefore, many efforts have to be done to increase the productivity of local goats. This study was set up to increase the productivity of kacang goats using fish meal and soybean meal (containing relatively high ruminally undegradable protein) in the ration. Beside investigating the performance of the goat, the quality of meat is also important to study for health conscious consumer's information.

MATERIALS AND METHODS

Twelve kacang goats, 1-1.5 year-old (the incisors have erupted 1), with the initial body weight of 17.84±1.57 kg (CV=8.80%) were used in this study and arranged with a completely randomized design. The goats were fed by 3 different rations: NG (control) = Natural grass, FM = *Pennisetum purpureum* (30%)+*Gliricidia* leave (30%)+concentrate with fish meal and SBM = *Pennisetum purpureum* (30%)+*Gliricidia* leave (30%)+concentrate with soybean meal. The ration was made Total Mixed Ration (TMR) containing 15% of crude protein (Table 1) and 1% of the mineral mix, except for NG. The goats were dewormed with 1.5 mL per head of valbendasol given orally and 0.5 mL per head of intermectin (Interchemie, Holland) administered sub-cutaneously. Water and feed were provided *ad libitum*. The goats were adapted for 5 weeks and treatment periods for 14 weeks.

Table 1: Feed ingredients and nutrients content in the ration

Feedstuffs/nutrients	NG	FM	SBM
Feed ingredients	----- (%) -----		
Natural grass	100	0	0
<i>Pennisetum purpureum</i>	0	30	30
<i>Gliricidia</i> leave	0	30	30
Cassava waste product	0	20.10	19.20
Wheat bran	0	13.75	13.80
Fish meal	0	6.15	0
Soybean meal	0	0	7.00
Nutrients content in the rations			
Dry matter (%)	18.58	91.26	91.53
Ash (100% dry matter)	12.06	10.41	10.11
Ether extract (100% dry matter)	2.37	2.48	2.56
Crude fiber (100% dry matter)	34.62	29.68	29.18
Crude protein (100% dry matter)	10.92	15.26	15.59
Nitrogen free extract (100% dry matter)	40.04	43.80	42.56
TDN (%)	63.23	56.21	57.95

Parameters observed were the goat's growth, carcass traits, physical and chemical properties of meat. The growth was recorded by weighing the bucks weekly and the average daily gain was calculated from linear regression of weekly weights (14 weeks). The bucks were fasted for 12-15 h with free access to fresh water and then were weighed before being slaughtered for carcass observation. Carcass traits included dressing percentage and the weight and percent of carcass composition (meat, fat and bone). Chevon quality was accessed in the *Biceps femoris* muscles. Chevon quality observed were physical quality included pH, water-holding capacity/WHC, cooking loss and tenderness using warner-bratzler shear force values¹¹ and chemical quality included water, fat, protein content and collagen in meat using near infrared spectroscopy (NIRS)¹². Data were analyzed by analysis of variance using the SPSS statistics software version 19.

RESULTS AND DISCUSSION

Growth of kacang goats fed ruminally undegradable protein: The growth of kacang goats fed ruminally undegradable protein (fish meal and soybean meal) was higher ($p < 0.01$) than those fed natural grass. This indicated that the performance of kacang goats improved by feeding ration containing fish meal and soybean meal. The average of daily gain of FM goats (59.03 g) was lower ($p < 0.01$) than those of SBM goats (80.06 g), but it was higher ($p < 0.01$) than that of NG goats (ADG = 27.22 g). However, the slaughter weight of goats fed TMR containing soybean meal (SBM = 25.56 kg) was the highest ($p < 0.01$) among all of the treatments (NG = 20.65 and FM = 20.59 kg) because the growth of SBM goats was also the highest than others (Fig. 1). Figure 1 shows that in

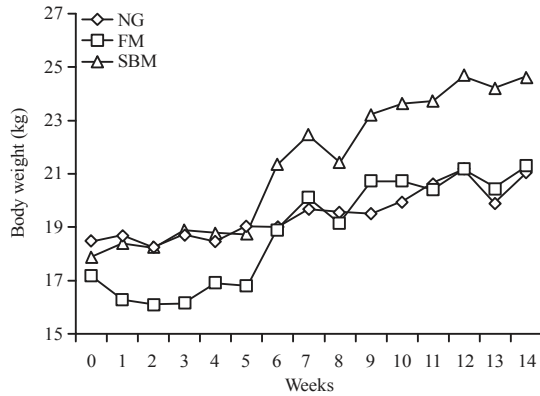


Fig. 1: Growth of kacang buck fed natural grass, total mixed ration containing fish meal and soybean meal (SBM)

Table 2: Slaughter weight, carcass weight, carcass and non-carcass percentage

Parameters	NG	FM	SBM
Slaughter (kg)	20.65 ^A	20.59 ^A	25.56 ^B
Carcass (kg)	8.43 ^A	8.87 ^A	11.94 ^B
Carcass (%)	40.79 ^a	42.96 ^{ab}	46.80 ^b
Non carcass (%)	59.21 ^a	57.04 ^{ab}	53.20 ^b

^{A,B}Means in the same column without common letter are different at $p < 0.01$,

^{a,b}Means in the same column without common letter are different at $p < 0.05$

Table 3: Carcass components and the percentages

Parameters	NG	FM	SBM
Meat (g)	5.713 ^A	6.396 ^A	8.408 ^B
Fat (g)	681 ^{Aa}	539 ^A	1.020 ^{Bb}
Bone (g)	1.869 ^{Aa}	1.801 ^A	2.272 ^{Bb}
Meat (%)	69.07	72.97	71.8
Fat (%)	8.20	6.26	8.73
Bone (%)	22.7	20.77	19.5
Meat+fat: Bone	3.45	3.85	4.18

^{A,B}Means in the same column without common letter are different at $p < 0.01$,

^{a,b}Means in the same column without common letter are different at $p < 0.05$

the first 5 weeks, the growth of FM goats was lower than NG and SBM goats, afterward, SBM goats grew significantly higher than those of NG and FM goats while NG and FM growth were relatively the same. The weight gains were highest for SBM goats and lowest for NG goats. Those were exactly reflected by the differences in Dry Matter Intake (DMI). The DMI of SBM goats (707.48 g) was higher than those of NG goats (502.17 g) and FM goats (597.86 g), but the DMI of NG goats were relatively the same as FM goats. Low DMI in NG goats might be caused by the high content of crude fiber (Table 1) as reported by Ukanwoko and Okehilem¹³ that high crude fiber content caused low feed intake, low total weight gain and poor performance of West African dwarf bucks. However, low DMI in FM goat might be caused by the low palatability of the ration. Kacang goats did not like the ration containing fish meal. This finding is in line with Addulah *et al.*¹⁴ study that reported kacang buck preferred ration containing 0% of fish meal.

Dry matter intake of NG goats (25.59 g kg⁻¹ b.wt. day⁻¹) was lower than those of FM goats (31.16 g kg⁻¹ b.wt. day⁻¹), SBM goats (32.93 g kg⁻¹ b.wt. day⁻¹) and Aryanto *et al.*¹⁵. Aryanto *et al.*¹⁵ stated that DMI of kacang goat fed *ad libitum* reached 29.42 g kg⁻¹ b.wt. day⁻¹. However, the DMI of FM and SBM goats was higher than those of kacang goats reported by Aryanto *et al.*¹⁵.

The ADG of kacang goats fed natural grass *ad libitum* (27.22 g) in this study was higher than those of grazing kacang goats (3.20 g) reported by Adiwiranti *et al.*¹⁰. The ADG of kacang goats fed TMR containing soybean meal (SBM = 80.06 g) was higher than those of kacang goats reported by Restitrisnani *et al.*¹⁶, but lower than those of kacang goats reported by Addulah *et al.*¹⁴. Restitrisnani *et al.*¹⁶ reported kacang goats having ADG of 23.5-69.4 g and Addulah *et al.*¹⁴ reported kacang goats fed fish meal having ADG of 77.5-101.6 g.

Carcass traits: The carcass weight and dressing percentage of goats fed TMR containing soybean meal (SBM) were also the highest among all of the treatments with having the lowest of non-carcass (%) (Table 2). The high carcass weight was influenced by slaughter weight (Table 2) and the growth rate of the goat. The slaughter weight and carcass weight of SBM goats were higher ($p < 0.01$) by 4.95 and 3.47 kg over NG and 5.01 and 3.03 kg over FM, while the slaughter weight and carcass weight of NG and FM were relatively the same ($p > 0.05$). This finding is in line with the previous study of Johnson *et al.*¹⁷ that reported heavier carcasses having a correlation to heavier ending weights of the goats.

The Dressing Percentages (DP) of this study were lower than those of kacang goats reported by Naser¹⁸ and Gafar *et al.*¹⁹. Dressing percentage of kacang goat reported by Naser¹⁸ was 47.4-51.6%. Gafar *et al.*¹⁹ reported kacang goats fed palm oil decanter cake having DP of 53.3-56.7%. However, this finding was similar to Hutama²⁰ that reported DP of kacang goat was 46.7%. In fact, DP of this research was higher than those of Sumardianto *et al.*²¹ study (DP: 40.86%).

The meat, bone and fat of SBM carcass was also the highest ($p < 0.01$) among others and those of NG and FM carcasses were relatively the same (Table 3). This finding is in line with Never²² that reported carcass composition was affected by carcass weight. However, the percentages of meat, fat and bone were similar ($p > 0.05$) among all of the treatments. The averages of meat, fat and bone percentages were 71.28, 7.73 and 20.99%. It indicated that higher carcass produced higher meat, fat and bone proportionally (Fig. 2).

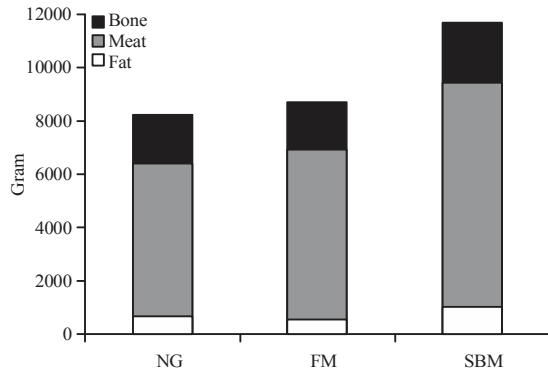


Fig. 2: Carcass components of kacang goats fed Natural Grass (NG), TMR containing Fish Meal (FM) and soybean meal (SBM)

Table 4: Physic-chemical properties of chevon from kacang buck fed ruminally undegradable protein

Parameters	NG	FM	SBM
Physical properties			
pH	6.05	6.08	6.05
Water-holding capacity (%)	40.65	38.40	39.57
Cooking loss (%)	38.61	38.56	37.63
Tenderness (kg cm ⁻²)	6.58	6.94	6.84
Chemical properties			
Water content (%)	71.45	72.30	72.39
Fat content (%)	3.68 ^{ab}	2.49 ^b	2.96 ^{bb}
Protein content (%)	21.96	21.54	22.14
Collagen (%)	1.91	2.02	1.81

^{A,B}Means in the same column without common letter are different at p<0.01, ^{a,b}Means in the same column without common letter are different at p<0.05

The meat+fat-bone ratios of all treatments were similar (p>0.05) that having averages of 3.83. These results were better than Sumardianto *et al.*²¹ that reported kacang bucks producing 3.49 kg of meat (63.2%), 0.546 kg of fat (9.70%), 1.57 kg of bone (28.02%) and 2.60 meat-bone ratio. However, Sebsibe *et al.*²³ reported that the meat-bone ratio of Ethiopian goats fed concentrates (4.03-5.01) was higher than those of kacang goats in this study.

Physic-chemical properties of chevon: The physical properties of chevon included pH, water-holding capacity/WHC, cooking loss and tenderness using Warner-Bratzler shear force values were relatively the same among all of the treatments (Table 4). The pH of the kacang buck meat (6.04) was relatively high compared to those of Ethiopian goats meat (pH: 5.61-5.94)²³ and Indian goats meat (pH: 5.63-5.79)¹. However, Pratiwi *et al.*²⁴ also reported high pH value of Australian Feral goats 20-40 kg that was about 5.8-6.0 and Judge *et al.*²⁵ also stated that a high post mortem animal pH was around 6.5-6.8. Meats from goat usually have

ultimate pH that is higher than mutton²⁶. The ultimate pH variation was influenced by energy metabolism during post mortem^{25,26} and antemortem handling²⁶.

The increasing of pH value will increase WHC and decrease cooking loss^{1,25,27}. The WHC of kacang goats in this study (39.9%) was higher compared to Indian goat (WHC: 22.9-24.01%)¹, but lower than Egyptian Baladi goat (WHC: 68.8%)²⁸. Therefore, the cooking loss of Egyptian baladi goat (27.9%) was lower than this study (37.9%). The cooking loss in this study was relatively similar to Indian goat (36.2-38.6%)¹ but lower than Australian feral goats 20-30 kg (31.1-46.4%)²⁴.

Tenderness of kacang goat in all of the treatments was not significantly different (p>0.05) because the collagen content in all treatments was also similar. The average of tenderness and collagen content in this study were 6.79 kg cm⁻² and 1.91%. The high collagen content will cause the meat less tender²⁹. The tenderness value of Kacang goat was relatively similar to Indian goat (5.8-6.5 kg cm⁻²)¹, but higher than Egyptian baladi goat (4.83 kg cm⁻²)²⁸. Goat meats were reported to be tougher than mutton²⁶.

The chevon fat content of goats fed Natural Grass (NG) was the highest (p<0.05) than other treatments. This condition might be caused by the increasing of protein in the ration of FM and SBM. The higher protein content in FM and SBM rations than those in NG (Table 1) were suspected causing the decrease of fat content that was in agreement with Soeparno³⁰. While other chemical properties of chevon were relatively the same (p>0.05) in all of the treatments. The fat content of kacang buck was lower than that of castrated etawah crossbred (8.36%) and castrated boer crossbred (8.98%)³¹.

Water content of kacang goat meat (72.05%) was relatively similar to that of kacang goat meat reported by Mirdhayati *et al.*³²: 73.8-74.5%, Indian goat meat reported by Das and Rajkumar²: 72.4-74.08%, however, it was lower than meat of Australian Feral goats 20-30 kg reported by Pratiwi *et al.*²⁴: 76.0-77.3%, refined white breed kid reported by Pieniak-Lendzion *et al.*³³: 76.5-78.03%. Pratiwi *et al.*²⁴ stated that heavier goat meats contained less water content than skinnier goat meats.

The average of protein content in kacang chevon was 21.9% that was higher than in refined white breed kid (19.1-20.8%)³³ in Etawah crossbred goat (17.1³¹ and 19.6-20.7%)² and also in boer crossbred goat (17.9%)³¹. However, it was lower than protein content in kacang chevon reported by Mirdhayati *et al.*³²: 23.2-23.5%. Judge *et al.*²⁵ reported that lean meat contained 19.0-23.0% of protein content.

CONCLUSION

It can be concluded that the use of fish meal and soybean meal in the ration improved the performance of local kacang goats. In fact, soybean meal in the ration can improve the productivity and carcass products of kacang goats better than fish meal.

SIGNIFICANCE STATEMENTS

- Kacang goats usually are raised traditionally by grazing during the day and housed at night, fed roughage without concentrate, so that the productivity is low
- This study was set up to improve the performance of local goats using ruminally undegradable protein feeds (fish meal and soybean meal). Natural grass was used for control, because farmers usually provide natural grass for the goat, but in this study the grass was provided *ad libitum*
- Kacang goats did not like the palatability of concentrate containing fish meal, therefore, the rations were made total mixed rations
- Total mixed rations containing fish meal and soybean meal can improve the productivity and carcass product of kacang goats

ACKNOWLEDGMENTS

The authors gratefully appreciate to the Directorate of Higher Education, Ministry of Education, the Republic of Indonesia for Doctoral Program Scholarship (BPP-DN) and Research Grant "Penelitian Unggulan Universitas Gadjah Mada". Appreciation is also expressed to "Kacang goats research team" that has assisted for data collection.

REFERENCES

1. Badan Pusat Statistik, 2013. Pematangan ternak menurut kabupaten/kota di Jawa Tengah tahun 2013. Provinsi Jawa Tengah (BPS Jateng). <http://jateng.bps.go.id/linkTabelStatis/view/id/1007>
2. Das, A.K. and V. Rajkumar, 2010. Comparative study on carcass characteristics and meat quality of three Indian goat breeds. *Indian J. Anim. Sci.*, 80: 1014-1018.
3. Musnandar, E., A. Hamidah and R.A. Muthalib, 2011. The effect of fermented oil palm fronds in diet on body weight gain and meat quality of goat. *J. Indonesian Trop. Anim. Agric.*, 36: 120-125.
4. BPS., 2013. Populasi ternak yang dipelihara oleh rumah tangga usaha peternakan sesuai jenis ternak yang diusahakan menurut wilayah dan jenis ternak. Badan Pusat Statistik. <http://st2013.bps.go.id/dev2/index.php/site/tabel?tid=51&wid=3600000000>
5. Badan Litbang Pertanian, 2013. Legalitas untuk lindungi kelestarian kambing kacang. <http://i.litbang.pertanian.go.id/berita/1495/>
6. Sianipar J., A. Batubara, S. Karokaro and S.P. Ginting, 2005. [Efficiency nutrition for goats Costa, Gembrong and Kacang]. *Prosiding Seminar Nasional Teknologi Peternakan dan Veteriner*, September 13-13, 2005, Bogor, Indonesia, pp: 630-636.
7. Panjono, I.G.S. Budisatria, G. Murdjito, N. Ngadiyono and E. Baliarti, 2012. Reproductive performance of Kacang, Kejobong and Ettawa grade goats does. *Proceedings of the 15th AAAP Animal Science Congress*, November 26-30, 2012, Thammasat University, Rangsit Campus, Thailand, pp: 1274-1277.
8. Elieser, S., S. Sumadi, G.S. Budisatria and S. Subandriyo, 2012. Productivity comparison between Boer and Kacang goat dam. *J. Indonesian Trop. Anim. Agric.*, 37: 15-21.
9. Adiwiranti, R., I.G.S. Budisatria, Kustantinah and Rusman, 2015. Carcass production and chevon quality of Kacang buck reared traditionally in Grobogan, Central Java, Indonesia. *Proceedings the 6th International Seminar on Tropical Animal Production*, October 20-22, 2015, Yogyakarta, Indonesia, pp: 694-698.
10. Adiwiranti, R., I.G.S. Budisatria, Kustantinah and Rusman, 2015. Kinerja produksi kambing Kacang jantan yang digembalakan. *Prosiding Seminar Nasional Peternakan Berkelanjutan 7 on Pengembangan Sumber Daya Lokal Dalam Agribisnis Peternakan*, November 11, 2015, Jatinangor, Indonesia, pp: 37-43.
11. Shirima, E.J.M., L.A. Mtenga, A.E. Kimambo, G.H. Laswai and D.M. Mgheni *et al*, 2013. Effects of days in feedlot on physico-chemical properties and meat tenderness from tanzanian long fat-tailed sheep. *J. Anim. Prod. Adv.*, 3: 40-48.
12. Prevolnik, M., M. Candek-Potokar and D. Skorjanc, 2004. Ability of NIR spectroscopy to predict meat chemical composition and quality-a review. *Czech J. Anim. Sci.*, 49: 500-510.
13. Ukanwoko, A.I. and O.V. Okehiele, 2016. Effect of *Gmelina (Gmelina arborea)* leaf meal based diets on growth performance of West African Dwarf bucks. *Asian J. Anim. Sci.*, 10: 154-158.
14. Addulah, M., K. Kusmartono, S. Suyadi, S. Soebarinoto and M. Winugroho, 2007. [The effect of feeding local and imported fish meal on daily weight gain, sexual performance and semen production of Kacang buck]. *Anim. Prod.*, 9: 135-144.

15. Aryanto, B. Suwignyo and Panjono, 2013. [Effect of reduction and refullment of feed quantity on feed intake and nutrient digestibility of Kacang and Etawah crossbred goat]. *Buletin Peternakan*, 37: 12-18, (In Indoensian).
16. Restitrisnani, V., A. Purnomoadi and E. Rianto, 2013. The production and body composition of Kacang goat fed different quality of diets. *J. Indonesian Trop. Anim. Agric.*, 38: 163-170.
17. Johnson, C.R., S.P. Doyle and R.S. Long, 2010. Effect of feeding system on meat goat growth performance and carcass traits. *Sheep Goat Res. J.*, 25: 78-82.
18. Naser, A., 2006. Pengaruh pemberian pakan dalam waktu berbeda terhadap bobot karkas dan persentase karkas kambing Kacang jantan. *J. Agroland*, 13: 282-287.
19. Gafar, A.A., A.R. Alimon, A.Q. Sazili, Y.C. Man and A.R. Abubakr, 2013. Effect of varying levels of palm oil decanter cake on feed intake, growth performance and carcass characteristics of Kacang goats. *IOSR J. Agric. Vet. Sci.*, 3: 24-29.
20. Utama, Y.G., 2014. Persentase karkas dan komponen non karkas kambing kacang jantan akibat pemberian pakan dengan kadar protein dan energi yang berbeda. Bachelor Thesis, Fakultas Peternakan dan Pertanian, Universitas Diponegoro, Semarang, Indonesia.
21. Sumardianto, T.A.P., E. Purbowati and Masykuri, 2013. [Carcass characteristic of male Kacang, Ettawa crossbred and Kejobong goat at one year old]. *Anim. Agric. J.*, 2: 175-182, (In Indonesian).
22. Never, A., 2015. Some major factors affecting carcass composition in goats. *Scient. J. Anim. Sci.*, 4: 81-88.
23. Sebsibe, A., N.H. Casey, W.A. van Niekerk, A. Tegegne and R.J. Coertze, 2007. Growth performance and carcass characteristics of three Ethiopian goat breeds fed grainless diets varying in concentrate to roughage ratios. *South Afr. J. Anim. Sci.*, 37: 221-232.
24. Pratiwi, N.M.W., P.J. Murray and D.G. Taylor, 2007. Feral goats in Australia: A study on the quality and nutritive value of their meat. *Meat Sci.*, 75: 168-177.
25. Judge, M.D., E.D. Aberle, J.C. Forrest, H.B. Hedrick and R.A. Merkel, 1989. *Principles of Meat Science*. 2nd Edn., Kendall/Hunt Publishing Co., Dubuque, IA, USA., ISBN-13: 9780840348272, Pages: 351.
26. Webb, E.C., N.J. Casey and L. Simela, 2005. Goat meat quality. *Small Rumin. Res.*, 60: 153-166.
27. Limea, L., M. Boval, N. Mandonnet, G. Garcia, H. Archimede and G. Alexandre, 2009. Growth performance, carcass quality and noncarcass components of indigenous Caribbean goats under varying nutritional densities. *J. Anim. Sci.*, 87: 3770-3781.
28. Moawad R.K., G.F. Mohamed, M.M.S. Ashour and E.M.A. El-Hamzy, 2013. Chemical composition, quality characteristics and nutritive value of goat kids meat from Egyptian Baladi breed. *J. Applied Sci. Res.*, 9: 5048-5059.
29. Lawrence, T.L.J. and V.R. Fowler, 2002. *Growth of Farm Animals*. 2nd Edn., CABI Publishing, Oxon, UK., ISBN-13: 9780851994840, Pages: 347.
30. Soeparno, 2009. *Ilmu dan Teknologi Daging*. Gadjah Mada University Press, Yogyakarta, Indonesia.
31. Rosyidi, D., L.K. Radiati and N. Uyun, 2009. [Chemical quality of male etawah crossbred and castrated boer crossbred goat meat]. *Jurnal Ilmu Teknologi Hasil Ternak*, 4: 9-16, (In Indonesian).
32. Mirdhayati, I., J. Hermanianto, C.H. Wijaya and D. Sajuthi, 2014. [Carcass profile and chemical characteristic of male Kacang goat (*Capra aegragus hircus*)]. *Jurnal Ilmu Ternak Veteriner*, 19: 26-34, (In Indonesian).
33. Pieniak-Lenzion, K., R. Niedziolka and E. Horoszewicz, 2006. Influence of sex and age at slaughter on profile of fatty acids in meat of kids. *Slovak J. Anim. Sci.*, 39: 201-204.