Effects of Alfalfa Meal on Growth Performance and Economic Benefit Analysis in Boer Goats: Postprint

Authors: Fan Wenna, Han Kangkang, Li Dongdong, Li Runlin, Wang Zhanbin, Wang Chengzhang

Date: 2017-10-11T00:00:00+00:00

Abstract

The present study aimed to investigate the effects of alfalfa meal on growth performance and economic benefit analysis in Boer goats. Seventy-five Boer goat does weighing 24–28 kg were randomly allocated to 5 groups using a completely randomized block design, with 3 replicates per group and 5 goats per replicate. The control group was fed a basal diet, while the other four groups (Experimental Groups I, II, III, and IV) were fed diets in which peanut vine was replaced by alfalfa meal at 10%, 20%, 30%, and 40%, respectively. The adaptation period lasted 7 days, and the experimental period lasted 60 days. The results showed that there was no significant difference in average daily feed intake among the five groups ($P>0.05$), but a decreasing trend was observed as the replacement level of alfalfa meal increased. The average daily gain of Experimental Groups III and IV was significantly higher than that of the other three groups, and showed an increasing trend with increasing alfalfa meal replacement level. The feed conversion ratio of the four experimental groups was lower than that of the control group, with Experimental Groups III and IV being significantly lower than the control group ($P<0.05$), and Experimental Group IV had the lowest value at 6.53. These results suggest that replacing peanut vine with alfalfa meal in Boer goat diets can increase average daily gain and reduce feed conversion ratio, with a 40% replacement level showing better growth performance, but with increased feed cost.

Full Text

Effects of Alfalfa Meal on Growth Performance of Boer Goats and Economic Benefits Analysis

FAN Wenna[1], HAN Kangkang[2], LI Dongdong[2], LI Runlin[1], WANG Zhanbin[1], WANG Chengzhang[2]*

[1]Animal Science and Technology College, Henan University of Science and Technology, Luoyang 471003, China
[2]College of Animal Science and Veterinary Medicine, Henan Agricultural University, Zhengzhou 450002, China

Abstract: This experiment was conducted to investigate the effects of alfalfa meal on growth performance of Boer goats and to analyze the economic benefits. Seventy-five Boer goat ewes weighing 24–28 kg were selected and divided into five groups using a completely randomized block design, with three replicates per group and five goats per replicate. The control group was fed a basal diet, while experimental groups I, II, III, and IV were fed basal diets in which peanut vine was isonitrogenously replaced with 10%, 20%, 30%, and 40% alfalfa meal, respectively. The pre-trial period lasted 7 days, and the formal trial period lasted 60 days. The results showed no significant differences in average daily feed intake among the five groups ($P>0.05$), though there was a decreasing trend as alfalfa meal substitution increased. Average daily gain in groups III and IV was significantly higher than in the other three groups ($P<0.05$), showing an increasing trend with higher alfalfa meal substitution levels. The feed-to-gain ratio in all four experimental groups was lower than that of the control group, with groups III and IV being significantly lower ($P<0.05$); group IV had the lowest ratio at 6.53. These results indicate that replacing peanut vine with alfalfa meal in Boer goat diets can increase average daily gain and reduce feed-to-gain ratio. A 40% substitution level yielded the best growth performance, though feed costs increased.

Keywords: Boer goat; alfalfa meal; growth performance; economic benefits

CLC number: S826

Introduction

With continuous improvement in living standards and changing dietary habits, people are increasingly selecting high-quality protein sources and emphasizing nutritional balance, which has accelerated the objective need for developing herbivorous livestock farming. In northern China, peanut vine is the primary roughage used for feeding goats. Although annual peanut vine production reaches 27–30 million tons, seasonal limitations and difficulties in intensive production have constrained the development of modern sheep farming [**?**]. Therefore, large-scale production of high-quality forage and forage products has be-

come imperative [?]. Alfalfa, known as the "king of forages," offers advantages including high yield, rich nutrition, excellent forage quality, good palatability, and ecological environmental improvement [?], making it the most important legume forage in northern China, including North China, Northwest, and Northeast regions. Research has demonstrated that alfalfa utilization can improve growth performance in dairy cows and other livestock [?], though studies in mutton sheep production remain relatively limited [?]. Processing alfalfa into meal can resolve seasonal imbalances in roughage supply for mutton sheep production while providing relatively high nutritional levels. Pelleted total mixed rations (TMR) can significantly improve diet palatability, effectively prevent selective feeding in herbivores, maintain relatively stable rumen internal environments and microbial populations, and sustain normal digestion, fermentation, absorption, and metabolism in the rumen, providing important guarantees for ruminant growth [?]. Therefore, this experiment used pelleted TMR with alfalfa meal isonitrogenously replacing peanut vine to feed Boer goats, investigating its effects on growth performance and analyzing economic benefits to provide scientific reference for alfalfa application in mutton sheep production.

1. Materials and Methods

1.1 Experimental Design This study selected 75 healthy Boer goat ewes with normal appetite, approximately 3 months of age, and weighing 24–28 kg. Following the principle of similar body weight, the goats were divided into five groups using a completely randomized block design: control group, experimental group I, experimental group II, experimental group III, and experimental group IV, with three replicates per group and five goats per replicate.

1.2 Experimental Diets and Management The control group was fed a basal diet composed of 40% concentrate, 40% peanut vine, 15% cassava distiller' s grains powder, and 5% selfheal powder, with nutrient levels referencing the "People' s Republic of China Agricultural Industry Standard–Feeding Standard of Meat-Producing Sheep" (NY/T 816-2004). Experimental diets were formulated by isonitrogenously replacing peanut vine with 10%, 20%, 30%, and 40% alfalfa meal in the basal diet. The composition and nutrient levels of experimental diets are shown in Table 1 . Roughage was accurately weighed according to formula, uniformly mixed with concentrate, and pelleted into cylindrical TMR pellets with a diameter of 0.80 cm and length of 1.5–2.0 cm. The pre-trial period lasted 7 days, and the formal trial period lasted 60 days.

The entire feeding trial was conducted under housed conditions. Before the experiment, all goat pens were cleaned and disinfected. After drying, Boer goat ewes of the same age with good health status and similar body size were selected, weighed, numbered, and grouped, followed by deworming and vaccination. During the pre-trial period, all experimental goats were fed the same basal diet while their behavior and health status were carefully observed for timely adjustments. Goats were fed twice daily at 08:00 and 16:00 with unlimited feed

allowance and free access to water. Feed troughs were cleaned once each morning before feeding, and leftover feed was recorded. Throughout the trial, feed intake, water consumption, defecation, and urination were carefully observed and recorded. Pens were cleaned every 2 days and disinfected every 30 days to prevent infectious diseases.

1.3 Measurement Indicators **Average Daily Feed Intake:** Feed amount was recorded at each feeding, and leftover feed was weighed each morning before feeding to calculate average daily feed intake.

Average Daily Gain: Experimental goats were fasted and weighed on the first morning of the formal trial period as initial body weight, and then fasted and weighed every 30 days. Average daily gain (ADG) was calculated.

Feed-to-Gain Ratio: Feed conversion efficiency was measured using feed-to-gain ratio, calculated as average daily feed intake divided by average daily gain.

1.4 Economic Benefit Analysis Feed cost per weight gain (RMB/kg) = Total feed intake × Total feed cost / Total weight gain.

1.5 Statistical Analysis Original data were organized using Excel 2007 and analyzed using the ANOVA model in SPSS 20.0 software. Results are expressed as "mean ± standard deviation," and Duncan' s multiple comparison method was used for pairwise comparisons among groups, with $P<0.05$ considered statistically significant.

2. Results

2.1 Average Daily Feed Intake at Different Growth Stages The effects of alfalfa meal on average daily feed intake (ADFI) of Boer goats at different growth stages are shown in Table 2 . The results indicate that ADFI differed among groups at different growth stages, with ADFI during days 31-60 showing an increasing trend compared to days 1-30. During days 1-30, ADFI in all four experimental groups was lower than that of the control group, showing a decreasing trend with increasing alfalfa substitution levels, though differences among groups were not significant ($P>0.05$). During days 31-60, no significant differences were observed in ADFI among the five groups ($P>0.05$). Over the entire 1-60 day period, the control group had the highest ADFI, while all four experimental groups had lower ADFI than the control group, showing a decreasing trend with increasing alfalfa meal substitution, though differences remained non-significant ($P>0.05$).

2.2 Average Daily Gain at Different Growth Stages The effects of alfalfa meal on average daily gain (ADG) of Boer goats at different growth stages are shown in Table 3 . The results show that ADG differed among the five groups at different growth stages, with ADG during days 31-60 being higher

than during days 1-30. During days 1-30, ADG in all four experimental groups was significantly higher than in the control group ($P<0.05$), showing an increasing trend with higher alfalfa meal substitution, and group IV was significantly higher than the other three experimental groups ($P<0.05$). During days 31-60, group I was significantly lower than the control group ($P<0.05$), group III was significantly higher than the control group ($P<0.05$), and group III was also significantly higher than groups I and II ($P<0.05$). Over the entire 1-60 day period, all experimental groups except group I had higher ADG than the control group, with groups III and IV being significantly higher ($P<0.05$). Among the four experimental groups, groups III and IV were significantly higher than groups I and II ($P<0.05$), showing a gradually increasing trend with higher alfalfa meal substitution levels.

2.3 Feed-to-Gain Ratio The effects of alfalfa meal on feed-to-gain ratio (F/G) of Boer goats are shown in Table 4 . The results indicate that all four experimental groups had lower F/G than the control group, with groups III and IV being significantly lower ($P<0.05$). Group IV was significantly lower than groups I, II, and the control group ($P<0.05$), with the lowest F/G of 6.53, indicating the highest feed conversion efficiency.

2.4 Economic Benefit Analysis Economic benefit analysis is presented in Table 5 . The results show that the control group without alfalfa meal had the lowest feed cost and lowest feed cost per weight gain, while the experimental groups with alfalfa meal addition had increased feed costs and feed costs per weight gain.

3. Discussion

3.1.1 Effects of Alfalfa Meal on Average Daily Feed Intake of Boer Goats Boer goats are animals that primarily consume roughage and can effectively utilize dietary crude fiber. Alfalfa hay is rich in fiber substances with relatively high digestible component content, making it an important roughage resource. Alfalfa meal contains 16%-22% crude protein, is rich in minerals, vitamins, and pigments, and contains saponins, polysaccharides, and various currently unidentified growth and reproduction factors. Its crude fiber content is generally around 25%, with a large proportion of digestible components, making it highly palatable for livestock. Research on alfalfa meal' s effects on animal growth performance remains relatively limited, with inconsistent results [**?**]. Xu et al. [**?**] used 0%, 10%, 20%, 30%, and 40% alfalfa hay to isonitrogenously replace roughage in diets and found that different substitution levels had no significant effects on growth performance of Dorper × Han crossbred F1 sheep. Liu et al. [**?**] fed fresh alfalfa to Boer goats and found no significant differences in feed intake between experimental and control groups throughout the trial period. Huang et al. [**?**] reported that adding 5% and 10% alfalfa meal to basal diets slightly increased average daily feed intake, possibly because alfalfa meal

has lower energy value, and direct addition could not meet pigs' energy requirements, prompting increased intake through physiological regulation mechanisms. However, Wang et al. [**?**] reported opposite results, showing a decreasing trend in average daily feed intake with increasing alfalfa meal addition. In this study, all four experimental groups had lower average daily feed intake than the control group, though differences were not significant. The reason may be that alfalfa has relatively high digestible energy for goats; as substitution levels increased, dietary energy gradually increased, leading to relatively reduced feed intake. Another possible reason is that alfalfa meal particles were too fine, generating gas in the rumen after ingestion and creating a sense of satiety that affected feed intake.

3.1.2 Effects of Alfalfa Meal on Average Daily Gain of Boer Goats
Regarding alfalfa application in mutton sheep production, existing studies have shown that processed alfalfa products such as hay, meal, and pellets can improve growth performance in ruminants. Chu et al. [**?**] replaced the same proportion of dry grass meal with 20% alfalfa meal for Hu sheep fattening and found that the experimental group gained 21.47% more weight than the control group. Chen et al. [**?**] conducted a fattening trial feeding alfalfa pellets to lambs, showing that the experimental group receiving 200 g alfalfa pellets daily had an average daily gain of 292.20 g, 33.00% higher than the non-supplemented group. Wang et al. [**?**] found that replacing equal amounts of cottonseed hull and peanut vine with alfalfa hay in beef cattle diets at 0, 2.5, 5.0, and 7.5 kg/d showed a trend toward increased daily gain and reduced feed-to-gain ratio. Li et al. [**?**] added alfalfa meal to Dorper × local Mongolian coarse-wool sheep F1 generation diets for fattening trials, concluding that optimal fattening results were achieved when alfalfa meal addition was controlled between 40.0%–47.5%. The results of this experiment are generally consistent with previous research, showing an increasing trend in average daily gain of Boer goats with higher alfalfa meal substitution levels. The improved daily gain may be attributed to: (1) alfalfa' s rich content of crude protein, vitamins, minerals, and unidentified growth factors, which increase dietary concentrations of these nutrients as substitution levels rise, allowing effective utilization by Boer goats to enhance daily gain; and (2) alfalfa meal' s ability to improve rumen fermentation conditions.

3.1.3 Effects of Alfalfa Meal on Feed-to-Gain Ratio of Boer Goats
Feed-to-gain ratio refers to the ratio of diet consumption to total weight gain, reflecting diet quality and feeding effectiveness—the lower the ratio, the better the diet quality and feeding effect [**?**]. This experiment showed that as alfalfa meal substitution levels increased, average daily feed intake of Boer goats gradually decreased while average daily gain showed an increasing trend, though results were not significant. Regarding feed-to-gain ratio, the four experimental groups showed a gradual decrease with increasing alfalfa meal substitution, with groups III and IV being significantly lower than the control group.

3.2 Economic Benefit Analysis In recent years, with improving living standards and changing consumption concepts, demands for mutton quality have increased, drawing growing attention to mutton quality research [**?**]. People have gradually accepted the concept of premium pricing for quality products. Since alfalfa meal is relatively more expensive than peanut vine, substituting peanut vine with alfalfa meal increases feed costs. However, after alfalfa meal addition, experimental groups showed reduced feed-to-gain ratios, and subsequent mutton quality testing revealed that replacing peanut vine with alfalfa meal in Boer goat diets could improve mutton tenderness and increase contents of dry matter, crude protein, and crude ash in meat, deposit richer essential and umami amino acids, reduce stearic acid content in mutton fatty acids, increase palmitoleic acid, oleic acid, and linolenic acid contents, and elevate n-3 polyunsaturated fatty acid levels [**?**]. According to the premium pricing principle, mutton produced from goats fed high-quality forage should command higher prices. Market surveys show significant price differences between premium and ordinary mutton, while the feed cost per weight gain in group IV of this experiment only increased by 1.48 RMB compared to the control group. As living standards continue to improve and health consciousness grows, demand for high-quality mutton will increase. Using alfalfa products to produce high-quality mutton will have broad market prospects and ultimately bring considerable economic benefits to farmers.

Conclusion

Replacing peanut vine with alfalfa meal in Boer goat diets can increase average daily gain and reduce feed-to-gain ratio. A 40% alfalfa meal substitution level yielded better growth performance in Boer goats, though feed costs increased.

References

[**?**] Liu Quanwei, Wang Chengzhang, Yan Xuebing, et al. Effects of fresh alfalfa feeding on slaughter traits and meat quality of Boer goats [J]. Acta Prataculturae Sinica, 2010, 19(1): 158-165.
[**?**] Lü Xiaodong. Study on introduction and comparison of foreign alfalfa varieties in Tumochuan Plain [D]. PhD thesis. Hohhot: Inner Mongolia Agricultural University, 2013: 67-78.
[**?**] Zhang Chunmei, Wang Chengzhang, Hu Xifeng, et al. Research progress on nutritional value and application of alfalfa [J]. China Feed, 2005(1): 15.
[**?**] Yang Li, Xu Ankai. Nutrition, feeding methods of alfalfa and its application in animal husbandry [J]. Jilin Agricultural Science, 2012, 33(2): 12-15.
[**?**] Long Ruijun, Shi Shangli, Wei Xiaohong, et al. Nutrition and feeding techniques of alfalfa [J]. China Dairy, 2002(2): 16-18.
[**?**] Liu Quanwei, He Yun, Wang Chengzhang, et al. Research progress on alfalfa application in ruminant feed [J]. Cereal & Feed Industry, 2006(3): 30-31.
[**?**] EKLUND M., RADEMACHER M., SAUER W C, et al. Standardized ileal digestibility of amino acids in alfalfa meal, sugar beet pulp, and wheat bran

compared to wheat and protein ingredients for growing pigs [J]. Journal of Animal Science, 2014, 92(3): 1037–1043.
[?] BAURHOO B, MUSTAFA A. Short communication: Effects of molasses supplementation on performance of lactating cows fed high-alfalfa silage diets [J]. Journal of Dairy Science, 2014, 97(2): 1072–1076.
[?] LAUDADIO V, CECI E, LASTELLA N M B, et al. Low-fiber alfalfa (Medicago sativa L.) meal laying hen diet: effects on productive traits and egg quality [J]. Poultry Science, 2014, 93(7): 1868–1874.
[?] ESCARCHA J F, CALLAWAY T R, BYRD J A, et al. Effects of dietary alfalfa inclusion on Salmonella typhimurium populations in growing layer chicks [J]. Foodborne Pathogens and Disease, 2012, 9(10): 945–951.
[?] WILDEUS S, TURNER K E, COLLINS J R. Growth, intake, diet digestibility, and nitrogen use in three hair sheep breeds fed alfalfa hay [J]. Small Ruminant Research, 2007, 69(1/2/3): 221.
[?] BOSCO A D, MUGNAI C, ROSCINI V, et al. Effect of dietary alfalfa on the fatty acid composition and indexes of lipid metabolism of rabbit meat [J]. Meat Science, 2014, 96(1): 606.
[?] Xu Hong, Li Guanzhen, Gao Yongge, et al. Effects of alfalfa hay on production performance and rumen pH and ammonia nitrogen of Dorper × Han F1 sheep [J]. Acta Agrestia Sinica, 2013, 21(5): 1012–1017.
[?] Liu Tingyu, Jia Yushan, Gegentu, et al. Effects of forage-based total mixed ration on lamb meat quality [J]. Acta Agrestia Sinica, 2012, 20(2): 378–382.
[?] Pan Junliang, Li Zhentian, Wang Chengzhang, et al. Application of alfalfa meal in animal feed [J]. Feed Research, 2006(7): 63–65.
[?] Wang Yanhua, Cheng Ningning, Zheng Airong, et al. Effects of alfalfa meal and alfalfa saponins on growth performance and antioxidant capacity of finishing pigs [J]. Chinese Journal of Animal Nutrition, 2013, 25(12): 2981–2988.
[?] Chu Guoliang, Ding Jianying, Hua Weihua, et al. Study on fattening effects of alfalfa meal on Hu sheep [J]. Jiangsu Agricultural Science, 2002(6): 67–68.
[?] Chen Wanfu, Yang Yongjun, Tang Xiaolu, et al. Experiment on feeding fattening lambs with alfalfa pellets [J]. China Herbivore Science, 2004, 35(S1): 143–144.
[?] Wang Wenjing, Li Xiaodong, Shi Yinghua, et al. Effects of alfalfa hay on production performance and cholesterol metabolism of beef cattle [J]. Pratacultural Science, 2010, 27(10): 135–141.
[?] Li Zhiqiang, Zhang Chun, Shao Tao. Effects of alfalfa meal addition on fattening and muscle nitrogen deposition of Dorper × local sheep F1 generation [C]//Proceedings of 2009 China Grassland Development Forum. Hefei: Chinese Grassland Society, 2009: 404–412.
[?] Qian Wenxi, Yan Hong, Cui Weixian. Study on flavor substances in muscle of grazing and housed Tan sheep [J]. Animal Husbandry & Veterinary Medicine, 2007, 39(1): 17–20.
[?] Sudesiqin, Biligebateer, Xin Manxi, et al. Study on meat performance and quality characteristics of Chahar sheep [J]. China Herbivore Science, 2014, 34(1): 11–16.
[?] Yang Yuwei, Zhou Yuxiang, Sun Zhanpeng. Overview of factors affecting

mutton quality and regulation measures [J]. Journal of Domestic Animal Ecology, 2013, 34(12): 82-85.
[?] Wu Tiemei. Effects of different feeding patterns on growth performance, slaughter performance, and meat quality of cashmere goat lambs [D]. PhD thesis. Hohhot: Inner Mongolia Agricultural University, 2013.
[?] Huang Qichao, Cheng Zhibin, Li Shijun, et al. Study on slaughter performance and meat physicochemical characteristics of Longling yellow goat lambs [J]. Journal of Yunnan Agricultural University, 2008, 23(5): 634-637.
[?] Wang Guiyin, Gao Aiqin, Dabuxilatu, et al. Analysis report on meat quality characteristics of Wulate sheep [J]. Xinjiang Agricultural Science, 2010(S1): 173-178.
[?] CONNOR W.E. Importance of n-3 fatty acids in health and disease [J]. American Journal of Clinical Nutrition, 2000, 71(S1): 171S-175S.
[?] SCOLLAN N D, ENSER M, GULATI S K, et al. Effects of including a ruminally protected lipid supplement in the diet on the fatty acid composition of beef muscle [J]. British Journal of Nutrition, 2003, 90(3): 709-716.
[?] RAES K, DE SMET S, DEMEYER D. Effect of dietary fatty acids on incorporation of long chain polyunsaturated fatty acids and conjugated linoleic acid in lamb, beef and pork meat: a review [J]. Animal Feed Science and Technology, 2004, 113(1/2/3/4): 199-221.
[?] Han Kangkang. Effects of alfalfa meal on growth performance, slaughter performance, and meat quality of Boer goats [D]. Master' s thesis. Zhengzhou: Henan Agricultural University, 2016, 32-46.

Note: Figure translations are in progress. See original paper for figures.