

Effects of Different Ratios of Hay to Corn Silage on Lactation Performance and Serum Biochemical Parameters in Laoshan Dairy Goats (Post-print)

Authors: Li Yongzhen, Fuhong Miao, Yang Guofeng, Cheng Ming, Yuan Li, Sun Juan

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Abstract

The objective of this study was to investigate the effects of different ratios of hay to corn silage on lactation performance and serum biochemical indices of Laoshan dairy goats. Twenty second-parity Laoshan dairy goats with a milk yield of (1.65 ± 0.05) kg/d were selected and randomly divided into 4 groups, with roughage hay to corn silage ratios of 8:2 (Group I), 6:4 (Group II), 4:6 (Group III), and 2:8 (Group IV), respectively, with 5 goats per group. The preliminary period was 7 d, and the formal experimental period was 60 d. The results showed that there were no significant differences in milk yield, dry matter intake, and feed-to-milk ratio among all groups ($P > 0.05$). Milk fat content showed no significant differences on day 0, day 20, and day 40 ($P > 0.05$), but on day 60, Group II was significantly higher than Group III ($P < 0.05$). The average milk protein content in Group II was significantly higher than that in the other groups ($P < 0.05$). Serum glucose content in both Group II and Group IV was significantly higher than that in Group I ($P < 0.05$), and serum cholesterol content in Group II was the lowest, being significantly lower than that in Group III ($P < 0.05$). In conclusion, the combination of hay to corn silage at a ratio of 6:4 yielded the best results for Laoshan dairy goats, with relatively higher contents of nutrients such as milk fat, milk protein, and lactose, and relatively lower serum cholesterol content.

Full Text

Effects of Different Proportions of Grass Hay and Corn Silage on Lactation Performance and Serum Biochemical Parameters of Laoshan Dairy Goats

**LI Yongzhen¹, MIAO Fuhong^{1*}, YANG Guofeng¹, CHENG Ming², YUAN Li³, SUN Juan¹ (1. College of Animal Science and Technology, Qingdao Agricultural University, Qingdao 266109, China; 2. Institute of Qingdao Husbandry and Veterinary, Qingdao 266100, China; 3. Linyi Animal Husbandry Bureau, Linyi 276000, China)

Abstract

This experiment was conducted to determine the effects of different proportions of grass hay and corn silage on lactation performance and serum biochemical parameters of Laoshan dairy goats. Twenty second-parity Laoshan dairy goats in mid-lactation with an average milk yield of (1.65 ± 0.05) kg/d were selected and randomly divided into four groups (n=5). The roughage portion consisted of grass hay and corn silage at ratios of 8:2 (Group I), 6:4 (Group II), 4:6 (Group III), and 2:8 (Group IV), respectively. The experiment included a 7-day pre-feeding period followed by a 60-day formal experimental period. The results showed that milk yield, dry matter intake (DMI), and feed-to-milk ratio did not differ significantly among groups ($P > 0.05$). Milk fat content showed no significant differences among groups on days 0, 20, and 40 ($P > 0.05$), but on day 60, Group II was significantly higher than Group III ($P < 0.05$). Average milk protein content in Group II was significantly higher than in the other groups ($P < 0.05$). Serum glucose content in Groups II and IV was significantly higher than in Group I ($P < 0.05$), while serum cholesterol content in Group II was the lowest among all groups and significantly lower than in Group III ($P < 0.05$). In conclusion, a 6:4 ratio of grass hay to corn silage produced the best results for Laoshan dairy goats, yielding relatively higher contents of milk fat, milk protein, and lactose, along with relatively lower serum cholesterol levels.

Keywords: grass hay; corn silage; Laoshan dairy goat; lactation performance; serum biochemical parameters

Introduction

Grass hay is produced from natural pasture grasses, primarily unimproved native grasses, that are harvested and sun-dried. China possesses nearly 4.0×10^8 hectares of natural grassland, with approximately 3.3×10^8 hectares being utilizable. These grasslands are mainly distributed in Inner Mongolia and northeastern China, offering excellent palatability, easy storage, and high nutrient content, including crude protein, minerals, and carotene.

Despite being a valuable source of high-quality roughage, most grass hay is utilized in pastoral animal husbandry and rarely enters agricultural regions. Therefore, the rational development and utilization of grass hay resources represent an effective approach to alleviating the grain-livestock competition in agricultural areas and ensuring stable development of animal husbandry [1-2].

Previous studies by Yu Tengfei et al. [3] and Xia Ke et al. [4] have investigated the associative effects of various roughage combinations including peanut vine, *Leymus chinensis* (Chinese ryegrass), corn silage, and alfalfa. However, research on the optimal combination of grass hay with other feedstuffs to maximize feed value remains scarce, necessitating further investigation into the associative effects of grass hay-based diets.

Laoshan dairy goats represent one of China's premium dairy goat breeds, characterized by strong disease resistance, tolerance to roughage, robust physique, and particularly high milk protein and fat contents. However, recent food safety incidents involving clenbuterol, growth hormones, and melamine have heightened consumer demands for dairy quality, health, and safety [5]. Since hormones, inorganic salts, and proteins in the blood of dairy animals can directly enter milk and become nutritional components, dairy product quality is intimately related to the health status of the animal's blood [6]. To investigate the effects of different grass hay to corn silage ratios on lactation performance and serum biochemical parameters of Laoshan dairy goats, this study utilized Inner Mongolian grass hay (primarily *Leymus chinensis*) as a dietary component, aiming to provide a theoretical basis for the rational development and utilization of grass hay resources.

Materials and Methods

Experimental Animals and Design

Twenty second-parity Laoshan dairy goats in mid-lactation were selected from Qingdao Aote Dairy Goat Farm, with average body weight of (56.50 ± 0.50) kg and milk yield of (1.65 ± 0.05) kg/d. The 67-day experiment consisted of a 7-day pre-feeding period and a 60-day formal experimental period. Grass hay was obtained from Xilingol Grassland, supplied by Inner Mongolia Caodu Agriculture and Animal Husbandry Development Co., Ltd. The goats were randomly allocated to four groups (n=5) following a randomized block design, with each goat serving as one replicate. A single-factor experimental design was employed with identical concentrate composition and a concentrate-to-roughage ratio of 4:6. The four experimental groups received different roughage ratios of grass hay to corn silage: 8:2 (Group I), 6:4 (Group II), 4:6 (Group III), and 2:8 (Group IV). Experimental diets were formulated according to the *Feeding Standard of Meat Sheep* (NY/T 816-2004), and nutrient levels were calculated based on feed composition and nutritional values from the *Chinese Feed Composition and Nutritional Value Table* [7]. Diet composition and nutrient levels are presented in Table 1, while roughage nutrient levels are

shown in Table 2 .

Feeding Management

Prior to the experiment, the goat house was thoroughly cleaned and disinfected, and all experimental goats were dewormed, vaccinated, and ear-tagged. Consistent environmental conditions were maintained for lighting and ventilation. Goats were housed individually and fed three times daily at 06:30, 11:30, and 17:30 in individual feeding troughs, with ad libitum access to feed and clean water. Feed offered and refusals were recorded before and after each feeding, and residual moisture content was measured within 2 hours to calculate dry matter intake (DMI). Machine milking was performed twice daily at 06:00 and 18:00.

Measurement Indicators

Daily milk yield was recorded each morning and evening to calculate daily milk production. Milk samples were collected on days 0, 20, 40, and 60 of the formal experimental period and analyzed for composition using a milk composition analyzer (FT-120, Beijing Foss Electric). On the final day of the experiment at 07:30, 5 mL of blood was aseptically collected from the jugular vein of each goat after overnight fasting. Serum was separated by centrifugation and stored at -20°C for subsequent analysis. Serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), total protein (TP), albumin (ALB), globulin (GLB), glucose (GLU), urea nitrogen (UN), uric acid (UA), triglycerides (TG), and cholesterol (CHOL) were measured using an automatic biochemical analyzer (D-280, Shenzhou Innova Medical Technology Co., Ltd.) with reagent kits purchased from Sichuan Mike Biological Technology Co., Ltd.

Statistical Analysis

Experimental data were processed using Excel and SPSS 19.0 software. One-way ANOVA was performed for single-factor variance analysis, and Duncan' s multiple comparison test was applied when significant differences were detected ($P < 0.05$).

Results

Effects on Milk Yield

As shown in Table 3 , Group II exhibited the highest average milk yield, which was 25.74%, 36.80%, and 19.58% higher than Groups I, III, and IV, respectively. Although no significant differences were observed among groups at any time point ($P > 0.05$), milk yield showed a declining trend over time across all groups.

Effects on Dry Matter Intake and Feed-to-Milk Ratio

Table 4 shows that DMI and feed-to-milk ratio did not differ significantly among groups ($P > 0.05$). However, Group II had the highest DMI, exceeding Groups

I, III, and IV by 8.48%, 8.48%, and 7.19%, respectively. Group II also demonstrated the lowest feed-to-milk ratio, which was 13.22%, 20.45%, and 10.26% lower than Groups I, III, and IV, respectively.

Effects on Milk Composition

Table 5 presents the effects on milk composition. No significant differences in milk fat content were observed among groups on days 0, 20, and 40 ($P>0.05$). On day 60, Group II was significantly higher than Group III ($P<0.05$), representing a 48.28% increase, while no significant differences were found with other groups ($P>0.05$). Milk fat content in Groups I and II increased over time, whereas Groups III and IV showed an initial increase followed by a decrease. No significant differences in milk protein content were detected among groups on days 0 and 20 ($P>0.05$), but on days 40 and 60 and for the overall average, Group II was significantly higher than all other groups ($P<0.05$). Milk protein content increased progressively over time in all groups. No significant differences were observed among groups for milk non-fat solids or lactose content ($P>0.05$), though both components showed an overall increasing trend over time, with Group II maintaining the highest average values.

Effects on Serum Biochemical Parameters

As shown in Table 6, serum GLU content in Groups II and IV was significantly higher than in Group I ($P<0.05$), with increases of 18.32% and 22.14%, respectively, while no significant differences were found among Groups II, III, and IV ($P>0.05$). Serum CHOL content in Group II was significantly lower than in Group III ($P<0.05$), showing a 24.37% reduction, with no significant differences among other groups ($P>0.05$). No significant differences were detected among groups for any other serum biochemical parameters ($P>0.05$).

Discussion

Effects on Milk Yield

Milk yield represents the most important indicator of lactation performance and a key determinant of economic profitability in dairy animals, being strongly influenced by dietary nutrient levels. Optimal nutritional value generally supports higher milk production. Although no significant differences in milk yield were observed among groups in this study, Group II achieved the highest production, suggesting that a 6:4 ratio of grass hay to corn silage was most effective. Li Ran et al. [8] reported that a 5:6 ratio of *Leymus chinensis* to corn silage produced higher milk yields in dairy goats than other ratios. This discrepancy with our findings may be attributed to differences in grass hay quality between the current study and that of Li Ran et al. [8].

Effects on Dry Matter Intake and Feed-to-Milk Ratio

Dry matter intake is a critical factor affecting animal health and production performance, representing one of the key indicators in ruminant nutrition [9]. Xia Ke et al. [4] observed that dairy goats fed combinations of corn silage and *Leymus chinensis* had higher DMI than those fed corn silage with corn stover silage. Zhang Qian et al. [10] reported that dairy cows fed a 6:4 ratio of *Leymus chinensis* to corn stover pellets exhibited higher DMI than those receiving 100% *Leymus chinensis* or 100% corn stover. Our findings align with Zhang Qian et al. [10], confirming that a 6:4 grass hay to corn silage ratio was optimal for DMI in Laoshan dairy goats. Feed-to-milk ratio is an important measure of feed conversion efficiency. The lowest ratio observed in Group II indicates that the 6:4 combination provided the best feed conversion and economic returns.

Effects on Milk Composition

Conventional milk components including fat, protein, non-fat solids, and lactose serve as crucial indicators of milk quality and nutritional value. Combining roughages with different nutritional characteristics can create complementary effects that enhance the overall nutritional value of mixed roughages and improve milk quality. Lei Dongzhi et al. [11] evaluated associative effects of various roughage combinations using an in vitro gas production method, finding that both corn stover-sweet clover (5:5) and corn stover-*Leymus chinensis* (5:5) combinations outperformed 100% corn stover. Wu Ren Tana [12] reported that dairy cows fed combinations of natural alfalfa hay and silage exhibited significantly higher milk fat, protein, and lactose contents than those receiving 100% silage. Our results are consistent with these findings and with those of Pan Meijuan et al. [13]. The observation that milk fat content increased over time in Groups I and II but decreased after an initial increase in Groups III and IV suggests that the 4:6 and 2:8 ratios failed to maintain optimal associative effects for milk fat synthesis over extended periods, further supporting 6:4 as the most suitable ratio for enhancing milk nutritional value in Laoshan dairy goats.

Effects on Serum Biochemical Parameters

Dairy product safety is a critical aspect of quality control. Since milk is synthesized from nutrients absorbed from blood, blood health and safety profoundly influence milk quality. Factors such as pesticide residues and contaminated feed can adversely affect blood composition and consequently milk quality, with consumption of low-quality dairy products potentially causing malnutrition, compromised immunity, and severe health consequences in infants [14-15]. Triglycerides and cholesterol reflect lipid metabolism, and elevated blood levels can increase their concentrations in milk, posing risks for kidney and cardiovascular diseases in humans. ALT, AST, GLU, UN, and UA play vital roles in the interconversion of proteins, fats, and carbohydrates [16-19]. Cui Zhanhong et al. [20] evaluated the associative effects of oat hay and native pasture using in vitro gas production, finding a 5:5 ratio optimal with better utilization efficiency than

single roughage feeding. Diao Bo et al. [21] similarly reported that wheat straw and native pasture at a 5:5 ratio produced the most positive associative effects. Our finding that Group II had the highest serum nutrient content and lowest CHOL levels aligns with these studies, demonstrating that a 6:4 grass hay to corn silage ratio maximizes roughage nutritional utilization and promotes blood health and safety in Laoshan dairy goats.

Conclusion

The optimal ratio of grass hay to corn silage for Laoshan dairy goats is 6:4, which yields relatively higher contents of milk fat, milk protein, non-fat solids, and lactose, while maintaining relatively lower serum cholesterol levels.

References

- [1] Li Zhiyong, Ning Bu, Yang Xiaodong, et al. Collection and preservation of Inner Mongolia forage germplasm resources [J]. Inner Mongolia Prataculture, 2006, 16(3): 1-2.
- [2] Shi Yue, Ma Yinlei, Ma Wenhong, et al. Forage yield and quality of China's grasslands: patterns and relationships with environmental factors [J]. Chinese Science Bulletin, 2013, 58(3): 226-239.
- [3] Yu Tengfei, Zhang Jiejie, Sun Guoqiang. Study on associative effects between peanut vine and four roughages [J]. Chinese Journal of Animal Nutrition, 2012, 24(7): 1246-1254.
- [4] Xia Ke, Wang Zhibo, Xi Weibin, et al. Effects of roughage combinations on nutrient digestibility, energy and nitrogen utilization in dairy cows [J]. Chinese Journal of Animal Nutrition, 2012, 24(4): 681-688.
- [5] Yu Ziyang, Yuan Cuilin, Wang Lihua, et al. Effects of protein level on lactation performance of Laoshan dairy goats [J]. Chinese Journal of Animal Science, 2015, 51(7): 32-36.
- [6] Li Xin. Effects of different dietary energy and protein levels on lactation performance and milk composition of Xinong Saanen dairy goats [D]. Master's Thesis. Yangling: Northwest A&F University, 2012: 6-7.
- [7] Xiong Benhai, Luo Qingyao, Zhao Feng, et al. Explanation of Chinese feed composition and nutritional value table (26th edition, 2015) [J]. China Feed, 2015(21): 23.
- [8] Li Ran, Sun Manji, Liu Caijuan, et al. Effects of different roughage combination indexes on blood parameters and milk performance of dairy goats [J]. China Feed, 2010(15): 8-12.
- [9] Van D T T. Some animal and feed factors affecting feed intake, behaviour and performance of small ruminants [D]. Ph.D. Thesis. Uppsala: Swedish University of Agricultural Sciences, 2006: 32.

- [10] Zhang Qian, Xia Jianmin, Li Shengli, et al. Effects of different ratios of pelleted straw and *Leymus chinensis* as roughage on rumen fermentation and performance of dairy cows [J]. Chinese Journal of Animal Nutrition, 2010, 22(2): 474-480.
- [11] Lei Dongzhi, Jin Shuguang, Wu Ren Tana. Evaluation of associative effects between different roughages and the same concentrate using in vitro gas production method [J]. Feed Industry, 2009, 30(3): 30-33.
- [12] Wu Ren Tana. Determination of roughage combination index and study on associative effects for dairy cows in Inner Mongolia [D]. Master' s Thesis. Hohhot: Inner Mongolia Agricultural University, 2008: 54-60.
- [13] Pan Meijuan, Xu Guozhong, Cui Yanzhao, et al. Evaluation of associative effects between oat hay and *Leymus chinensis* in dairy cow diets using in vitro gas production method [J]. Journal of Shanghai Jiao Tong University: Agricultural Science Edition, 2014, 32(2): 25-30, 41.
- [14] Chen Jie. Livestock Physiology [M]. 4th Edition. Beijing: China Agriculture Press, 2005: 154-156.
- [15] Duan Chengli. Study on quality and safety management of raw milk and dairy products in China [D]. Master' s Thesis. Beijing: Chinese Academy of Agricultural Sciences, 2005: 12-14.
- [16] Wright C L, Spears J W. Effect of zinc source and dietary level on zinc metabolism in Holstein calves [J]. Journal of Dairy Science, 2004, 87(4): 1085-1091.
- [17] Nimrick K, Hatfield E E, Kaminski J, et al. Quantitative assessment of supplemental amino acid needs for growing lambs fed urea as the sole nitrogen source [J]. The Journal of Nutrition, 1970, 100(11): 1301-1306.
- [18] Coma J, Carrion D, Zimmerman D R. Use of plasma urea nitrogen as a rapid response criterion to determine lysine requirement of pigs [J]. Journal of Animal Science, 1995, 73(2): 472-481.
- [19] Xiao Yu. Effects of functional oligosaccharides on rumen fermentation parameters and serum biochemical and immune indices in goats [D]. Master' s Thesis. Qingdao: Qingdao Agricultural University, 2012.
- [20] Cui Zhanhong, Hao Lizhuang, Liu Shujie, et al. Evaluation of associative effects between oat hay and native pasture in Qinghai Plateau using in vitro gas production method [J]. Acta Prataculturae Sinica, 2012, 21(3): 250-257.
- [21] Diao Bo, Cui Zhanhong, Zhang Xiaowei, et al. Evaluation of associative effects between wheat straw and native pasture in Qinghai Plateau using in vitro gas production method [J]. China Feed, 2013(8): 10-14.

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