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# Effects of Dietary Protein Level on Milk Production Performance and Serum Biochemical Indicators of Dairy Goat

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## Abstract

This experiment was conducted to determine the effect of protein level on performance and serum biochemical indicators in dairy goat. 45 healthy dairy goats in lactation with same weight, milk yield, parous (2~3 times) were used by single-factor randomized design and equally divided into 3 groups and 15 goats per group. Dietary protein level was 10%, 12.5% and 15% respectively. It was 10 days in advance to do the preparation of experiments, followed by the period of time in true experiments with 35 days.

**Results:** The higher dietary protein levels can increase milk production significantly ($P<0.05$); the milk protein yield in group received 12.5% dietary protein level was nearly-identical to group with 15% $P>0.05$), the group of 12.5% have the highest milk contents, The goat albumin, urea nitrogen content in group with 12.5% and 15% dietary protein level were significantly higher than that of group with 10% ($P<0.05$), the difference between the group with 12.5% and group with 15% dietary protein level was not significant ($P>0.05$); The different dietary protein levels had no significant effect on total cholesterol, glucose, and serum alanine aminotransferase and aspartate aminotransferase activity ($P>0.05$).

**Conclusion:** According to the 4% standard milk production, milk composition and serum biochemical indexes, the 12.5% of dietary crude protein level was more conducive to play production performance of dairy goat.

**Keywords:** Protein level; Milk yield; Milk composition; Biochemical index

## Introduction

Goat milk is increasingly favoured by consumers with its nutrient-rich, higher calcium content, digestible and absorbed, lower cholesterol. The energy content of the 1 kg goat milk is higher than that of the milk 200 kJ, the fat particle diameter of goats' milk is 3-4 μm, and vitamin and mineral content is very rich in goats' milk. Milk protein accounted for about 3.5 per cent, with lower milk casein protein content and higher whey protein content, it is very suitable for infants and young children and the elderly to drink. Because the goat milk production is not big, the structure of our country's milk source has not been changed. Currently, in order to change this situation, dairy goat rearing has entered a process of large-scale breeding, diet as their main source of nutrition, Nutritional composition and nutrient content of the diet has an important influence on lactation performance and digestion and metabolism of dairy goats, Therefore, it is extremely necessary to study on the nutrient requirements of each diet. Especially on crude protein levels as a required nutrient. The merits of goat's milk, is affected by many factors, such as breed, stage of lactation and level, environment, disease and nutrition. Nutrition is the most important factor in above, the rational use of the diet is essential for the development of high-quality milk maximum production potential. Such as Davidson et al. [1] have reported, the effects of milk yield and milk composition were affected by dietary factors.Suitable crude protein level in the diet not only makes dairy goat and give full play to the high level of performance, also can improve the utilization efficiency of dietary protein, and reduce the nitrogen pollution caused by animals which eat a lot of dietary crude protein.In this paper, we give the goats three diets which had different dietary crude protein level, and then we discussed the effects of different protein levels on the production performance and serum biochemical indexes of dairy goats. Provide data support for preliminary determination of suitable dietary crude protein of lactating dairy goat.

## Materials and Methods

### Experimental animal and design

Experiments were conducted at Qingdao Aote breeding farm. 45 healthy dairy goats in lactation with same weight, milk yield, parous (2~3 times) were used by single-factor randomized design and equally divided into 3 groups and 15 goats per group. Recommended by NRC (2007) of the milk goats feeding standards, the energy level of TMR diet in 3 experimental groups were 10 MJ/kg, protein levels were 10%, 12.5%, 15%. The dietary composition and nutrition level of the experiment were shown in Table 1.

### Feeding management of goat

The trial period was 60 d, and the pre-trial period was 10 d. The TMR (Quantitative) was fed at 06:30, 12:30 and 18:30, and the

remaining time was free of drinking water, free exercise. Milking at 06:30 and 18:00 every day. The milk yield and herd health status were recorded, followed by goat farm immunization program.

| Item | Content | | |
|---|---|---|---|
| **Ingredients** | **Group A** | **Group B** | **Group C** |
| Apple pomace /% | 17.5 | 17.5 | 17.5 |
| Whole-plant maize /% | 52.5 | 52.5 | 52.5 |
| Corn/% | 16.3 | 14 | 12.1 |
| Soybean meal /% | 3.6 | 10 | 13 |
| Wheat bran /% | 8 | 4 | 3 |
| Limestone /% | 0.5 | 0.4 | 0.3 |
| CaHPO4/% | 0.1 | 0.1 | 0.1 |
| Nacl /% | 0.5 | 0.5 | 0.5 |
| Premix1) /% | 1 | 1 | 1 |
| Nutrient levels2)/(MJ·kg-1) | 10.01 | 10 | 10.03 |
| CP /% | 10.1 | 12.56 | 15 |
| NDF /% | 53.38 | 52.25 | 51.6 |
| ADF /% | 30.78 | 30.5 | 30.43 |
| Ca /% | 0.55 | 0.55 | 0.55 |
| P /% | 0.33 | 0.32 | 0.32 |

**Table 1:** Composition and nutrient levels of experimental diets (DM basis). 1) Premix provided following per kilogram of diet: VA17500 IU VE 43 mg, VD3 3500 IU,VB525.74 mg, Mn (as manganese sulfate) 31 mg, Zn (as zinc sulfate) 92.5 mg, Cu (as copper sulfate) 30 mg, Co (as cobaltous sulfate) 0.72 mg, I (as potassium iodide) 1.25 mg, Se (as sodium selenite) 1.00 mg. 2) DE was a calculated value while others were measured values.

## Test index and method

**During the test period:** The automatic milking machine was used for milking, and the amount of lactation on the milking machine was accurately read. And the amount of lactation into calibration.

$$FCM = 0.4M + 15F$$

**In formulas:** FCM was the weight of fat corrected milk (Kg), M was the weight of non-standard milk (Kg), F is fat content of non-standard milk.

**Analysis of the milk composition:** Collection of milk sample at the pre-trial period 10 d, and 20 d, 40 d, 60 d of the trial period.

Each collection milk samples at 18:00 and the next day 06:00 acquisition 25 mL, two mixed together, General composition of goats milk was analyzed by using FOSSMilkoScanTMFT120 automatic analyzer, and calculate milk protein yield.

Milk protein yield (kg) = nonstandard milk weight (kg) * milk protein content (%)

**Blood collection and serum biochemical parameters analysis:** In the positive trial period 30 d and 60 d, 5 mL blood were collected from the jugular vein before the morning feeding, and after 2h, centrifuge at 4, 4300 Rev/min 15 min, The supernatant was transferred into 2 mL centrifuge tubes, and was kept in the refrigerator of -80. Determination of projects including total protein (TP), albumin (ALB), and serum urea nitrogen (BUN), glucose (Glu), total cholesterol (T-Cho) and the content of aspartate aminotransferase (GPT) activity and alanine aminotransferase (GPT) activity by Nanjing Jiancheng institute of biological engineering are provided for reagent kit and method were determined.

## Statistical analysis

The experimental data were analyzed by Excel 2013 software, and then analyzed by SPSS20.0 software and Duncan's method.

# Results and Analysis

## Effects of different CP level on milk yield and milk composition of lactating dairy goat

Table 2 shows that dairy goat milk yield with the rise of dietary crude protein level significantly increased, namely group 10%<group 12.5%<group 15% ($P<0.001$). There was no significant difference between group 12.5% and the group 15% ($P>0.05$) about FCM, and this two groups were significantly higher than the group 10%. Group

12.5% and group 15% of milk protein production was almost the same (P>0.05), were very significantly higher than group 10% (P<0.01).

| Items | Crude protein level/% | | | SEM | P-value |
|---|---|---|---|---|---|
| | 10% | 12.5% | 15% | | |
| Milk yield/(kg/d) | $1.56^{A}$ | $1.76^{B}$ | $2.03^{C}$ | 0.028 | <0.001 |
| FCM /(kg/d) | $1.93^{A}$ | $2.56^{B}$ | $2.74^{B}$ | 0.265 | 0.001 |
| Milk protein yield/(g/d) | $49.45^{A}$ | $58.11^{B}$ | $58.19^{B}$ | 0.882 | 0.003 |
| Milk fat percentage/% | $3.56^{AB}$ | $3.96^{B}$ | $3.11^{A}$ | 0.123 | 0.020 |
| Milk protein percentage/% | $3.17^{B}$ | $3.30^{B}$ | $2.87^{A}$ | 0.050 | 0.001 |
| Milk non- solid percentage/% | $8.46^{AB}$ | $8.74^{B}$ | $8.10^{A}$ | 0.082 | 0.005 |
| Lactose percentage/% | 4.28 | 4.28 | 4.26 | 0.033 | 0.961 |
| FPD/°C | $0.50^{ab}$ | $0.51^{b}$ | $0.49^{a}$ | 0.004 | 0.053 |
| Acidity/°T | $14.76^{AB}$ | $16.04^{B}$ | $13.20^{A}$ | 0.367 | 0.006 |

**Table 2:** Effects of CP level on milk yield and milk composition of lactating dairy goat. Note: In the same row, values with different capital letter superscripts mean very significant difference (P<0.01), values with different small letter superscripts mean significant difference (P<0.05), while with the same or no letter superscripts mean no significant difference (P>0.05).

| Items | Time | Crude protein level/% | | | SEM | P-value |
|---|---|---|---|---|---|---|
| | | 10% | 12.5% | 15% | | |
| ALB (g/L) | 30 d | $31.73^{a}$ | $42.46^{b}$ | $47.54^{b}$ | 4.452 | 0.022 |
| | 59 d | $51.47^{a}$ | $58.28^{b}$ | $61.90^{b}$ | 3.234 | 0.017 |
| TP (g/L) | 30 d | $68.14^{a}$ | $79.25^{ab}$ | $81.44^{b}$ | 0.231 | 0.047 |
| | 60 d | $73.62^{a}$ | $82.59^{ab}$ | $85.71^{b}$ | 0.322 | 0.033 |
| BUN (mmol/L) | 30 d | $9.24^{a}$ | $11.06^{b}$ | $11.12^{b}$ | 1.761 | 0.014 |
| | 60 d | $10.07^{a}$ | $12.41^{b}$ | $12.53^{b}$ | 1.354 | 0.029 |
| GLU (mmol/L) | 30 d | 3.92 | 3.91 | 3.73 | 0.224 | 0.756 |
| | 60 d | 3.87 | 4.49 | 5.11 | 0.368 | 0.614 |
| T-CH (mmol/L) | 30 d | 1.42 | 1.48 | 1.49 | 0.277 | 0.985 |
| | 60 d | 1.49 | 1.65 | 1.61 | 0.235 | 0.799 |
| GOT (U/L) | 30 d | 103.22 | 101.37 | 103.68 | 2.364 | 0.877 |
| | 60 d | 109.29 | 109.32 | 110.86 | 3.689 | 0.614 |
| GPT (U/L) | 30 d | 22.37 | 22.89 | 23.74 | 2.349 | 0.832 |
| | 60 d | 22.43 | 23.08 | 23.65 | 1.128 | 0.769 |

**Table 3:** Effects of CP levels on serum biochemical indices of dairy goat.

It is Can be seen, the milk composition index of group 15% was lower than that in group 10% and 12.5%, group 12.5% was the highest. Among them, the milk fat rate, on-fat solid content and acidity of group 12.5% were significantly higher than those of group of 15% (P<0.01), the group 10% less than 12.5%, and higher than that of the group of 15%, but the difference was not significant (P>0.05); The milk protein of group 15% were significantly lower than group 10% and group 12.5%, while the group 10% had no significant difference with group 12.5% (P>0.05); the freezing point of group 12.5% was significantly higher than the group of 15% (P<0.05), the group 10% was lower than the group 12.5%, but the difference was not significant

of them (P>0.05). The effects of different dietary protein levels had no effect on lactose.

### Effects of different CP levels on serum biochemical indices of dairy goat

Results in Table 3 illustrates that the tested goat serum albumin, total protein, glucose, blood urea, nitrogen, total cholesterol and alanine aminotransferase decreased with the increase in dietary protein level. The contents of albumin and urea nitrogen in group 12.5% and group15% were significantly higher than those in the group 10% (P<0.05), and the difference between the group of 12.5% and the group of 15% was not significant (P>0.05); The serum total protein content of the group of 15% was significantly higher than that in the group of 10%, group 12.5% was higher than group 10% (P<0.05), but there was no significant difference (P>0.05). Effects of dietary protein level on serum total cholesterol, glucose, aspartate and alanine aminotransferase had no effect (P>0.05).

## Discussion

### Effects of different CP level on milk yield of lactating dairy goat

The amount of milk is the most important indicator of the level of animal production performance, but also was the protection of the industry which has a reliable income. There are many factors that affect the level of lactation, which mainly including two aspects of feeding management and genetic factors. According to the determination, the heritability of milk goat milk yield is only 0.3 to 0.35. Therefore, the ups and downs of the dairy goat milk yield and feeding and management factors such as relationship greatly, and the dietary protein level is one of the main factor. According to Shi Shuyan [2] reported that the highest amount of milk was the highest in Laoshan with high nutrition level. In recent years, many scholars studied the lactating ruminants nutrition level and milk yield, with increasing dietary protein level, the amount of lactating animals does not change. As reported in the Zhai Shaowei, lactating dairy cattle feeding of diets with different protein level (13.2%, 14.%,15%,16.2%, with the increase of dietary protein level, lactation milk yield between group difference was not significant. The results of Bach's study also showed that, dietary crude protein levels had no effect on the amount of lactation in Holstein cows [3]. Sheng Hejun [4], has reported that dietary protein level in the following 16%, with the increase of dietary crude protein level, Saanen dairy goat milk yield increased significantly. Zou Caixia [5] reports, crude protein level of diet increased from 13.6% to 14.4%, significantly increased milk yield of FCM, When dietary crude protein level was 15.2%, the FCM is 13.1 kg/d, but crude protein level of diet rose to 16, the FCM yield fell to 12.2 kg/d. The nitrogen level of lactating buffalo and buffalo milk yield was two times curve. The test results show that, the dairy goat lactation with the level of crude protein in diet increased significantly,while there was no significant difference between the group 12.5% of FCM and group 15%, this shows that high crude protein level of diet did not significantly improve the yield of FCM. Li Hongyu [6] also believes that, above a certain level of dietary protein, can reduce the yield of FCM. Above scholars and the test results show that, this paper sets the crude protein level in the diet may has not yet reached the top point of the quadratic curve, or it is the vertex, need to further improve the dietary crude protein level to discuss it again.

### Effects of different CP level on milk composition of lactating dairy goat

Milk composition is a measure of the quality of dairy products. Li Xin [7] reports, with the increase of dietary crude protein level, Saanen dairy goat milk yield increased, milk protein, milk fat and non-fat solids decreased significantly. These studies indicate that, milk fat, milk protein and non-fat solids increased with the increase in dietary crude protein initially and then decreased, The output of milk protein in the group 12.5% was almost the same as group 15%, This shows that the of dietary crude protein conversion efficiencies for milk protein in the group 15% less than group 12.5%, so the excess crude protein of dietary excreted in urine nitrogen and fecal nitrogen amount was higher. There are reports that the dairy quality and small intestinal amino acid patterns have a greater relationship, which may be another way to improve the quality of dairy products; In addition, suitable caloric-protein ratio in of the diet will influence crude protein digestion and absorption, and will affect the efficiency of crude protein in diet convert to milk protein, this also need to increase the energy factor design was further studied. The study also found that, different dietary crude protein levels had no effect on lactose, consistent with this study by Wang Xingling [8]. Results in Table 3 illustrates that the tested milk Acidity of 12.5% group was significantly higher than 15% group, Since the 15% group which the protein content and energy not balanced in the diet, Result in lower efficiency of rumen microbial use of ammonia, Excess ammonia into the blood, resulting in increased blood alkaline, which causes low milk acidity. Non-fat milk solids is composed of protein, lactose and ash, the lactose and milk protein of group 12.5% were higher than the group 15%, therefore, the non-fat milk solids content of group 12.5% is higher than the group 15%.

### Effects of different CP levels on serum biochemical indices of dairy goat

Serum biochemical index can effectively evaluate the transformation and transportation of nutrients in animal production. In general, ALB of serum as a donor to provide protein, and maintain osmolality of plasma and other functions, When protein intake is insufficient or absorption barriers, cause a decrease in the number of ALB in serum [9]. In this experiment, the content of ALB in the serum of the high protein group was higher than that in the low protein group, and the results were consistent with the results of Cai Jiansen. According to the report, the animal blood sugar concentration should be in the range of 6.1 mmol/L. The results of this experiment are similar to Li Jiang et al. [10], in the normal range, the blood sugar level of the low yielding animal is lower than the high yield. The higher total cholesterol in serum will affect the health of the body, from the data of the three groups of goat serum total cholesterol are not beyond the normal range of 5.2 mmol/L, so that different protein levels have no effect on the serum total cholesterol content of the tested goat.

The decomposition of protein in the rumen and the decomposition of the body tissue determines the concentration of ammonia nitrogen in the rumen. The contents of serum urea nitrogen reflect the metabolism and balance of amino acids in the animal body.

In this experiment, goat serum urea nitrogen content decreased with the rise of dietary crude protein level increased significantly, which due to diet containing higher nitrogen content or protein utilization rate decreased and increased absorption from the rumen ammonia may be, leading to the rise in serum urea nitrogen content. This shows that high levels of dietary protein diet does not have to

increase the utilization of nitrogen, it is shown that the number of nitrogen in feces and urine were excluded [11]. The quality of Liver function can reflect from the activity of aspartate aminotransferase and alanine aminotransferase, so these two indicators are necessary inspection items in conventional liver function tests, the test of aspartate aminotransferase and alanine aminotransferase activity were within the normal rangeit explained that three levels of dietary crude protein metabolism of liver damage.

## Conclusion

Under the conditions of this experiment. With the increase of dietary crude protein levels can significantly increase the amount of milk goat milk, Serum total protein, albumin and blood urea nitrogen increased significantly, reduce milk fat percentage, milk protein and milk composition. Blood glucose, total cholesterol, aspartate and alanine aminotransferase were not affected by protein levels. 12.5% of the crude protein level in the diet is more conducive to play a production performance of dairy goat.

## References

1. Davidson S, Hopkins BA, Diaz DE, Bolt SM, Brownie C, et al. (2003) Effects of amounts and degradability of dietary protein on lactation, nitrogen utilization, and excretion in early lactation Holstein cows. J Dairy Sci 86: 1681-1689.
2. Shi SY, Zhao JS, Wang WX (2009) Study on the feeding conditions of Laoshan dairy goat lactation pattern. Journal of Domestic Animal Ecology 2009: 69-71.
3. Bach A, Huntington GB, Calsamiglia S, Stern MD (2000) Nitrogen metabolism of early lactation cows fed diets with two different levels of protein and different amino acid profiles. J Dairy Sci 83: 2585-2595.
4. Bava L, Rapetti L, Crovetto GM, Tamburini A, Sandrucci A, et al. (2001) Effects of different energy and protein levels on the performance of Saanen goat lactation milk and milk composition. J Dairy Sci 84: 2450-2459.
5. Zhou CX, Wei SJ, Liang XW (2012) Effect of dietary crude protein levels on lactating buffalo milk production and nitrogen metabolism. Journal of Animal Nutrition 24: 946-952.
6. Li HY, Miao SJ, Cheng YB, Qian ZY (2010) Effect of dietary protein levels on the cold north Chinese Holstein lactation performance and urea nitrogen in vivo. Chinese Journal of Animal Science 46: 36-39.
7. Li X, Luo J, Zhu JJ (2013) Effect of different energy and protein levels in diets on lactation performance of Xinong dairy goat. Journal of Domestic Animal Ecology 34: 30-35.
8. Wang XL, Liu CL, Zhao HB, You W, Cheng HJ (2012) Dietary crude protein levels affect milk production, nitrogen utilization and blood hormones of Chinese Holstein dairy cows. Journal of Animal Nutrition 24: 669-680.
9. Cai JS (2007) Effect of protein sources on performance and organ development and serum biochemical indexes in early-weaned lambs. Beijing: Chinese academy of agricultural sciences master dissertation.
10. Li J (2003) Progress in nosogenesis of Low fiberal diarrhoea and nutrient regulation of weaned rabbits. Baoding: Agricultural University of Hebei.
11. Ahmed AF, Constable PD, Misk NA (2002) Effect of feeding frequency and route of administration on abomasal luminal pH in dairy calves fed milk replacer. J Dairy Sci 85: 1502-1508.