Effects of Dietary Neutral Detergent Fiber Levels on Growth Performance, Serum Biochemical Indices, and Slaughter Performance of Early-Weaned Lambs during the Fattening Period: Postprint

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Abstract

This experiment aimed to investigate the effects of feeding early-weaned lambs diets with different neutral detergent fiber (NDF) levels on growth performance, serum biochemical indices, and slaughter performance during the fattening period. One hundred healthy male Hu lambs with a body weight of (6.10±0.10) kg and age of (18±2) days were selected and randomly divided into 4 groups, with 5 replicates per group and 5 lambs per replicate. Four experimental diets were formulated with NDF levels of 10% (10N group, as control), 15% (15N group), 20% (20N group), and 25% (25N group). During the 21-90 day age period, lambs in each group were fed diets with different NDF levels; during the 91-150 day age period, all lambs were fed the same total mixed ration (TMR) with an NDF level of 30%. At 150 days of age, 6 lambs with body weight similar to the group average were selected from each group to determine serum biochemical indices, slaughter performance, and tissue organ development indices. The results showed: 1) At 90 days of age, the body weight of the 15N, 20N, and 25N groups was significantly higher than that of the 10N group ($P<0.05$); at 120 days of age, the body weight of the 20N and 25N groups was significantly higher than that of the 10N group ($P<0.05$); at 150 days of age, the body weight of the 20N and 25N groups showed an increasing trend compared with the 10N group ($P=0.079$). During the 91-120 day age period, the average daily gain (ADG) of lambs in the 20N and 25N groups was significantly higher than that in the 10N and 15N groups ($P<0.05$), and the average dry matter intake (DMI) of lambs in the 20N group was significantly higher than that in the 10N group ($P<0.05$); however, during the 121-150 day age period, the ADG of lambs in the 20N and 25N groups was significantly lower than that in the 10N and 15N groups

(P<0.05). During the 90-150 day age period, there were no significant differences in ADG, average DMI, and feed-to-gain ratio among groups (P>0.05). 2) The serum total protein content in the 20N group was significantly higher than that in the 10N group (P<0.05), the serum albumin content in the 20N and 25N groups was significantly higher than that in the 10N group (P<0.05), and the serum -hydroxybutyrate content in the 25N group was significantly higher than that in the 10N and 15N groups (P<0.05). 3) The carcass weight of lambs in the 20N and 25N groups showed an increasing trend compared with the 10N group (P=0.061). 4) The proportion of head weight to pre-slaughter live weight in the 10N group was significantly higher than that in the 20N group (P<0.05), and there were no significant differences among groups in other indices (P>0.05). In conclusion, feeding early-weaned lambs diets with NDF levels not lower than 15% can improve the growth performance of lambs during the fattening period.

Full Text

Effects of Feeding Different Neutral Detergent Fiber Level Diets for Early Weaned Lambs on Growth Performance, Serological Parameters and Slaughter Performance of Lambs at Fattening Stage

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Abstract

This experiment was conducted to investigate the effects of feeding different neutral detergent fiber (NDF) level diets to early-weaned lambs on their growth performance, serological parameters, and slaughter performance during the fattening period. One hundred healthy male Hu lambs with an initial body weight of (6.10±0.10) kg and aged (18±2) days were randomly allocated into four groups with five replicates per group and five lambs per replicate. Four experimental diets were formulated with NDF levels of 10% (10N group, as control), 15% (15N group), 20% (20N group), and 25% (25N group). From 21 to 90 days of age, lambs in each group were fed diets with different NDF levels; from 91 to 150 days of age, all lambs were fed the same total mixed ration (TMR) with an NDF level of 30%. At 150 days of age, six lambs per group with body weight close to the group mean were selected to determine serological parameters, slaughter performance, and tissue and organ development indices.

The results showed: 1) At 90 days of age, body weight in the 15N, 20N, and 25N groups was significantly higher than in the 10N group (P<0.05). At 120 days of age, body weight in the 20N and 25N groups was significantly higher than in the 10N group (P<0.05). At 150 days of age, body weight in the 20N and 25N groups showed an increasing trend compared with the 10N group (P=0.079). During the 91–120 day period, average daily gain in the 20N and 25N groups was significantly higher than in the 10N and 15N groups (P<0.05), and average dry matter intake in the 20N group was significantly higher than in the 10N group (P<0.05). However, during the 121–150 day period, average daily gain in the 20N and 25N groups was significantly lower than in the 10N and 15N groups (P<0.05). No significant differences were observed among groups in average daily gain, average dry matter intake, or feed-to-gain ratio during the 90–150 day period (P>0.05). 2) Serum total protein content in the 20N group was significantly higher than in the 10N group (P<0.05). Serum albumin content in the 20N and 25N groups was significantly higher than in the 10N group (P<0.05). Serum -hydroxybutyrate content in the 25N group was significantly higher than in the 10N and 15N groups (P<0.05). 3) Carcass weight in the 20N and 25N groups showed an increasing trend compared with the 10N group (P=0.061). 4) The proportion of head weight to live weight before slaughter was significantly higher in the 10N group than in the 20N group (P<0.05), while no significant differences were found in other parameters among groups (P > 0.05). In conclusion, feeding early-weaned lambs diets with NDF levels not lower than 15% can improve their growth performance during the fattening period.

Key words: neutral detergent fiber; early weaned lambs; growth performance; slaughter performance; metabolic imprinting

Introduction

Metabolic imprinting refers to an epigenetic response whereby early nutritional regulation can alter later physiological performance. It is now widely accepted that nutritional intervention during the neonatal stage in infants can program epigenetic modifications in sensitive tissues and cells, affecting long-term outcomes. Research has shown that early microbial colonization in the infant gut can influence later physiology, metabolism, and immunity. In animal nutrition research, early feeding strategies, nutritional levels, and dietary structure in young ruminants are closely correlated with later production performance, and early nutrition or metabolic programming has lifelong effects on subsequent growth and health. Further understanding of the long-term effects of early nutritional regulation on later fattening performance in lambs is important for developing and improving scientific rearing and fattening strategies.

Early weaning technology not only significantly shortens the lactation period and lambing interval in ewes but also promotes lamb growth and development. Feeding alfalfa to early-weaned lambs can improve growth performance before

and after weaning, as well as rumen development and carcass weight after weaning. The regulatory effects of dietary neutral detergent fiber (NDF) level and source on lamb growth and development have been studied. Our previous research indicated that when dietary NDF level was not lower than 20%, growth performance, slaughter performance, and the weight of organs such as heart and liver in early-weaned lambs could be improved. However, the long-term effects of dietary NDF level regulation on growth and development in early-weaned lambs remain unclear. Therefore, this experiment was conducted to investigate the effects of feeding different NDF level diets during the suckling period on growth performance, serological parameters, and slaughter performance of lambs during the fattening period, aiming to explore the long-term effects of early dietary NDF nutritional regulation on lamb growth and provide new insights and theoretical basis for lamb fattening strategies.

1.1 Experimental Time and Location

This experiment was conducted from November 2016 to April 2017 at Jiangsu Hailun Sheep Industry Co., Ltd.

1.2 Experimental Design

This experiment adopted a single-factor design. One hundred male Hu lambs with similar body weight [(6.10±0.10) kg] and aged (18±2) days were randomly divided into four groups with five replicates per group and five lambs per replicate. Four experimental diets were formulated: the control diet contained no roughage (10% NDF, 10N group), while the other three diets contained alfalfa to achieve NDF levels of 15% (15N group), 20% (20N group), and 25% (25N group). The experiment included a 3-day pre-trial period. From 21 to 90 days of age, lambs in each group were fed diets with different NDF levels. After 90 days of age, all lambs were fed the same TMR with 30% NDF until 150 days of age, with a 7-day transition period during diet change.

Before 90 days of age, diets were formulated with alfalfa as the main NDF source, and the four diets were isoenergetic and isonitrogenous. After 90 days of age, diets were formulated with Chinese wildrye grass, alfalfa, and soybean straw as NDF sources. Lamb milk replacer and premix were provided by Beijing Precision Animal Research Center, and other ingredients were provided by the experimental farm. The composition and nutrient levels of experimental diets are shown in Table 1 .

Table 1 Composition and nutrient levels of experimental diets (DM basis) %

Item	Ingredient	NDF Level/%
Corn		
Soybean meal		

Item	Ingredient	NDF Level/%
Wheat bran		
Fat powder		
DDGS		
Extruded soybean		
Chinese wildrye grass		
Soybean straw		
Alfalfa		
Limestone		
CaHPO		
NaCl		
Premix[1])		
Total		
Nutrient levels		
ME/(MJ/kg)[2])		
DM		
CP		
EE		
Ash		
NDF		
TP		

[1])The premix provided the following per kg of diet: VA 12,000 IU, VD 2,000 IU, VE 30 IU, Cu 12 mg, Fe 64 mg, Mn 56 mg, Zn 60 mg, I 1.2 mg, Se 0.4 mg, Co 0.4 mg.
[2])Nutrient values were all measured values except ME.

1.4 Feeding Management

All experimental lambs were ear-tagged, and the immunization program followed the standard farm procedure. The sheep house was disinfected every two weeks (0.5% iodophor, 0.1% benzalkonium bromide). Lambs were gradually transitioned from suckling to milk replacer powder starting at 18 days of age, while being fed pellets. The formal experiment began at 21 days of age. Milk replacer powder was fed at 1% of body weight until 60 days of age, following the method described by Qi et al. Pellets were fed ad libitum throughout the experiment, with both pellets and milk replacer fed twice daily (06:00 and 16:00). After 60 days of age, liquid feed was stopped and lambs were fed pellets only. From 90 days of age onward, all lambs were fed the same TMR until 150 days of age, with a 7-day transition period during diet change.

1.5 Measurements

1.5.1 Determination of Routine Nutritional Components in Experimental Diets Gross energy was determined using a Parr-6400 oxygen bomb

calorimeter. Crude protein content was determined using a KDY-9830 automatic Kjeldahl nitrogen analyzer. Dry matter, crude fat, NDF, acid detergent fiber (ADF), calcium, and total phosphorus content were determined according to *Feed Analysis and Feed Quality Detection Technology*.

1.5.2 Growth Performance Body weight was recorded before morning feeding at 90, 120, and 150 days of age. Feed intake was recorded daily, and refusals were recorded every 5 days to calculate body weight, average dry matter intake, average daily gain, and feed-to-gain ratio for each period.

1.5.3 Serological Parameters At 150 days of age, six lambs per group with body weight close to the group mean were randomly selected for jugular venous blood collection. Blood was centrifuged at 1,040×g for 10 minutes, and serum was stored at -20°C for analysis. Serum glucose (GLU), total protein (TP), albumin (ALB), globulin (GLB), urea nitrogen (UN), uric acid (UA), and creatinine (Cre) contents were determined using a Hitachi 7160 automatic biochemical analyzer, and albumin-to-globulin ratio (A/G) was calculated. Serum insulin (INS), -hydroxybutyrate (BHBA), growth hormone (GH), and insulin-like growth factor-I (IGF-I) were determined by enzyme-linked immunosorbent assay.

1.5.4 Slaughter Performance and Tissue and Organ Development Indices At 150 days of age, six healthy lambs per group with body weight close to the group mean were selected, fasted for 16 hours, and then slaughtered by exsanguination. Live weight before slaughter (LWBS) was recorded. After dissection, carcass, head, feet, skin and wool, heart, liver, spleen, lungs, and kidneys were weighed. Dressing percentage and tissue and organ development indices were calculated.

1.6 Data Processing Experimental data were initially processed using Excel 2007. One-way ANOVA was performed using the ANOVA procedure in SPSS 19.0 software. Duncan' s multiple comparison was used when significant differences were detected. Linear and quadratic regression analyses were used to evaluate the effects of dietary NDF level. $P<0.05$ was considered statistically significant, and 0.05 $P<0.10$ was considered a trend.

Results

2.1.1 Effects of Feeding Different NDF Level Diets for Early Weaned Lambs on Body Weight of Lambs at Fattening Stage

As shown in Table 2 , with increasing dietary NDF level, body weight of lambs at 90, 120, and 150 days of age increased linearly ($P=0.003$, $P<0.001$, $P=0.034$). At 90 days of age, body weight in the 15N, 20N, and 25N groups was significantly higher than in the 10N group ($P<0.05$). At 120 days of age, body weight in the 20N and 25N groups was significantly higher than in the 10N group ($P<0.05$),

with no significant differences among other groups (P>0.05). At 150 days of age, the 25N group had the highest body weight and the 10N group had the lowest, with the 15N, 20N, and 25N groups showing an increasing trend compared with the 10N group (P=0.079).

Table 2 Effects of feeding different NDF level diets for early weaned lambs on body weight of lambs at fattening stage

Group	P-value	Days of Age
Treatment	Linear	Quadratic
18.17b	21.47a	22.64a
25.35b	28.24ab	30.80a
32.23B	35.89A	35.72A

In the same row, values with different small letter superscripts indicate significant differences (P<0.05), and different capital letter superscripts indicate a trend (0.05 P<0.10). The same applies below.

2.1.2 Effects of Feeding Different NDF Level Diets for Early Weaned Lambs on Average Daily Gain of Lambs at Fattening Stage

As shown in Table 3 , with increasing dietary NDF level, average daily gain of lambs during the 91-120 day period increased linearly (P=0.006), while it decreased linearly during the 121-150 day period (P<0.001). During the 91-120 day period, average daily gain in the 20N and 25N groups was significantly higher than in the 10N and 15N groups (P<0.05). During the 121-150 day period, average daily gain in the 20N and 25N groups was significantly lower than in the 10N and 15N groups (P<0.05). For the entire sampling period (91-150 days), no significant differences in average daily gain were observed among groups (P>0.05).

Table 3 Effects of feeding different NDF level diets for early weaned lambs on average daily gain of lambs at fattening stage

Group	P-value	Days of Age
Treatment	Linear	Quadratic
91-120	238.93b	236.03b
121-150	229.47a	226.42a
91-150	<0.001	

2.1.3 Effects of Feeding Different NDF Level Diets for Early Weaned Lambs on Average Dry Matter Intake of Lambs at Fattening Stage

As shown in Table 4 , with increasing dietary NDF level, average dry matter intake of lambs during the 91-120 day period increased linearly (P=0.025). During

the 91-120 day period, average dry matter intake in the 20N group was significantly higher than in the 10N group (P<0.05), with no significant differences among other groups (P>0.05). Although average dry matter intake increased linearly with dietary NDF level during the 121-150 day period (P<0.001), no significant differences were observed among groups (P>0.05). For the entire sampling period, no significant differences in average dry matter intake were found among groups (P>0.05).

Table 4 Effects of feeding different NDF level diets for early weaned lambs on average dry matter intake of lambs at fattening stage

Group	P-value	Days of Age
Treatment	Linear	Quadratic
91-120	573.60b	634.90ab
121-150	<0.001	
91-150		

2.1.4 Effects of Feeding Different NDF Level Diets for Early Weaned Lambs on Feed-to-Gain Ratio of Lambs at Fattening Stage

As shown in Table 5 , no significant differences in feed-to-gain ratio were observed among groups during the 91-120 day period (P>0.05). During the 121-150 day period, feed-to-gain ratio increased linearly with dietary NDF level (P=0.025), with the 15N group having the lowest ratio and the 25N group the highest, but differences among groups were not significant (P>0.05). For the entire sampling period, no significant differences in feed-to-gain ratio were found among groups (P>0.05).

Table 5 Effects of feeding different NDF level diets for early weaned lambs on feed-to-gain ratio of lambs at fattening stage

Group	P-value	Days of Age
Treatment	Linear	Quadratic
91-120		
121-150		
91-150		

2.2 Effects of Feeding Different NDF Level Diets for Early Weaned Lambs on Serological Parameters of Lambs at Fattening Stage

As shown in Table 6 , with increasing dietary NDF level, serum TP, ALB, and BHBA contents increased linearly (P=0.046, P=0.006, P=0.003). Serum TP content in the 20N group was significantly higher than in the 10N group (P<0.05), with no significant differences among other groups (P>0.05). Serum ALB content in the 20N and 25N groups was significantly higher than in the 10N

group (P<0.05), with no significant differences among other groups (P>0.05). Serum BHBA content in the 25N group was significantly higher than in the 10N and 15N groups (P<0.05), with no significant differences among other groups (P>0.05). Feeding different NDF level diets to early-weaned lambs had no significant effects on serum GLU, GLB, A/G, UN, UA, Cre, INS, GH, or IGF-I contents at 150 days of age (P>0.05).

Table 6 Effects of feeding different NDF level diets for early weaned lambs on serological parameters of lambs at fattening stage

Parameter	Group	P-value
	Treatment	Linear
GLU (mmol/L)		
TP (g/L)	56.93b	59.49ab
ALB (g/L)	26.86b	28.72ab
GLB (g/L)		
A/G		
UN (mmol/L)		
UA (mol/L)		
Cre (mol/L)		
INS (IU/mL)		
BHBA (mol/L)	21.44b	33.18b
GH (ng/mL)		
IGF-I (ng/mL)		

2.3 Effects of Feeding Different NDF Level Diets for Early Weaned Lambs on Slaughter Performance of Lambs at Fattening Stage

As shown in Table 7 , with increasing dietary NDF level, live weight before slaughter and carcass weight increased linearly (P=0.034, P=0.015). No significant differences in live weight before slaughter were observed among groups (P>0.05). Carcass weight was highest in the 25N group and lowest in the 10N group, with the 20N and 25N groups showing an increasing trend compared with the 10N group (P=0.061). No significant differences in dressing percentage were found among groups (P>0.05).

Table 7 Effects of feeding different NDF level diets for early weaned lambs on slaughter performance of lambs at fattening stage

Item	Group	P-value
	Treatment	Linear
LWBS (kg)		
Carcass weight (kg)	14.24B	15.81AB
Dressing percentage (%)		

2.4 Effects of Feeding Different NDF Level Diets for Early Weaned Lambs on Tissue and Organ Development of Lambs at Fattening Stage

As shown in Table 8 , with increasing dietary NDF level, head weight and its proportion to live weight before slaughter showed linear increasing and decreasing trends, respectively (P=0.096, P=0.083). No significant differences in head weight were observed among groups (P>0.05), but the proportion of head weight to live weight before slaughter was significantly lower in the 20N group than in the 10N group (P<0.05). Foot weight in the 15N group showed an increasing trend compared with the 10N group (P=0.070), and the proportion of foot weight to live weight before slaughter decreased with increasing dietary NDF level (P=0.090), but no significant differences were found among groups (P>0.05). With increasing dietary NDF level, heart weight increased linearly (P=0.034), while the proportions of lung and kidney weights to live weight before slaughter decreased linearly (P=0.038, P=0.026), though no significant differences were observed among groups (P>0.05).

Table 8 Effects of feeding different NDF level diets for early weaned lambs on tissue and organ development of lambs at fattening stage

Item	Group	P-value
	Treatment	Linear
Head		
Weight (g)		
Proportion of LWBS (%)	5.34a	5.00ab
Feet		
Weight (g)	843.33B	931.67A
Proportion of LWBS (%)		
Skin & wool		
Weight (g)		
Proportion of LWBS (%)		
Heart		
Weight (g)		
Proportion of LWBS (%)		
Liver		
Weight (g)		
Proportion of LWBS (%)		
Spleen		
Weight (g)		
Proportion of LWBS (%)		
Lungs		
Weight (g)		
Proportion of LWBS (%)		
Kidneys		
Weight (g)		
Proportion of LWBS (%)		

Discussion

3.1 Effects of Feeding Different NDF Level Diets on Growth Performance of Lambs at Fattening Stage

The results of this experiment indicate that feeding different NDF level diets to early-weaned lambs affected body weight at 120 days of age and average daily gain and average dry matter intake during the 91–120 day period. Body weight at 120 days of age in the 20N and 25N groups was 21.5% and 23.17% higher, respectively, than in the 10N group. This may be because during the 21–90 day period, the 10N diet contained low NDF (mostly readily fermentable carbohydrates), while the 20N and 25N diets had moderate NDF levels that helped regulate rumen fermentation rate, increase rumen fluid pH, and maintain a suitable rumen environment, thereby improving nutrient digestibility. Additionally, dietary roughage helped remove dead cells from the rumen wall, preventing parakeratosis and clumping of rumen papillae, which promoted nutrient absorption by the rumen epithelium. This early development of rumen structure and function laid the foundation for high growth performance after 90 days of age.

Furthermore, during the initial period of uniform feeding (91–120 days of age), average dry matter intake in the 20N and 25N groups remained significantly higher than in the 10N group, likely because the early 20% and 25% NDF diets were more conducive to full rumen development, ultimately leading to increased intake. Chen et al. studied the growth and development patterns of Hu sheep and established an optimal growth model, showing that growth began to decline from 3 to 7 months of age and plateaued after 7 months. Measured body weight also showed that average daily gain decreased significantly after 7 months of age. Comparing these findings with our results indicates that Hu sheep growth rate declines significantly after reaching approximately 30 kg body weight, suggesting that the decreased growth rate in the 20N and 25N groups during the 121–150 day period may be due to the inherent growth pattern of Hu sheep.

In contrast, the 10N and 15N groups showed relatively stable average daily gain during the 121–150 day period compared with the 90–120 day period, primarily due to feeding low-NDF diets during the 21–90 day period. High levels of readily fermentable carbohydrates cause rapid accumulation of fermentation products, leading to decreased rumen fluid pH, parakeratosis, and clumping of rumen epithelial mucosa, which ultimately impairs nutrient absorption by the rumen epithelium. After 90 days of age, feeding an appropriate NDF level diet for a period allowed rumen structure and function to gradually improve. This "compensatory development" of rumen structure and function promoted feed intake, resulting in relatively stable average daily gain during the 121–150 day period. Although no significant differences in feed-to-gain ratio were observed among groups during any period, the ratio increased linearly with dietary NDF level during the 121–150 day period, possibly because lambs in the 20N and 25N groups entered a stable growth phase. Additionally, body weight at 150 days of

age in the 15N, 20N, and 25N groups was 11.36%, 10.83%, and 12.29% higher, respectively, than in the 10N group, indicating that feeding early-weaned lambs diets with 15%, 20%, or 25% NDF effectively promoted growth performance before 150 days of age.

In summary, feeding early-weaned lambs diets with NDF levels not lower than 20% promoted growth performance during the 91–120 day period. After 120 days of age, lambs previously fed low-NDF diets grew at a faster rate. However, considering growth performance throughout the entire experimental period, diets with 15%, 20%, and 25% NDF produced the best results.

3.2 Effects of Feeding Different NDF Level Diets on Serological Parameters of Lambs at Fattening Stage

Blood biochemical parameters can reflect metabolic function and the health status of related organs. Serum TP consists of ALB and GLB. TP is related to immunity and metabolic level, and its increase is beneficial for improving immunity and metabolic level, promoting healthy and rapid animal growth. The primary functions of ALB are maintaining plasma osmotic pressure and serving as a nutrient carrier, in addition to being a protein source for the body. The results show that serum TP content in the 20N group was significantly higher than in the 10N group, mainly due to serum ALB content. At 150 days of age, serum ALB content in the 20N and 25N groups was significantly higher than in the 10N group, indicating that feeding different NDF level diets to early-weaned lambs affected serum ALB content at 150 days of age and suggesting that early feeding of 20% and 25% NDF diets was more conducive to later lamb growth. Additionally, although serum ALB content differences were not significant at 90 days of age, there was a trend of increase with NDF level. The reasons for the effects of different NDF level diets on serum ALB content at 90 and 150 days of age require further research or data on protein digestion and metabolism for explanation.

The main metabolic pathway of butyrate in rumen epithelial cells is ketone body production; therefore, serum BHBA content can, to some extent, measure the metabolic capacity of rumen epithelial butyrate conversion to BHBA and the degree of rumen epithelial development. Serum BHBA content in early-weaned young animals is affected by feeding strategy, dietary structure, and weaning time. Deelen et al. reported that serum BHBA content in early-weaned young animals is positively correlated with feed intake. This experiment also found that high-NDF diets promoted serum BHBA content and average dry matter intake at 90 days of age. Therefore, whether the increase in serum BHBA content is due to high-NDF diets promoting dry matter intake or promoting rumen epithelial butyrate metabolism and development requires further verification. However, at 150 days of age, serum BHBA content increased linearly with dietary NDF level, with the 25N group being significantly higher than the 10N group, while no significant differences in average dry matter intake were observed among groups during the 121–150 day period. This indicates that serum

BHBA content during this period was not influenced by feed intake, suggesting that early feeding of high-NDF diets likely promoted butyrate metabolism and rumen epithelial development, and this effect was persistent and long-lasting.

3.3 Effects of Feeding Different NDF Level Diets on Slaughter Performance and Tissue and Organ Development of Lambs at Fattening Stage

In this experiment, at 90 days of age, carcass weight in the 15N, 20N, and 25N groups was 14.40%, 24.68%, and 28.45% higher, respectively, than in the 10N group, while at 150 days of age, the differences were 11.03%, 14.68%, and 15.38%, respectively. The narrowing gap in carcass weight corresponded to growth performance indicators because the 10N group grew faster after being fed normal-NDF diets, while the 20N and 25N groups entered a growth plateau in the later experimental period, leading to reduced differences in carcass weight. Despite the narrowing gap, feeding low-NDF diets to early-weaned lambs still reduced slaughter performance and affected meat production. At 90 days of age, the proportion of head weight to live weight before slaughter was highest while foot weight was lowest, and the same phenomenon was observed at 150 days of age, the reasons for which require further research. Feeding high-NDF diets to early-weaned lambs promoted the development of the heart, liver, and spleen, but differences among groups largely disappeared by 150 days of age, indicating that after a period of uniform feeding, these organs and their functions reached consistent levels.

Conclusion

Under the conditions of this experiment, feeding early-weaned lambs diets with higher NDF levels (20% and 25%) improved their growth performance during the fattening period. Faster early growth promoted growth performance during the fattening period, but this growth-promoting effect lasted only one month, with growth intensity decreasing in the later fattening period. This indicates that appropriate dietary NDF levels cannot be determined based solely on early performance, and investigating dietary NDF levels based on long-term growth performance is more scientific.

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