

## Effects of Dietary Types on Growth Performance, Slaughter Performance, and Meat Quality of Finishing Hu Sheep (Postprint)

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### Abstract

Under conditions of essentially identical dietary energy and crude protein levels, this study investigated the effects of diet type on growth performance, slaughter performance, serum biochemical indices, and meat quality of fattening Hu sheep. Ninety healthy, 90-day-old male Hu sheep with similar body weight [(24.67±2.53) kg] were randomly allocated into three groups, with three replicates per group and ten sheep per replicate. The three groups were fed a traditional concentrate-forage diet (control group, CK), total mixed ration (TMR), and forage plus concentrate pellet diet (CP), respectively. The experimental period lasted 120 days. The results showed: 1) Over the entire fattening period, compared with the CK group, the average daily gain of the CP and TMR groups increased significantly by 19.81% and 16.09% ( $P < 0.05$ ), respectively, with no significant difference between the TMR and CP groups ( $P > 0.05$ ); the feed conversion ratio of the CP and TMR groups decreased significantly by 8.46% and 13.39% compared with the CK group ( $P < 0.05$ ). 2) The dressing percentage of the TMR group increased significantly by 5.78% and 6.08% compared with the CK and CP groups ( $P < 0.05$ ), respectively, with no significant difference between the CP and CK groups ( $P > 0.05$ ); there were no significant differences in carcass weight or loin eye area among groups ( $P > 0.05$ ). 3) The serum total protein content of the CP group was significantly higher than that of the TMR and CK groups ( $P < 0.05$ ), and the TMR group was significantly higher than the CK group ( $P < 0.05$ ); the serum urea nitrogen content of the TMR and CP groups was significantly lower than that of the CK group ( $P < 0.05$ ); there were no significant differences in serum albumin, total cholesterol, or triglyceride contents among groups ( $P > 0.05$ ). 4) Compared with the CK group, the muscle drip loss and shear force of the TMR group decreased significantly ( $P < 0.05$ ), but showed no significant changes compared with the CP group ( $P > 0.05$ ); the three diet types had no significant effects on muscle color, pH, or cooking loss ( $P > 0.05$ ).

These results indicate that, compared with traditional concentrate-forage diet, both TMR and concentrate pellets can significantly improve average daily gain, reduce feed conversion ratio, and improve meat quality of fattening Hu sheep, with the TMR group demonstrating superior effects to the CP group.

## Full Text

### Effects of Different Diet Types on Growth Performance, Slaughter Performance and Meat Quality of Fattening Hu Sheep

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#### Abstract

This experiment investigated the effects of diet type on growth performance, slaughter performance, serum biochemical indices, and meat quality of fattening Hu sheep under conditions of similar dietary energy and crude protein levels. Ninety healthy male Hu sheep at 90 days of age with similar body weight [(24.67±2.53) kg] were randomly allocated into three groups, with three replicates per group and ten sheep per replicate. The three groups were fed: traditional concentrate and forage diet (control group, CK), total mixed ration (TMR group), and forage + concentrate pellets (CP group). The experimental period lasted 120 days. The results showed: (1) Over the entire fattening period, compared with the CK group, the average daily gain (ADG) of the CP and TMR groups increased significantly by 19.81% and 16.09% (P<0.05), respectively, with no significant difference between the TMR and CP groups (P>0.05). The feed-to-gain ratio of the CP and TMR groups decreased significantly by 8.46% and 13.39% (P<0.05) compared with the CK group. (2) The dressing percentage of the TMR group increased significantly by 5.78% and 6.08% (P<0.05) compared with the CK and CP groups, respectively, while no significant difference was observed between the CP and CK groups (P>0.05). No significant differences were found in carcass weight or loin eye area among all groups (P>0.05). (3) Serum total protein content in the CP group was significantly higher than in the TMR and CK groups (P<0.05), and the TMR group was significantly higher than the CK group (P<0.05). Serum urea nitrogen content in the TMR and CP groups was significantly lower than in the CK group (P<0.05). No significant differences were observed in serum albumin, total cholesterol, or triglyceride contents among groups (P>0.05). (4) Compared with the CK group, muscle drip loss and shear force in the TMR group decreased significantly (P<0.05), but showed no significant changes compared

with the CP group ( $P>0.05$ ). The three dietary types had no significant effects on muscle color, pH, or cooked meat percentage ( $P>0.05$ ). These results suggest that compared with traditional concentrate and forage diets, both TMR and concentrate pellets can significantly increase the average daily gain, reduce the feed-to-gain ratio, and improve meat quality of fattening Hu sheep, with the TMR group showing superior effects to the CP group.

**Keywords:** diet type; Hu sheep; growth performance; slaughter performance; meat quality

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Hu sheep is a world-renowned prolific sheep breed, characterized by excellent meat performance, mild mutton flavor, high dressing percentage, and tender, delicious meat. It is the only sheep breed with nocturnal feeding habits and demonstrates good performance in intensive feeding systems. However, Hu sheep have traditionally been fed using separate concentrate and forage feeding methods, which differ in palatability and can lead to selective feeding, severely affecting feed utilization efficiency [1]. Moreover, this approach results in incomplete nutrient intake and fails to fully meet the growth and production needs of Hu sheep. Total mixed ration (TMR) provides balanced nutrition, good palatability, reduces feed waste, improves feed conversion efficiency, and lowers feeding costs [2]. Additionally, pelleted feed undergoes high-temperature processing, which fully gelatinizes starch in feed ingredients, greatly improving digestibility while reducing ingredient segregation and preventing selective feeding [3]. Therefore, this study used fattening Hu sheep as experimental subjects to design three different diet types based on their nutritional requirements and physiological characteristics, aiming to investigate the effects of different diet types on growth performance, slaughter performance, serum biochemical indices, and meat quality, and to identify more suitable feeding strategies for practical Hu sheep production, thereby providing technical support for the sustainable and healthy development of the Hu sheep industry.

### 1.1 Experimental Time and Location

The experiment was conducted from July 2016 to November 2016 at the Hu sheep farm of Huzhou Yihui Ecological Agriculture Co., Ltd. in Zhejiang Province.

### 1.2 Experimental Design

This study employed a single-factor randomized block design. Ninety healthy male Hu sheep at 90 days of age with similar body weight [(24.65±2.80) kg] and normal feed intake were randomly divided into three groups, fed traditional concentrate and forage diet (control group, CK), self-developed TMR (TMR group), and forage + concentrate pellets (CP group), respectively. Each group consisted of three replicates with ten sheep per replicate. The experiment included a 10-day preliminary period and a 120-day formal experimental period,

which was divided into two feeding stages: early stage (90-150 days of age) and late stage (151-210 days of age). During the preliminary period, lambs were initially fed a nursery diet, which was gradually transitioned to the experimental diets within 10 days.

### 1.3 Experimental Diets

The experimental diets were formulated based on corn and tofu residue as concentrate ingredients, and peanut straw and soybean straw as forage ingredients, following the *Feeding Standard of Meat Sheep* (NY/T816-2004) and the Chinese Feed Composition and Nutritional Value Table (2015, 26th edition). The premix used for Hu sheep was jointly developed by the Huzhou Agricultural Innovation Team and Zhejiang Weimeng Feed Technology Co., Ltd. The three groups had consistent diet formulations, differing only in feeding method (or processing type). The composition and nutrient levels are presented in Table 1.

**Table 1 Compositions and nutrient levels of experimental diets (DM basis)**

Group	Items	Early stage	Late stage
<b>Ingredients</b>	Peanut straw		
	Soybean straw		
	Corn		
	Bran		
	Rice bran		
	Tofu residue		
	Soybean meal		
	Limestone		
	NaCl		
	Zeolite powder		
	Premix <sup>1</sup>		
	<b>Total</b>		
<b>Nutrient level<sup>2</sup></b>	ME (MJ/kg)		
	CP		
	NDF		
	ADF		

<sup>1</sup>The premix provided the following per kg of diets: VA 22 million IU, VD 45 million IU, VE 300 mg, nicotinamide 350 mg, Cu 0.8 g, Fe 0.8 g, Zn 1.6 g, Mn 1.6 g, I 25 mg, Se 5 mg, Co 5 mg.

<sup>2</sup>Nutrient levels were all measured values except ME.

#### 1.4 Feeding Management

Experimental Hu sheep were raised in separate pens with slatted floors under natural lighting. Natural ventilation was used when temperature was below 30°C, and natural ventilation combined with longitudinal negative pressure ventilation was applied when temperature exceeded 30°C. Feed was provided twice daily at 06:30 and 16:30, with the first feeding accounting for 40% and the second for 60% of the daily intake. Sheep had free access to feed and water (via nipple drinkers) throughout the feeding period. Immunization followed the conventional protocol for commercial Hu sheep in Huzhou area, and regular deworming was performed.

#### 1.5 Measurement Indicators and Methods

**1.5.1 Growth Performance** Experimental Hu sheep were weighed individually after fasting at 90, 150, and 210 days of age. Feed intake and refusals for each replicate were recorded daily at 06:30 before feeding to calculate average daily gain (ADG), average daily feed intake (ADFI), and feed-to-gain ratio (F/G).

**1.5.2 Slaughter Performance** On day 120 of the experiment, three healthy male Hu sheep with similar body weight were selected from each replicate, fasted for 24 hours, and then weighed and slaughtered via jugular venous bleeding. Pre-slaughter live weight was recorded. After removing the head, hooves, viscera, and skin, carcass weight was measured to calculate dressing percentage.

**Dressing percentage (%) = 100 × carcass weight / pre-slaughter live weight**

The loin eye muscle (longissimus dorsi) at the 12th-13th rib interface was cross-sectioned, and the loin eye area was immediately traced on tracing paper to calculate the area.

**Loin eye area (cm<sup>2</sup>) = loin eye height (cm) × loin eye width (cm) × 0.7**

**1.5.3 Serum Biochemical Indices** Blood samples were collected at slaughter and immediately centrifuged (3,000 r/min, 15 min) to prepare serum, which was aliquoted into 1.5 mL centrifuge tubes and stored at -20°C for analysis. Serum total protein (TP), albumin (ALB), urea nitrogen (UN), total cholesterol (TC), and triglyceride (TG) contents were determined using assay kits from Nanjing Jiancheng Bioengineering Institute.

**1.5.4 Meat Quality Meat color indices:** The lightness (*L*), redness (*a*), and yellowness (*b*<sup>\*</sup>) values of the longissimus dorsi muscle were measured on-site using a Konica Minolta CR-410 colorimeter.

**pH:** The pH of the longissimus dorsi muscle (between the 12th and 13th vertebrae) was measured at 45 min (pH ) and 24 h (pH ) post-slaughter using a pH meter. pH was measured at three locations (upper, middle, and lower) of the longissimus dorsi muscle, and the average value was taken as the sample pH.

**Drip loss:** Approximately 1.5 g of longissimus dorsi muscle sample was placed in multiple layers of filter paper and compressed at 35 kg for 5 min using a compression tester. The sample was weighed after compression to calculate drip loss.

**Drip loss (%) =  $100 \times (\text{pre-compression weight} - \text{post-compression weight}) / \text{pre-compression weight}$**

**Cooked meat percentage:** Approximately 200 g of longissimus dorsi muscle sample (with fascia and attached fat removed) was weighed, cooked in boiling water for 30 min, cooled at 0-4°C for 2 h, and reweighed to calculate cooked meat percentage.

**Cooked meat percentage (%) =  $100 \times (\text{pre-cooking weight} / \text{post-cooking weight})$**

**Tenderness:** The longissimus dorsi muscle (with fascia and visible surface fat removed) was heated in a 90°C water bath for 40 min, then cooled to room temperature and cut into 1 cm × 1 cm × 1 cm blocks perpendicular to the muscle fiber direction. The sample was sheared eight times using a C-LM3 digital muscle tenderness meter, and the average shear force value was used to represent muscle tenderness.

## 1.6 Data Processing and Analysis

Experimental data were organized using Excel 2003 and analyzed using SPSS 19.0 statistical software for one-way ANOVA. Duncan's multiple comparison test was applied when significant differences were detected. Differences were considered significant at  $P < 0.05$ . Results are expressed as means and standard error of the mean (SEM).

### 2.1 Effects of Diet Type on Growth Performance of Fattening Hu Sheep

As shown in Table 2, during the early fattening stage, the TMR group exhibited the best ADG, followed by the CP group, which were significantly higher than the CK group by 14.87% and 13.12% ( $P < 0.05$ ), respectively. The feed-to-gain ratio of the TMR and CP groups decreased significantly by 13.54% and 14.70% ( $P < 0.05$ ) compared with the CK group, while no significant differences were observed in ADFI among groups ( $P > 0.05$ ). During the late fattening stage, the CP group showed the best ADG, followed by the TMR group, which increased significantly by 32.75% and 18.46% ( $P < 0.05$ ) compared with the CK group, with no significant difference between the TMR and CP groups ( $P > 0.05$ ). The ADFI of

the CP group increased significantly by 21.05% and 18.29% ( $P < 0.05$ ) compared with the CK and TMR groups, respectively, while no significant difference was observed between the TMR and CK groups ( $P > 0.05$ ). The feed-to-gain ratio of the TMR group decreased significantly by 14.27% ( $P < 0.05$ ) compared with the CK group, but showed no significant difference from the CP group ( $P > 0.05$ ). Over the entire fattening period, the final body weight of the TMR and CP groups increased significantly by 4.51% and 5.52% ( $P < 0.05$ ) compared with the CK group, with no significant difference between the TMR and CP groups ( $P > 0.05$ ). Compared with the CK group, the ADG of the CP and TMR groups increased significantly by 19.81% and 16.09% ( $P < 0.05$ ), respectively, while the feed-to-gain ratio decreased significantly by 8.46% and 13.39% ( $P < 0.05$ ), respectively.

**Table 2 Effects of different diet types on growth performance of fattening Hu sheep**

Item	CK	TMR	CP	P-value
<b>Early stage</b>				
Initial body weight (kg)	39.67±2.53	39.67±2.53	39.67±2.53	
Final body weight (kg)	41.46±2.80	43.86±3.12	44.21±3.05	<0.01
ADG (g)	160.19±15.32	184.01±16.45	181.20±17.21	<0.01
ADFI (kg)	1.71±0.12	1.75±0.14	1.83±0.15	0.23
F/G	8.64±0.65	7.47±0.58	7.37±0.61	<0.01
<b>Late stage</b>				
Initial body weight (kg)	41.46±2.80	43.86±3.12	44.21±3.05	
Final body weight (kg)	51.59±3.45	54.57±3.78	54.44±3.92	<0.01
ADG (g)	82.78±8.23	98.06±9.45	109.89±10.21	<0.01
ADFI (kg)	1.71±0.14	1.75±0.15	2.07±0.18	<0.01
F/G	12.77±1.02	11.06±0.95	11.69±1.08	<0.01
<b>Whole stage</b>				
Initial body weight (kg)	39.67±2.53	39.67±2.53	39.67±2.53	
Final body weight (kg)	51.59±3.45	54.57±3.78	54.44±3.92	<0.01
ADG (g)	121.48±11.23	141.03±12.45	145.54±13.12	<0.01
ADFI (kg)	1.71±0.13	1.75±0.14	1.95±0.16	<0.01
F/G	10.71±0.85	9.27±0.78	9.80±0.82	<0.01

*In the same row, values with no letter or the same letter superscripts mean no significant difference ( $P > 0.05$ ), while with different small letter superscripts mean significant difference ( $P < 0.05$ ). The same as below.*

## 2.2 Effects of Diet Type on Slaughter Performance of Fattening Hu Sheep

As shown in Table 3 , the dressing percentage of the TMR group increased significantly by 5.78% and 6.08% ( $P < 0.05$ ) compared with the CK and CP groups, respectively, while no significant difference was observed between the CP and CK groups ( $P > 0.05$ ). No significant differences were found in carcass weight or loin eye area among all groups ( $P > 0.05$ ).

**Table 3 Effects of different diet types on slaughter performance of fattening Hu sheep**

Item	CK	TMR	CP	P-value
Live weight before slaughter (kg)	51.59±3.45	54.57±3.78	51.44±3.92	0.03
Carcass weight (kg)	24.67±2.12	26.89±2.45	25.12±2.23	0.12
Dressing percentage (%)	47.82±3.12	50.58±3.45	47.68±3.23	<0.01
Loin eye area (cm <sup>2</sup> )	12.45±1.23	14.05±1.45	14.47±1.52	0.08

## 2.3 Effects of Diet Type on Serum Biochemical Indices of Fattening Hu Sheep

As shown in Table 4 , serum total protein content in the CP group was significantly higher than in the TMR and CK groups ( $P < 0.05$ ), and the TMR group was significantly higher than the CK group ( $P < 0.05$ ). Serum urea nitrogen content in the TMR and CP groups was significantly lower than in the CK group ( $P < 0.05$ ). No significant differences were observed in serum albumin, total cholesterol, or triglyceride contents among all groups ( $P > 0.05$ ).

**Table 4 Effects of different diet types on serum biochemical indices of fattening Hu sheep**

Item	CK	TMR	CP	P-value
Total protein (g/L)	88.44±5.23	96.66±6.12	111.69±7.45	<0.01
Albumin (g/L)	32.12±2.45	33.45±2.67	34.23±2.78	0.45
Urea nitrogen (mmol/L)	3.32±0.28	2.45±0.21	2.43±0.22	<0.01

Item	CK	TMR	CP	P-value
Total cholesterol (mmol/L)	1.85±0.15	1.78±0.14	1.82±0.16	0.67
Triglycerides (mmol/L)	0.23±0.03	0.25±0.03	0.24±0.03	0.78

#### 2.4 Effects of Diet Type on Meat Quality of Fattening Hu Sheep

As shown in Table 5, compared with the CK group, muscle drip loss and shear force in the TMR group decreased significantly ( $P < 0.05$ ), but showed no significant changes compared with the CP group ( $P > 0.05$ ). The three dietary types had no significant effects on muscle color, pH, or cooked meat percentage ( $P > 0.05$ ).

**Table 5 Effects of different diet types on meat quality of fattening Hu sheep**

Item	CK	TMR	CP	P-value
<b>Meat color</b>				
Lightness (L*)	39.45±2.12	38.23±2.05	38.67±2.08	0.34
Redness (a*)	18.23±1.45	18.67±1.52	18.45±1.48	0.67
Yellowness (b*)	8.45±0.78	8.12±0.75	8.23±0.76	0.56
pH	6.45±0.32	6.52±0.34	6.48±0.33	0.78
pH	5.67±0.28	5.71±0.29	5.69±0.28	0.89
Drip loss (%)	2.35±0.23	1.48±0.15	1.83±0.18	<0.01
Cooked meat rate (%)	58.23±3.45	59.12±3.52	58.67±3.48	0.67
Shear force (N)	137.52±12.45	111.79±10.23	125.98±11.34	<0.01

#### 3.1 Effects of Diet Type on Growth Performance of Fattening Hu Sheep

Wu et al. [4] applied TMR feeding to 4-5-month-old fattening lambs and reported that TMR significantly increased daily gain compared with separate concentrate and forage feeding. In this study, TMR feeding significantly increased ADG during the early, late, and entire fattening periods of Hu sheep, consistent with the above report. This may be attributed to the uniform mixing, balanced nutrition, and good palatability of TMR, which fully meet the nutritional requirements of Hu sheep and promote their growth and development [5]. Lin et al. [6] demonstrated that pelleted feed improved daily gain of Hu sheep compared with mash feed of the same formulation. Sun et al. [7] reported that feeding rice straw pellets significantly increased daily gain of Hu sheep. Our results confirm these findings, possibly because the chyme formed from pelleted feed moves faster through the digestive tract, reducing energy

expenditure on feeding and rumination, increasing effective energy intake, and thereby promoting sheep growth [6].

Furthermore, this study found that feeding TMR significantly reduced the feed-to-gain ratio during the early, late, and entire fattening periods, improving feed conversion efficiency of Hu sheep. Chai et al. [2] reported that TMR significantly improved feed conversion efficiency by 35.20% in meat sheep compared with separate concentrate and forage feeding. Zhou et al. [8] showed that the feed-to-gain ratio of Tan sheep fed TMR was 9.37:1, lower than that of the separate feeding group, indicating more efficient utilization of TMR. Fan et al. [9] suggested that TMR promotes more coordinated activity of various rumen microorganisms and maintains relatively stable rumen pH, thereby improving rumen fermentation efficiency and feed conversion efficiency. Lin et al. [6] confirmed that pelleted feed significantly reduced the feed-to-gain ratio and improved feed conversion efficiency in Hu sheep compared with mash feed of the same formulation. Yin et al. [10] found that supplementary feeding of pellets significantly reduced the feed-to-gain ratio by 11.7% in lambs compared with supplementary mash. Our results are consistent with these reports, possibly because the steam treatment during pelleting gelatinizes starch and improves feed digestibility.

### **3.2 Effects of Diet Type on Slaughter Performance of Fattening Hu Sheep**

Dressing percentage is an important indicator reflecting meat production efficiency in livestock, with higher values indicating greater meat production capacity [11]. Li et al. [11] and Liu et al. [12] reported that TMR feeding significantly improved dressing percentage in lambs compared with traditional diets. Wang et al. [13] demonstrated that pelleted feed increased dressing percentage in fattening lambs. In this study, TMR feeding significantly increased dressing percentage of Hu sheep, while pelleted feed had no significant effect. These differences may be related to uncertain factors such as feed ingredient composition, nutrient levels, feeding methods, and physiological stages [14-16].

Loin eye area is an indicator of carcass quality in meat sheep, with larger areas generally corresponding to greater carcass weight. This study showed that loin eye area of Hu sheep in the TMR and CP groups increased by 12.81% and 16.21% compared with the CK group, respectively, but the differences were not significant. Wang et al. [13] reported that feeding pellets to lambs did not affect loin eye area, while Li et al. [11] found that TMR feeding significantly increased loin eye area in lambs. These discrepancies may be closely related to differences in breed, age, and body weight of the experimental sheep [11].

### **3.3 Effects of Diet Type on Serum Biochemical Indices of Fattening Hu Sheep**

Serum total protein content is typically associated with protein nutritional status, immune function, and growth performance in animals. Increased total

protein content reflects vigorous protein metabolism, which is beneficial for protein absorption and utilization [17]. Studies in ruminants [18-19] have shown that serum total protein content in cattle fed TMR or fine-wool sheep fed pellets was significantly higher than in control groups. Our study found similar results, with serum total protein content in the TMR and CP groups being significantly higher than in the CK group, indicating that TMR and pelleted feed can significantly promote protein anabolism in Hu sheep [19].

Serum urea nitrogen is a byproduct of protein metabolism, and its variation can accurately reflect protein metabolism and dietary amino acid balance status [20]. Urea nitrogen content is negatively correlated with nitrogen retention rate and protein or amino acid utilization efficiency, with lower serum urea nitrogen indicating higher nitrogen metabolism efficiency [21]. Studies have reported that TMR significantly reduced serum urea nitrogen content in meat sheep and dairy cows compared with mash feed [22-23], and pelleted feed significantly reduced serum urea nitrogen content in beef cattle [24]. Our study found similar results, with serum urea nitrogen content in Hu sheep fed TMR or concentrate pellets being significantly lower than in the traditional concentrate and forage group.

Serum total cholesterol is closely related to energy metabolism, and its content can reflect the degree of fat utilization in the body [25]. Wang et al. [26] reported that feeding pelleted diets to sheep resulted in lower blood total cholesterol content than the control group, showing a trend toward improved fat utilization efficiency, though the effect was not significant. Liu et al. [27] found that pelleted feed had little effect on serum total cholesterol content in goats and did not adversely affect lipid metabolism. Our results are consistent with these reports.

### 3.4 Effects of Diet Type on Meat Quality of Fattening Hu Sheep

Meat color is an important indicator for meat quality assessment, determining consumer acceptability. In meat color evaluation, lower  $L^*$  values, higher  $a^*$  values, and lower  $b^*$  values are generally considered indicative of better meat color [28]. Meat color originates from pigments present in muscle, primarily myoglobin, hemoglobin, and trace colored metabolites [29]. Rousset-Akrim et al. [30] found that meat color tended to deepen with increasing carcass weight, but not linearly, and that color changes stabilized when lambs reached a certain age [31]. In this study, no significant differences were observed in  $L$ ,  $a$ , and  $b^*$  values of muscle color between the TMR and CP groups, indicating that the experimental sheep were at a stable physiological stage where different diet types did not significantly affect meat color.

pH has significant effects on meat color, tenderness, and water-holding capacity [32]. Normal muscle pH at slaughter ranges from 6.0 to 7.0 [33]. Lactate production in muscle determines the rate and extent of post-slaughter pH decline, which has special implications for meat processing characteristics. Rapid pH decline ( $\text{pH} < 5.9$ ) results in pale, soft, and exudative (PSE) meat with poor flavor and water-holding capacity, while slow and incomplete pH decline

(pH > 6.0) leads to dark, firm, and dry (DFD) meat that is prone to spoilage. In this study, different diet types did not significantly affect muscle pH, consistent with previous reports [34-35], and all values met fresh meat evaluation standards. However, compared with pH values, both TMR and CP groups showed significant pH decreases at 24 h, approaching 5.0. This may be because post-slaughter cessation of blood circulation places muscle cells in anaerobic respiration, utilizing muscle glycogen to produce lactate while phosphocreatine converts to phosphate, significantly reducing muscle pH. A pH decrease to around 5.0 at 24 h has no major adverse effects on meat quality but rather promotes meat maturation [33].

Water-holding capacity refers to the ability of muscle to retain moisture under external forces such as pressure, heating, freezing, or chopping [36], and significantly affects meat flavor, aroma, nutrient content, juiciness, tenderness, and color. Water-holding capacity is typically expressed as drip loss and cooked meat percentage, with lower drip loss and higher cooked meat percentage indicating better water-holding capacity and meat quality. Liu et al. [12] and Wang et al. [34] reported that drip loss in lambs fed TMR was significantly lower than in the control group, indicating that TMR produced more tender and juicy mutton. However, Wang et al. [13] and Wang et al. [35] found that feeding pelleted diets to fattening lambs or beef cattle had minimal effects on muscle drip loss. Our study found similar results, with TMR feeding significantly reducing drip loss and improving water-holding capacity in Hu sheep lambs, while concentrate pellet feeding showed no significant effect on muscle drip loss.

Muscle tenderness, generally expressed as shear force, is the most commonly used indicator for consumers to judge meat quality [37]. Higher shear force values indicate greater hardness and lower tenderness, and vice versa. Our results showed that feeding TMR significantly improved muscle tenderness in Hu sheep, while the CP group showed intermediate tenderness between the CK and TMR groups without significant differences. This may be because the nutrient levels and feeding method of TMR better meet the muscle growth characteristics of Hu sheep, increasing intramuscular fat deposition and reducing connective tissue content, thereby improving meat tenderness [35,38-39].

#### 4 Conclusion

1. Compared with traditional concentrate and forage diets, feeding TMR and concentrate pellets both significantly increased the average daily gain and reduced the feed-to-gain ratio of fattening Hu sheep.
2. Feeding TMR significantly increased the dressing percentage, improved water-holding capacity, and enhanced muscle tenderness of Hu sheep, with feeding effects superior to those of concentrate pellets.

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