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RESEARCH ARTICLE

## Protein requirements of early-weaned Dorper crossbred female lambs



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### Abstract

The net protein (NP) and metabolizable protein (MP) requirements of Dorper crossbred female lambs from 20 to 35 kg body weight (BW) were assessed in a comparative slaughter trial. Thirty-five Dorper×thin-tailed Han crossbred lambs weaned at approximately 50 d of age ((19.1±2.37) kg of BW) were used. Seven randomly selected lambs were slaughtered at the beginning of the trial as baseline group (BL). An intermediate group of seven randomly selected lambs fed *ad libitum* (AL) intake was slaughtered when the lambs reached an average BW of 28.6 kg. The remaining 21 lambs were allotted randomly to three levels of dry matter intake: AL or restricted to 70 or 40% of the AL intake. All lambs were slaughtered when the sheep fed AL intake reached 35 kg of BW. Total body N and N retention were determined. The results showed that the maintenance requirements for NP and MP were 1.75 and 3.37 g kg<sup>-1</sup> metabolic shrunk body weight (SBW<sup>0.75</sup>), respectively. The partial efficiency of protein use for maintenance was 0.52. The NP requirements for growth ranged from 10.9 to 42.4 g d<sup>-1</sup> for the lambs gaining 100 to 350 g d<sup>-1</sup> from 20 to 35 kg BW. The partial efficiency of MP for growth was 0.52. In conclusion, the NP and MP requirements for the maintenance and growth of Dorper crossbred female lambs were lower than those reported by AFRC (1993) and NRC (2007) recommendations.

**Keywords:** growth, maintenance, metabolizable protein, net protein, lamb

## 1. Introduction

At present, several feeding systems, such as Agricultural and Food Research Council (AFRC 1993), Commonwealth

Scientific and Industrial Research Organisation (CSIRO 2007), and National Research Council (NRC 2007) have reported protein and other nutrient requirements for sheep, which are widely adopted for diet formulation around the world. In the intensive livestock industry, protein is commonly the most expensive feed component and therefore, it is necessary to have a precise understanding of protein requirements of livestock not only to ensure farm profitability, but also to help reduce nitrogen (N) emission to the environment (Ma *et al.* 2016). The current nutritional systems for sheep specify protein requirements as metabolizable protein (MP), which is defined as the total digestible true protein (amino acids) available to the animal for metabolism

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after digestion and absorption of the feed in the animal's digestive tract (AFRC 1993).

China has the largest sheep and goat population (approx. 300 million) in the world and 15 autochthonous sheep breeds (Tu 1989), among which the thin-tailed Han sheep is one of the most famous native breeds. It displays excellent characteristics of high prolificacy, as it carries mutations in both the *BMPR-1B* and *BMP15* genes; therefore, it has a greater litter size (2.61) than those with either mutation alone (Chu et al. 2007). In recent years, the Dorper sheep was imported to improve meat production traits and thus, the Dorper×thin-tailed Han crossbreed has become one of the most important sheep breeds for dual purposes.

Our research team conducted a systematic study on the nutrient requirements (energy, protein, and minerals) of fattening Dorper×thin-tailed Han sheep using a comparative slaughter technique (Deng et al. 2012, 2014; Xu et al. 2015; Ma et al. 2016). In this paper, we reported the protein requirements of female lambs after weaning with body weights (BW) ranging from 20 to 35 kg, with an aim to provide knowledge of the protein requirements of Dorper crossbred lambs.

## 2. Materials and methods

The research was conducted from March to June 2011 at the Experimental Station of the Chinese Academy of Agricultural Sciences (CAAS), Nankou (40°22'N, 116°1'E), Beijing, China. The mean minimum and maximum room temperatures observed during the experimental period were 6.0 and 20.0°C (average 13.0°C), respectively. The experimental protocol was approved by the CAAS Animal Ethical Committee, and humane animal care and handling procedures were followed throughout the experiment.

### 2.1. Comparative slaughter trial

Thirty-five Dorper×thin-tailed Han crossbred female lambs weaned at approximately 50 d of age with (20.4±2.15) kg of BW were used in a completely randomized design to measure protein requirements for maintenance and growth. The experimental diet with a concentrate-to-forage ratio of 44:56 on a dry matter (DM) basis was formulated according to the NRC (2007). The diet was pelleted to prevent possible selectivity and waste for accurate measurements of feed intake. The ingredient and chemical compositions of the diet are shown in Table 1. The lambs with *ad libitum* (AL) intake were fed once daily at 0800 h and allowed 10% of orts. The amount of feed provided to the restricted feed intake groups was adjusted daily based on the average DM intake of the AL group from the previous day. Feed and orts

**Table 1** Ingredient and chemical compositions of the pelleted mixture diet

| Items <sup>1)</sup>                      | Value |
|--|-------|
| Ingredients (DM basis)                   |       |
| Milled Chinese wildrye hay (%)           | 55.0  |
| Cracked corn grain (%)                   | 29.4  |
| Soybean meal (%)                         | 14.0  |
| Dicalcium phosphate (%)                  | 0.86  |
| Salt (%)                                 | 0.50  |
| Mineral/Vitamin premix (%) <sup>2)</sup> | 0.24  |
| Chemical composition                     |       |
| ME (MJ kg <sup>-1</sup> DM)              | 8.89  |
| DM (% as fed)                            | 95.5  |
| CP (% of DM)                             | 11.9  |
| EE (% of DM)                             | 2.71  |
| Ash (% of DM)                            | 6.32  |
| NDF (% of DM)                            | 40.9  |
| ADF (% of DM)                            | 15.2  |
| Calcium (% of DM)                        | 0.68  |
| Phosphorus (% of DM)                     | 0.33  |

<sup>1)</sup> DM, dry matter; ME, metabolizable protein; CP, crude protein; EE, ether extract; NDF, neutral detergent fibre; ADF, acid detergent fibre.

<sup>2)</sup> Manufactured by Precision Animal Nutrition Research Centre, Beijing, China. The premix contained (per kg): 113.7 g FeSO<sub>4</sub>·7H<sub>2</sub>O, 5.62 g CuSO<sub>4</sub>, 27.0 g MnSO<sub>4</sub>, 66.9 g ZnSO<sub>4</sub>, 0.42 g Na<sub>2</sub>SeO<sub>3</sub>, 1.66 g Ca(IO<sub>3</sub>)<sub>2</sub>, 0.36 g CoCl<sub>2</sub>·6H<sub>2</sub>O, 3.2 g vitamin A, 0.8 g vitamin D<sub>3</sub>, and 0.4 g vitamin E.

were sampled daily and frozen at -20°C until the analyses.

A comparative slaughter trial was conducted, as described by Xu et al. (2015). Briefly, the initial body composition was measured on seven lambs slaughtered at 20 kg BW (baseline group). An intermediate slaughter group with seven randomly selected lambs fed AL were slaughtered when they reached 28.6 kg BW. The remaining 21 lambs were randomly assigned to three levels of DM intake: AL or restricted to either 70 or 40% of the AL intake. Thus, the lambs were pair-fed in seven slaughter groups, with each group consisting of one lamb from each level of intake. When the lambs fed AL of each slaughter group reached 35 kg BW, all three lambs within a slaughter group were fasted and slaughtered. All lambs were slaughtered by exsanguination after stunning by CO<sub>2</sub> inhalation. Blood, carcass, head, feet, hide, wool, viscera, and adipose tissue removed from the internal organs were weighed. The empty body weight (EBW) was calculated by subtracting the weight of the digestive tract contents from the shrunk body weight (SBW), which was measured as BW after a 16-h fast of feed and water. Carcasses and heads were split longitudinally into two identical halves and the muscle, bone, and fat were dissected from the right-half carcass, head, and feet, while the whole hide and whole viscera were ground and homogenized separately and frozen at -20°C until the analyses. Wool was clipped with electrical clippers after slaughter, and subsamples were collected and stored at 4°C.

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