Small Ruminant Research 109 (2013) 107–112

Contents lists available at SciVerse ScienceDirect

Small Ruminant Research

journal homepage: www.elsevier.com/locate/smallrumres

Body composition and net energy requirements for Santa Ines lambs

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ARTICLE INFO

Article history:
Received 7 April 2011
Received in revised form 11 July 2012
Accepted 15 July 2012
Available online 14 August 2012

Keywords:
Growth
Hair
Maintenance
Wool

ABSTRACT

A comparative slaughter trial was conducted on 24 non-castrated Santa Ines lambs (initial body weight 13.00 ± 0.56 kg) to determine their net energy requirements for growth and maintenance. Four animals were slaughtered at the start of the trial, as a reference group, in order to estimate the initial empty body weight (EBW) and body composition. The remaining animals were assigned to a randomized block design, with five replications per block, and four diets with increasing metabolizable energy contents (2.08, 2.28, 2.47 and 2.69 Mcal/kg DM). Non-linear regression analysis was used to describe heat production as a function of metabolizable energy intake; the net energy requirement for maintenance (kcal/EBW$^{0.75}$/d) was estimated by extrapolation when MEI was set at zero. Regression equations of logarithms of body fat and body energy were then fitted onto the EBW logarithm. The derivatives of these equations allowed estimates of the fat content of the empty body weight gain (EBWG), and the net energy requirement for EBWG, respectively. The net energy requirement for maintenance obtained was 61.50 ± 4.56 kcal/EBW$^{0.75}$/day. The energy and fat contents of the EBW of the animals increased from 1.91 Mcal/kg and 85.16 g/kg of EBW, respectively, to 2.78 Mcal/kg and 221.23 g/kg, as the BW increased from 15 to 30 kg. The net energy requirements for EBWG also increased, from 2.94 to 4.28 Mcal/EBWG, for body weights of 15 and 30 kg, respectively. There was no indication of a reduced value for the net energy requirement for maintenance of Santa Ines hair sheep, when compared with the values recommended by the major systems of nutrient requirements and feed evaluation.

1. Introduction

Variations in the energy requirements of small domestic ruminants occur mainly as a result of differences between species, physiological conditions, age, gender, physical activity, environmental temperature and genotype (NRC, 2007). However, variations between breeds have been the main focus of several studies performed in recent years (Silva et al., 2003, 2007; Galvani et al., 2008, 2009). Differences in nutritional requirements between breeds of sheep may be due to the presence of hair versus wool coats. The major systems of nutritional requirements and food assessment used in the world are based on data from wool sheep, which may be different in terms of their nutritional requirements.

The Santa Ines hair sheep, originally from semiarid regions of Brazil, is used as a terminal breed. It is the main Brazilian breed for meat production, and it is located mainly on the northeast region, presenting mature weight between 40 and 50 kg. The absence of specific adjustment store commendations from the international committees with regard to hair sheep have led to a bias in the productive responses (Resende et al., 2008). In addition to the difference described above, the climatic conditions where

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0921-4488/$ – see front matter © 2012 Published by Elsevier B.V.
http://dx.doi.org/10.1016/j.smallrumres.2012.07.011

Table 1
Ingredients and chemical composition of the experimental diet.

Ingredient	Levels of metabolizable energy (Mcal/kg DM)			
	2.08	2.28	2.47	2.69
Tifton-85 hay	75.0	62.5	50.0	37.5
Concentrate	25.0	37.5	50.0	62.5
Ground corn[a]	77.9	77.6	77.4	77.4
Soybean meal[a]	20.0	20.0	20.2	20.0
Urea[a]	0.9	1.2	1.2	1.3
Limestone[a]	0.0	0.3	0.3	0.6
Dicalcium phosphate[a]	0.3	0.3	0.3	0.3
Salt[a]	0.9	0.6	0.4	0.4
Premix[a,b]	0.1	0.0	0.1	0.1
Nutrient (%DM)				
Dry matter	92.1	91.8	91.8	91.2
Ash content	5.4	5.2	4.8	4.6
Crude protein	12.7	14.4	16.0	17.7
Ether extract	1.5	2.1	2.9	3.0
aNDFom	54.5	47.6	41.3	33.9
Total carbohydrate	80.3	78.3	76.3	74.8
Non fiber carbohydrate	25.9	30.7	35.1	40.9
Total digestible nutrient	57.4	63.1	68.4	74.5

[a] Ingredients in concentrated portion of the diets.
[b] Composition: Ca 7.5%; P 3%; Fe 16.500 ppm, Mn 9.750 ppm, Zn 35.000 ppm, I 1.000 ppm, Se 225 ppm, Co 1.000 ppm.

these animals were selected may influence their nutritional requirements, due to heat stress, and possibly to adaptations to their semiarid conditions. For that reason, the database for hair sheep needs to be extended.

Therefore, this study was developed with the aim of determining the body composition and net energy requirements for maintenance and weight gain in growing Santa Ines lambs fed diets offering different levels of energy.

2. Materials and methods

The experiment was carried out at the Animal Laboratory of the Department of Animal Science of the Federal University of Ceara (UFC) in Fortaleza, CE, Brazil. Humane animal care and handling procedures were followed according to the guidelines of the university's animal care committee.

2.1. Animals, diets and experimental procedures

Twenty-four non-castrated Santa Ines lambs, initial body weight (BW) 13.00 ± 0.56 kg, at about 50 days of age, were used. First, the animals were identified, deformed and placed in individual stalls (1.5 m × 1.5 m) with feeding troughs to supply the diets and water. After an adaptation period of ten days, four animals were randomly selected and slaughtered to serve as a reference group for the initial empty body weight (EBW) and initial body composition of the other animals. The remaining lambs ($n = 20$) were separated according to body mass classes, and this parameter was used to determine the blocking criteria. Four treatments consisting of increasing levels of metabolizable energy (2.08, 2.28, 2.47 and 2.69 Mcal/kg MS) and crude protein (12.7, 14.4, 16.0 and 17.7%DM) obtained from different roughage: concentrate ratios (75:25, 62.5:37.5, 50:50, 37.5:62.5) were randomized to the experimental units. Diets were formulated to maintain the same ratio of energy/protein, and to avoid excess nitrogen from the rumen when feeding diets with low fermentable carbohydrate, as well as nitrogen deficits in diets with high fermentable carbohydrate. The experimental diets consisted of Tifton-85 hay, ground corn, soybean meal, urea, limestone, dicalcium phosphate, salt and premix (Table 1).

Animals were fed once daily at 0700 h with ad libitum intake as a total mixed ration, allowing for up to 20% of orts. Feeds and orts were sampled and frozen for subsequent chemical analysis.

Animals were weighed weekly to follow their body weight gain (BWG); when the mean BW of the treatment reached 28 kg, the animals were slaughtered. On this occasion, one animal from the group with the lowest energy concentration was also slaughtered (animals receiving the diet with 2.08 Mcal/kg DM of ME). This procedure was carried out for each group until all the animals had been slaughtered.

2.2. Slaughter procedures

Before slaughter, shrunk body weight (SBW) was measured as the BW after 18 h without food or water. At slaughter, lambs were stunned using a cash knocker and killed by exsanguination. Blood was weighed and sampled. The gastrointestinal tract was washed, and after draining weighed with other organs (liver, heart, trachea + lungs + tongue + esophagus, bladder, kidneys, reproductive tract and spleen), body parts (carcass, head, blood and hooves), and adipose tissues (omental, perirenal and mesenteric). Skin was weighed and sampled at slaughter and frozen. The carcass was split into two identical longitudinal halves.

All body components were initially frozen at −6 °C, then cut into small pieces, ground with a large screw grinder through a plate with 0.32 cm holes, and mixed by two additional passes through the grinder. After grinding, carcass and organ mixtures, homogenates and samples were collected and frozen. Empty BW (EBW) was defined as SBW at slaughter minus digestive tract contents.

2.3. Digestion trial

A digestion trial was conducted in parallel with the comparative slaughter trial. Sixteen non-castrated Santa Ines lambs (BW, 28 kg) were used, distributed in a randomized block design (body mass class) with four treatments (experimental diets) and four replicates. Lambs were placed in metabolic cages to determine the total digestible nutrients and metabolizable energy of the experimental diets. The experiment lasted 17 days, with ten days of adaptation to the diets and cages, and seven days of total collection. All samples were frozen at −20 °C.

The TDN was calculated according to Weiss (1999): $TDN = CP_d + NFC_d + aNDFom_d + EE_d \times 2.25$ (subscript means digestible). The digestible energy (DE) of the diets was estimated as 4.409 Mcal/kg of TDN consumed, and DE was converted to metabolizable energy using an efficiency of 82% (NRC, 2007).

2.4. Chemical analysis

Feeds, recomposited refuse and feces samples were dried at 55 °C for 72 h, in a forced air oven, then ground in a knife mill with a 1 mm screen (Wiley mill, Arthur H. Thomas, Philadelphia, PA, USA). The samples were analyzed for dry matter (DM; AOAC, 1990, method number 930.15), ash content (Ash; AOAC, 1990, method number 924.05), crude protein (CP; AOAC, 1990, method number 984.13), ether extract (EE; AOAC, 1990; method number 920.39) and organic neutral detergent fiber with thermostable alpha amylase and without sodium sulfite (aNDFom). Table 1 shows the chemical composition of the diets.

Body components were dried at 55 °C for 72 h, in a forced air oven. After this procedure, the samples were analyzed for dry matter contents (DM; AOAC, 1990; method number 930.15) and later defatted by extraction with ether in a Soxhlet apparatus (AOAC, 1990; method number 920.39). After ether extraction, the samples were ground in the ball mill and analyzed for crude protein (CP; AOAC, 1990; method number 984.13) and ash content (Ash; AOAC, 1990; method number 924.05).

2.5. Energy calculations

The body contents of fat (BCF) and protein (BCP) were determined according to their percentages in empty body. The body contents of energy (BCE) were obtained according to the equation (Eq. (1)) (ARC, 1980):

$$\mathrm{BCE\,(Mcal)} = 5.6405\,(\mathrm{EBP, kg}) + 9.3929\,(\mathrm{EBF, kg}) \quad (1)$$

The net energy requirement for empty body weight gain (EBWG) was calculated using the methodology described by ARC (1980), where we obtained an ordinary least square linear regression between the logarithm of energy (Mcal) and fat (g) body contents versus the logarithm of empty bodyweight (kg) (Eq. (2)).

$$\log Y = a + b \times \log \mathrm{EBW} \quad (2)$$