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Short communication

Protein and energy requirements of castrated male Saanen goats

Angela Cristina Dias Ferreira, Enrique Alejandro Yáñez, Ariosvaldo Nunes de Medeiros, Kleber Tomas de Resende, J.M. Pereira Filho, Márcia Helena Machado da Rocha Fernandes, Amélia Katiane Almeida, Izabelle Auxiliadora Molina de Almeida Teixeira *

UNESP, Univ Estadual Paulista, Department of Animal Science, Jaboticabal, SP 14884-900, Brazil

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ABSTRACT

A comparative slaughter trial was conducted to determine the energy and protein requirements for growth of castrated male Saanen goats weighing from 20 to 35 kg body weight (BW). Regarding maintenance requirements, 36 castrated male Saanen goats with an initial BW of 20.7 ± 0.5 kg, and aged 3.3 ± 0.6 months, were used. Nine animals were randomly chosen and slaughtered at the beginning of the experimental phase (BW of 21.0 ± 0.4 kg), representing the baseline (BL) group. The 27 remaining castrated male goats were pair-fed into nine groups (blocks) of three animals each, fed either *ad libitum* or restricted to 30 or 60% of *ad libitum* intake. A group was slaughtered when the animal fed *ad libitum* reached 35 kg BW. Regarding requirements for gain, 27 castrated male Saanen goats were fed *ad libitum* and nine were slaughtered at 21.0 ± 0.4 kg BW, nine at 27.7 ± 0.5 kg BW and nine at 35.1 ± 0.3 kg BW. The BL and *ad libitum*-fed animals used to determine maintenance requirements were also used to estimate gain requirements. The net energy (NE) requirement for maintenance was 261.5 kJ/kg$^{0.75}$ BW. The metabolizable energy (ME) requirement for maintenance was 404.2 kJ/kg$^{0.75}$ BW; therefore, the partial efficiency of use of ME for NE was 0.65. The minimal endogenous N losses were 262 ± 48.4 mg N/kg$^{0.75}$ empty BW (EBW), corresponding to a net protein requirement for maintenance of 1.39 ± 0.257 g/kg$^{0.75}$ BW. The net energy for gain increased by approximately 40% (from 12 to 17 MJ/kg EBW gain) and the net protein for gain slightly decreased by 3% (from 166 to 160 g/kg EBW gain) as the BW increased from 20 to 35 kg. Our study contributes to the improvement of goat nutrition because it provides estimates of the protein and energy requirements of castrated male Saanen goats.

1. Introduction

The National Research Council (NRC, 2007) has recommended different energy and protein requirements for the growth of goats according to their productive purpose (dairy, meat and indigenous biotypes). This recommendation was based on studies using empirical models to assess the requirements by regressing intake of metabolizable energy or protein against response, such as body weight

* Corresponding author at: Faculdade de Ciências Agrárias e Veterinária – UNESP, Via de acesso Prof. Paulo Donato Castellane s/n, CEP 14884-900 Jaboticabal, Brazil. Tel.: +55 16 3209 7437; fax: +55 16 3209 2682.
E-mail address: izabelle@fcav.unesp.br (I.A. Molina de Almeida Teixeira).

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change (Sahlu et al., 2004). Because the nutritional requirements for gain are directly related to body composition, Lofgreen and Garrett (1968) proposed the comparative slaughter technique, which can address net requirements and is largely used to establish nutritional guidelines for cattle (NRC, 2000); however, few studies with goats have utilized this method (Fernandes et al., 2007; Bompadre et al., 2014).

As an economic activity, goat production aims to maximize efficiency and profitability. In a dairy herd, the castration of male goats is a common management practice for preventing inbreeding, avoiding unwanted pregnancies, reducing gamey flavor and enhancing farm profitability by selling goat meat. In addition to sanitary and reproductive management, an adequate nutritional program helps animals convert nutrients into meat more efficiently, which avoids economic losses and reduces environmental impact.

Castration has been reported to greatly influence the proportion of muscle, fat and bone in the carcass, which will affect the total nutritional requirements. However, the effect of castration on total fat content has not been consistent in goats. Body fat of castrated male goats were either higher (Ruvuna et al., 1992; Zamiri et al., 2012), unchanged (Tahir et al., 1994) or lower (Koyuncu et al., 2007) compared to intact male goats. NRC (2007) assumed that castrated males and females have similar requirements, different from those of intact males; however this difference was based on experiments with beef cattle (NRC, 2000). In addition, Luo et al. (2004a,b), on which studies NRC (2007) was based, stated that the gender effect on requirements for goats is still unclear.

Therefore, a comparative slaughter trial was carried out to determine the energy and protein requirements for the growth of castrated male Saanen goats weighing from 20 to 35 kg body weight (BW). Our results will directly assist farmers to formulate optimal diets for castrated male goats to maximize profitability of goat production and also can contribute to improve the database of future feeding systems.

2. Materials and methods

The experiment was conducted at the Goat Facility of Univ Estadual Paulista/Jaboticabal (UNESP, Sao Paulo, Brazil). Humane care and handling procedures were conducted in accordance with the University's Animal Care Committee (Comissão de Etica e Bem Estar Animal – CEBEA) under protocol number 004972-09.

2.1. Requirements for maintenance

2.1.1. Animals and management

Thirty-six castrated male Saanen goats with an initial BW of 20.7 ± 0.5 kg, and aged 3.3 ± 0.6 months, were used. Animals were surgically castrated on the second week of life. Nine animals were randomly chosen and slaughtered at the beginning of the experimental phase (BW of 21.0 ± 0.4 kg), representing the initial body composition or baseline (BL) group. The 27 remaining castrated male goats were randomly assigned into 9 groups (blocks) of 3 animals according to treatments defined based on the dry matter intake (DMI): *ad libitum* or restriction to 30 or 60% of *ad libitum* intake. The daily intake of the restricted-fed animals within a group was determined by the DMI of the animal fed *ad libitum* within the same group on the previous day. Each group was slaughtered when the animal fed *ad libitum* in the group reached 35 kg BW. Animals were weighted weekly during the experimental period and daily when target BW was approaching.

During the experimental phase, the animals were individually housed in 1-m^2 pens that were protected from rain and wind with free access to fresh water. The experimental diet (Table 1) was formulated to meet the nutritional requirements according to the AFRC standard (1998) for a gain of 150 g/day (d) and consisted of dehydrated corn (*Zea mays*) (Fernandes et al., 2007), cracked corn grain, soybean (*Glycine max*) meal, molasses, soybean oil, limestone and mineral supplement. The diet was provided twice a day (8.00 and 15.00 h), and the orts were removed prior to morning feeding, weighed, sampled and further analyzed.

2.1.2. Metabolism essay

When castrated male goats fed *ad libitum* reached 29.5 ± 0.6 kg BW, a metabolism assay was carried out to determine the digestible energy (DE), metabolizable energy (ME), energy metabolisability of the diet (q) and digestibility coefficient of nutrients using 18 animals separated into six groups with three animals, one of which was allocated to a level of intake (*ad libitum* or restricted to 30 or 60% of *ad libitum* intake), during 5 d after a 3-d adaptation period to the metabolic cages. These animals were part of those used for estimation of maintenance requirements. The animals were individually housed in metabolic cages in a randomized complete block design. The feed, orts, feces and urine were collected daily for 5 d, and a 10% sample was collected and stored at −20 °C. The urine was acidified daily with 20 mL of 6 *M* (6 N) HCl. The feed, orts and feces samples were dried at 60 to 65 °C for 72 h and ground through a 1-mm screen using a Wiley mill. The urine samples were filtered through a sieve. The energy losses by gas production were estimated according to Blaxter and Clapperton (1965).

2.1.3. Slaughter procedures and body composition

The BW was measured immediately before feed and water were withdrawn. Shrunk BW (SBW) was measured immediately before slaughter. At slaughter, the animals were stunned and killed by exsanguination using conventional humane procedures. The blood was weighed and sampled. The gastrointestinal tract was weighed, cleaned and weighed again to obtain the empty body weight (EBW), which was computed as the SBW minus the digestive tract content. The empty whole body was initially frozen at −6 °C and then cut into small pieces that were ground with a large screw grinder through a plate with 0.32-cm holes. After grinding and homogenization, the samples were collected, frozen again, and freeze-dried to determine the dry matter (DM). These samples were further analyzed for fat, protein, ash and gross energy (GE) contents.

2.1.4. Laboratory analyses

The feed ingredients, orts, feces, urine and body were analyzed for DM content (AOAC, 1997; method number 930.15), fat (by loss in weight of the dry sample upon extraction with petroleum ether in a Soxhlet extraction apparatus for 6 h; AOAC, 1997; method number 930.39), protein (N analysis *via* Dumas combustion using LECO FP-528 LC (Etheridge et al., 1998)), ash (complete combustion in a muffle furnace at 600 °C for 6 h; AOAC, 1997; method number 924.05) and GE using a bomb calorimeter (Parr Instrument Co., Moline, IL). The feed ingredients, orts and feces were also analyzed for neutral detergent fiber with amylase and without sulphite (Mertens, 2002) and acid detergent fiber (ADF; AOAC, 1997, method number 973.18).

2.1.5. Calculation of initial body composition

The initial empty body composition (fat, protein and energy) of the animals slaughtered at the end of experiment was estimated from the BL group, using the relationship between body composition and EBW of these animals. The initial EBW of the animals slaughtered at the end of experiment was computed from the SBW (Eq. (1), R^2 = 0.60; residual standard deviation (RSD) = 0.41; P = 0.01).

$$\text{EBW, kg} = -1.85(\pm 5.73) + [0.93(\pm 0.28) \times \text{SBW, kg}] \quad (1)$$

where EBW is empty body weight and SBW is shrunk body weight.

The initial empty body protein (Eq. (2), R^2 = 0.65, RSD = 0.01, P = 0.008) and energy (Eq. (3), R^2 = 0.42; RSD = 0.039, P = 0.05) were estimated as follows:

$$\text{Log protein, g} = 2.28(\pm 0.33) + [0.97(\pm 0.27) \times \text{Log EBW, kg}] \quad (2)$$

$$\text{Log energy, kJ} = 2.69(\pm 1.06) + [1.97(\pm 0.87) \times \text{Log EBW, kg}] \quad (3)$$