

Efficiency of energy use for pregnancy by meat goat does with different litter size

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Abstract

Twenty-four Boer × Spanish does (3 years of age, having kidded once previously and with an initial BW of 42.7 ± 1.2 kg) were used to determine the efficiency of ME utilization for pregnancy (k_{preg}). Six does were nonpregnant and, based on ultrasound determination on day 45 of gestation, six had a litter size (LS) of 1, 2, and 3. However, only 10 of the pregnant does delivered the expected number of kids (3, 4, and 3 with LS of 1, 2, and 3, respectively). Does were fed a diet of approximately 50% concentrate in accordance with assumed maintenance plus pregnancy energy requirements based on estimated nonpregnancy tissue BW and LS. Recovered energy (RE) was determined by subtraction of energy expenditure (EE; respiration calorimetry) near days 80, 100, 120, and 140 of gestation from ME intake (MEI). RE was assumed attributable to pregnancy tissues (fetus, fetal fluids and membranes, uterus, and mammary gland), and ME used for pregnancy (ME_{preg}) was estimated by subtracting ME_{m} determined with nonpregnant goats from MEI by those pregnant. For does with actual LS equal to that expected, the no-intercept equation for the regression of RE against ME_{preg} was: $\text{RE} = \text{ME}_{\text{preg}} \times 0.252$ (S.E. = 0.030; $R^2 = 0.64$), indicating a k_{preg} of 25%. A regression including LS (1 versus 2 or 3) suggested greater k_{preg} for LS of 1 ($40.2 \pm 5.6\%$) versus 2 or 3 ($20.5 \pm 3.2\%$). Regressions for goats with LS different from expected suggested positive effects of use of energy mobilized from nonpregnancy tissues on k_{preg} and of use of dietary ME for energy accretion in nonpregnancy tissues on the efficiency of whole body ME utilization. In conclusion, the average efficiency of ME use for pregnancy regardless of LS in goats was near 25%, which when considering the expected proportion of all pregnancy tissues attributable to fetal or conceptus tissues implies an energy requirement for pregnancy of goats similar to common recommendations for sheep and cattle.

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1. Introduction

The energy requirement for pregnancy represents a considerable proportion of total needs of reproducing ruminants. Though the efficiency of ME use for true fetal growth is not markedly different from that for gain by growing ruminants (Bell, 1986), with consideration of

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ME use for maintenance and development of all tissues involved in pregnancy the efficiency of energy use is quite low (ARC, 1980; Bell, 1993).

NRC (1981) recommended an additional 318 kJ/kg BW^{0.75} of ME in the last 2 months of gestation for goats, and a 20% increase was proposed for multiple births. AFRC (1998) based pregnancy ME requirements of goats on a k_{preg} of 13.3% (ARC, 1980), sheep tissue composition data, mean birth weights from dairy and fiber-producing goat kid data sets, and use of a Gompertz equation. NRC (1985) recommendations for the net energy requirement of pregnancy of sheep were based on reports of Rattray et al. (1974b) for the gravid uterus (plus contents) and mammary gland. CSIRO (1990) predicted a ME requirement for maintenance and development of the gravid uterus for cattle, sheep, and goats with a Gompertz model adapted from that of ARC (1980). Sahlu et al. (2004) proposed a system to predict the ME requirement for pregnancy (ME_{preg}) of goats in late gestation, based on Eq. II of Koong et al. (1975) developed for sheep to predict fetal weight at different days of gestation, sheep data of Rattray et al. (1974b) to predict total energy and protein in all pregnancy tissues, including the mammary gland, and a k_{preg} of 13.3% (ARC, 1980).

In contrast to the findings outlined above, Voicu et al. (1993) reported a higher efficiency of ME use for growth of the fetus and fetal membranes of goats of 21%. Furthermore, based on these data Drochner et al. (2003) proposed an efficiency of ME use for conceptus growth of 30%. In this regard, because of the small number of studies with goats and some ME_{preg} recommendations based on data from other ruminant species, this experiment was conducted to evaluate effects of litter size on the efficiency of energy utilization for pregnancy in meat goats.

2. Materials and methods

2.1. Animals and diet

Twenty-four Boer × Spanish does, 3 years of age and having kidded once previously, were used in the study, with 18 pregnant and 6 nonpregnant. Initial BW on day 64 of gestation was 42.7 ± 1.2 kg. Based on an ultrasound determination at approximately 45 days of gestation, there were 6 does each with 0, 1, 2, and 3 fetuses. On day 64, does were placed in 1.05 m × 0.55 m elevated pens with plastic-coated expanded metal floors and nipple waterers, where they resided at times other than during nutrient balance and gas exchange determinations. Does were allocated to six sets, each consisting of one doe expected to have a litter size (LS) of 0, 1, 2, and 3.

Table 1

Composition of the diet fed to pregnant meat goat does

Item	DM (%)	ME concentration (MJ/kg); NRC (1981)
Ingredient		
Cottonseed hulls	35.63	6.82
Ground alfalfa hay	15.10	9.08
Ground corn	21.16	13.47
Soybean meal	21.14	13.31
Molasses	2.10	11.97
Dried molasses product	2.63	9.57
Dicalcium phosphate	1.12	
Vitamin premix ^a	0.56	
Trace mineralized salt ^b	0.56	
Chemical composition		
Ash	6.5	
CP	18.5	
NDF	44.0	

^a Contained 2200 IU/g Vitamin A, 1200 IU/g Vitamin D₃, and 2.2 IU/g Vitamin E.

^b Contained 95–98% NaCl and at least 0.24% Mn, 0.24% Fe, 0.05% Mg, 0.032% Cu, 0.011% Co, 0.007% I, and 0.005% Zn.

On days 70, 92, 113, and 132 of gestation, doe sets were moved sequentially to metabolism crates equipped with head-boxes similar to those used later for gas exchange measurement, with water available at all times.

An approximately 50% concentrate diet (Table 1) was fed twice daily at 08:00 and 15:00 h. Nonpregnant does were offered an amount of feed adequate for maintenance (ME_m), which was assumed 438 kJ/kg BW^{0.75} (AFRC, 1998). The dietary ME concentration assumed, based on ingredient proportions and ME concentrations of NRC (1981), was 10.0 MJ/kg DM. Pregnant does were also fed at this level of intake from days 64 to 90 of gestation. On days 91, 101, 111, 121, and 131 of gestation, the level of intake was increased in accordance with assumed LS and requirements for pregnancy described by Sahlu et al. (2004), which were based on predicted birth weights, the Eq. II sheep fetal growth curve of Koong et al. (1975), and mass and composition of sheep pregnancy tissues (fetus, fetal fluids and membranes, uterus, and mammary gland) on different days of gestation of Rattray et al. (1974b). However, only 10 of the pregnant does had the expected LS (3, 4, and 3 with LS of 1, 2, and 3, respectively). Five does had less kids than expected and, thus, were fed more than desired, and three does had a greater number of kids than assumed and were fed less than assumed required.

2.2. Nutrient balance

Feces and urine were collected four times during the gestation period over 6-day periods of days 75–80,

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