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Partitioning of late gestation energy expenditure in ewes using indirect calorimetry and a linear regression approach

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Abstract
Late gestation energy expenditure (EE\textsubscript{gest}) originates from energy expenditure (EE) of development of conceptus (EE\textsubscript{conceptus}) and EE of homeorhetic adaptation of metabolism (EE\textsubscript{homeorhetic}). Even though EE\textsubscript{gest} is relatively easy to quantify, its partitioning is problematic. In the present study metabolizable energy (ME) intake ranges for twin-bearing ewes were 220 – 440, 350 – 700, 350 – 900 kJ per metabolic body weight (W\textsuperscript{0.75}) at week seven, five, two \textit{pre-partum} respectively. Indirect calorimetry and a linear regression approach were used to quantify EE\textsubscript{gest} and then partition to EE\textsubscript{conceptus} and EE\textsubscript{homeorhetic}. Energy expenditure of basal metabolism of the non-gravid tissues (EE\textsubscript{bmng}), derived from the intercept of the linear regression equation of retained energy [kJ/W\textsuperscript{0.75}] and ME intake [kJ/W\textsuperscript{0.75}], was 298 [kJ/W\textsuperscript{0.75}]. Values of the intercepts of the regression equations at week seven, five, and two \textit{pre-partum} were 311, 398, and 451 [kJ/W\textsuperscript{0.75}], respectively. The difference between the intercepts for different weeks was used to calculate EE\textsubscript{homeorhetic}. The remaining part of EE\textsubscript{gest} was considered to be EE\textsubscript{conceptus}. In conclusion, the good agreement between our values of EE\textsubscript{conceptus} and those in the literature indicates the method’s validity.

Keywords: Energy expenditure, gestation, gravid tissues, indirect calorimetry, ovine

1. Introduction
Increased energy expenditure during late gestation (EE\textsubscript{gest}) originates partly from the energy expenditure required for the maintenance and growth of conceptus (EE\textsubscript{conceptus}) (Graham 1964; Langlands & Sutherland 1968; Rattray et al. 1974a) and partly from increased metabolism in the non-gravid tissues linked with the homeorhetic adaptation of metabolism. The latter includes the regulation of nutrient partitioning and metabolism during pregnancy (Bell 1995; Bell & Bauman 1997; Bauman 2000) as well as increased metabolic work in different maternal organs, such as the liver (Freely & Ferrell 1997), heart (Rosenfeld 1977), and mammary gland (Rosenfeld 1977). Energy expenditure associated with this is here
Partitioning energy expenditure in ewes

2. Materials and methods

2.1. Experimental animals and feeding

Twenty twin-bearing Shropshire ewes aged 3 – 4 years were used in the experiment. The ewes grazed on a grass field during the first and second trimesters of gestation, and thereafter were shorn and kept indoors. All ewes were fed hay silage (Table I) *ad libitum* for two weeks to adapt to the ration, and then at approximately maintenance level for weeks eight and seven pre-partum. During the last six weeks of gestation, half of the ewes were adequately fed (group A) according to the National Research Council (NRC 1985) on a diet containing hay silage, barley (200 g·d⁻¹), and a protein supplement (Table I). The protein supplement was adjusted weekly, increasing from 25 g·d⁻¹ to 200 g·d⁻¹ over the last six weeks of gestation in the group A. The restricted group (R) was fed restrictedly in late pregnancy, receiving only hay silage equivalent to 60% of their energy and protein requirements until the day of parturition. The rations for individual ewes were adjusted weekly based on the body weight of the ewe in accordance with NRC (1985). All animals had free access to water, and feed was offered in two equal amounts at 10:00 and 15:00 h. Body weight was recorded weekly. All ewes were kept in the same stable (temperature 8 – 14 °C, humidity 75 – 85%) except when placed in metabolic cages (59 cm wide, 160 cm long and 80 cm high) for balance trials. All experimental procedures complied with the guidelines of and were approved by the National Committee on Animal Experimentation, Denmark.