

ISBN 89-950054-9-1 93520  
89-950054-7-5 93520

*Proceedings*

***CONTRIBUTED PAPERS – Vol. II***



**The 8th World Conference on Animal Production**  
**June 28 – July 4, 1998**  
**Seoul National University**  
**Seoul, Korea**

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## Determination of blood flow, oxygen consumption and heat production by gravid uterine tissues of goats

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### Introduction

It is important to maintain body condition in pregnant period for subsequent lactation especially in high producing dairy cows. A basic understanding of the nutritional requirement for normal development of gravid uterine tissues is essential to establish an accurate feeding system in late pregnancy. For this, some experiments were carried out to measure Oxygen (O<sub>2</sub>) consumption or blood flow by the gravid uterus at several stage of gestation in ewe (1) and Hereford cows (5), since the O<sub>2</sub> consumption is an index of energy use by the tissue. Ferrell and Reynolds (2) reported heat production of gravid uterine tissues may account for about 44% of heat increment of gestation in Hereford cows and suggested maternal energy expenditure increased as pregnancy progressed. However, there are few data on blood flow and O<sub>2</sub> consumption by gravid uterus in goats. O<sub>2</sub> uptake by gravid uterus and heat production by maternal body and gravid uterus were measured quantitatively in goats.

### Materials and methods

Five pregnant Saanen goats (average body weight 39.7kg) were kept in metabolic cages. Italian ryegrass hay wafer (second cut) was fed once daily at 9:00 A.M. from day-100 of pregnancy at the feeding level to meet for maintaining maternal and fetal energy requirements (4). Goats were fitted with a transit time ultrasonic flow probe (diameter 2 or 3 mm, Transonic Systems Inc., USA) and heparinized catheters (Anthon, 14G, 2.1mm O.D., Toray Industries, Inc., Tokyo). Surgery for fitting these instruments was done at day-105 from mating under general anesthesia by mixture of oxygen and halothane (Fluothane, Takeda Chemical Industries, Ltd., Osaka) with soda lime for removal of carbon dioxide. The probe was fitted around the uterine artery for measurement of blood flow into the gravid uterus. Catheters were inserted into the uterine vein and carotid artery and filled with sterile, heparinized (100IU/ml) saline when not in use.

Uterine blood flow was measured continuously for 24 hours at 1 minute intervals, while blood samples were collected at every 3 hours at day-111 of pregnancy. Blood samples were withdrawn anaerobically into 10 ml syringes, capped with a stopper and immediately analyzed for O<sub>2</sub> saturation and hemoglobin content using automatic blood gas analyzer (Chiron840, Chiron, Inc., Tokyo) and oximeter (CO-oximeter, Chiron, Inc., Tokyo). These analyses were completed within 5 minutes after the collection of the blood. O<sub>2</sub> concentration was calculated by the following equation:

$$\begin{aligned} \text{O}_2(\%) &= \text{physical O}_2 \text{ solubility} + \text{chemical O}_2 \text{ solubility} \\ &= (0.23 \cdot \text{pO}_2 / 760) \cdot 100 + 1.34 \cdot \text{Hb} \cdot \text{O}_2 \text{sat} \end{aligned}$$

pO<sub>2</sub>: partial pressure of O<sub>2</sub> in blood (mmHg)

Hb: hemoglobin content (g/ml)

O<sub>2</sub>sat: O<sub>2</sub> saturation (3)

Net tissue uptake of O<sub>2</sub> was calculated by multiplying blood flow by the arterial-venous (A-V) concentration difference. The whole body gas exchange in the goats were determined by open circuit respiration chambers during 3 days after the collection of blood and flow data.

## Results and discussion

Blood flow rate in uterine artery and O<sub>2</sub> concentrations in uterine artery and vein during 24 hours at day-111 of pregnancy are shown in Figure 1. O<sub>2</sub> concentrations in arterial blood were higher than in venous blood during experimental period. O<sub>2</sub> A-V concentration differences in uterine changed little across stages of gestation and uterine uptake was reflected mainly by changes in uterine blood flows in Hereford cows (2).

Average O<sub>2</sub> consumption by whole body of pregnant goat and in gravid uterus were 359.9 liter/day and 24.6 liter/day (6.8% of whole body), respectively. In this experiment, by assumption 1 liter O<sub>2</sub> contains 21.1 kJ (2), average heat production of pregnant goats and gravid uterus were estimated to be 7521.0 kJ/day (corrected by carbon dioxide, methane and urinary nitrogen excretion) and 518.6 kJ/day, respectively. Meanwhile, the distribution of blood flow and O<sub>2</sub> uptake between the two uterine horns was strongly correlated with placental mass distribution (4). A single (n=2) and twin (n=3) pregnant goats were used and the blood on fetal uterine horn side were only measured for flow rate and O<sub>2</sub> concentration in this experiment, therefore it might be necessary to correct with the fetal number and sampling side.

These results showed that the techniques used in the present experiment to determine nutrients requirements by gravid uterine tissues in ruminants.

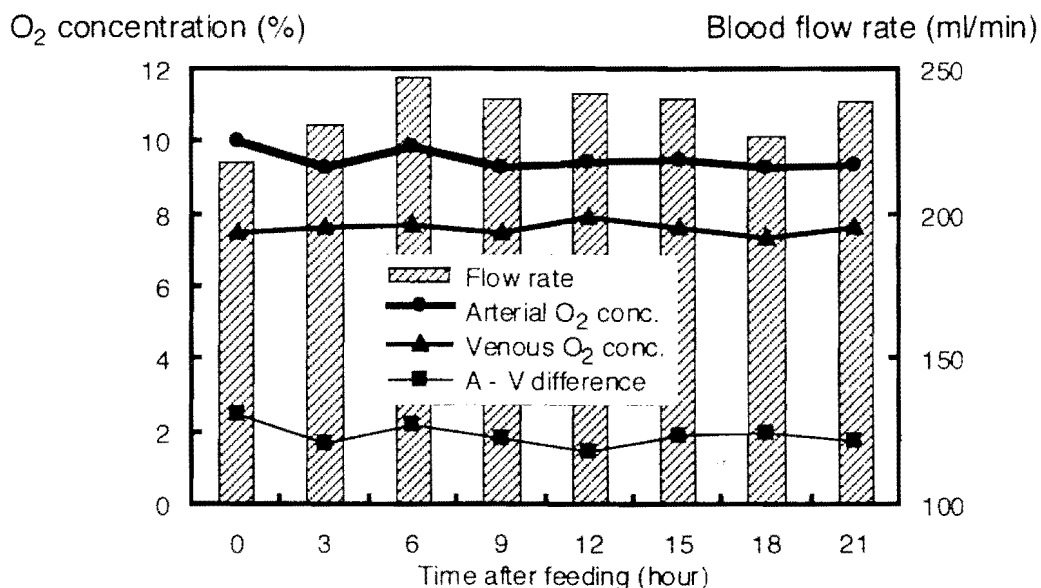


Fig. 1. Flow rate and O<sub>2</sub> concentration of uterine blood in goat

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