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The influence of abomasal infusion of protein or energy on ovulation rate in ewes

G. J. CRUICKSHANK, J. F. SMITH AND D. G. FRASER

Ruakura Agricultural Centre
Ministry of Agriculture and Fisheries, Hamilton

ABSTRACT

Sixty nine ewes, fitted with abomasal catheters, were individually penned and offered a pelleted diet at maintenance level. Each ewe received, in a random order, an abomasal infusion of water (CON), glucose (GLU), lactalbumin (LAC) and soy protein isolate (SPI) from days 8 to 17 of 4 consecutive oestrous cycles (day 17 = ovulation). Ovulation was initially synchronised using controlled internal drug releasers (CIDR) and subsequently by prostaglandin injection. Ovulation rate was measured by laparoscopy approximately 5 d after expected ovulation.

Ovulation rate was 161, 172, 177 and 175% for CON, GLU, LAC and SPI respectively. When expressed as the percentage of ewes multiple ovulating both protein infusions were associated with a significant ($P<0.05$) increase of 55 *v* 72 and 74% ewes multiple ovulating, for CON *v* LAC and SPI respectively. Glucose, with 65% ewes multiple ovulating, was not significantly different ($P>0.05$) from any treatment.

These results show that ovulation rate can be modified by short term abomasal infusion of nutrients and confirm the positive influence of protein absorption on ovulation rate, but do not exclude the possibility that the effect of protein may be due to its energy content.

Keywords Sheep; ovulation rate; protein; energy; abomasal infusion.

INTRODUCTION

It has long been recognised that level of nutrition is an important determinant of ovulation rate (OR) in ewes, yet our understanding of the mode of action remains unclear. Traditional research has highlighted the importance of live weight, reflecting differences in nutrition earlier in life, and the so-called flushing effect, reflecting differences in nutrition immediately prior to ovulation (Coop, 1966; Adalsteinsson, 1979). However, more recent research has been stimulated by the observation that feeding sweet lupin seed for as little as 6 to 7 d prior to ovulation has a marked effect on OR (Knight *et al.*, 1975; Oldham and Lindsay, 1984; Nottle *et al.*, 1986).

Several studies in Australia have attempted to isolate the components of lupin seed responsible for the increased OR, but the results have been conflicting and inconclusive. Teleni *et al.* (1984; 1985) concluded that the increased OR was due to increased energy supply, simulated by intravenous infusion of glucose and/or acetate, and that additional protein, simulated by adding formaldehyde treated casein to the diet, was unimportant. Conversely, Nottle *et al.* (1985) observed that the addition of 160g/d of formaldehyde treated casein increased OR to the same extent as 500g/d of lupin seed. The addition of 400 g starch/d to the basal diet or 200g starch/d to the diet containing protein had no effect on OR.

In New Zealand Smith (1985) reported data from a series of experiments studying the relative importance of energy and protein intake on OR. Feeding a range of diets varying in energy and protein concentration for 1 complete oestrous cycle he observed a continuous increase in OR with increasing digestible energy intake and an independant step-wise increase in OR when digestible crude protein intake increased above 125g/d.

The reasons for the conflicting conclusions in these experiments are unclear and may, at least partly, be due to the techniques used to modify the supply of protein and energy. Most of the data, particularly with respect to protein, were obtained by modifying diet formulation and/or level of feed intake. This introduces the possiblitlity of variable fermentation of supplements in the rumen. The success in altering the ratio of absorbed protein:energy and, in particular, altering the absorption of protein and energy independently is therefore equivocal.

This study investigated the effect of short term post-ruminal infusions of protein and energy on ovulation rate in ewes.

MATERIALS AND METHODS

Animals and Housing

Seventy five 2-year-old parous Coopworth ewes were fitted with a Foley catheter (size 14Fr) entering the body of the abomasum. The ewes were housed in individual pens and tethered to the side of the pen to prevent turning. This removed the possibility of ewes chewing or twisting catheters.

Feeding and Supplementation

A pelleted diet, comprising barley (35%), grassmeal (30%), lucerne straw (29%), mollasses (5%), limestone (0.9%) and minerals and vitamins (0.1%), was offered at approximately maintenance level (850gDM/d) throughout the experiment.

Supplements were infused in 1 l of solution daily via abomasal catheters for 10 d up to and including the expected day of ovulation, (days 8 to 17 of the oestrous cycle). Four supplements were studied; diluent only (CON), glucose 65g/d (GLU), lactalbumin 50g/d (LAC) and soy protein isolate 50g/d (SPI). The glucose was calculated to provide a similar metabolizable energy to the protein supplements, based on the values for absorption and metabolizability of casein and glucose given by Blaxter and Martin (1962) and Blaxter (1962) respectively. Infusion was by gravity from a reservoir suspended approximately 1m above each pen and connected to the Foley catheter via a saline drip chamber and tap (Travenol Laboratories, Auckland). The drip rate was adjusted to provide continuous infusion over each 24h period.

Synchronisation of Ovulation

Initially ovulation was synchronised using controlled internal drug releasers (CIDR). Subsequently, synchronisation was maintained by injection of a prostaglandin analogue (estrumate) on day 15 of the cycle, (2 d prior to expected ovulation).

Observations

Ovulation rate was determined by laparoscopy approximately 5 d after ovulation or 7 d after synchronisation treatment. A total of 5 measurements were made, following the initial synchronisation (pre-trial) and the subsequent 4 cycles when ewes were receiving supplements.

Live weight was recorded at each laparoscopy.

Analysis

Ovulation rate was expressed as the number of ovulations/ewe and statistically analysed as the logit transformed value of the proportion of ewes multiple ovulating (%) (EMO).

RESULTS AND DISCUSSION

Due to irreversible catheter loss prior to and soon after the commencement of the experiment data were obtained from only 69 ewes. One ewe failed to ovulate in the pre-trial cycle with all ewes ovulating in the subsequent 4 cycles.

The realised infusion rate for LAC and SPI was 47gDM/d (44 and 41g crude protein/d respectively) and for glucose 62gDM/d. Assuming the supplements had a similar energy content to the casein (23.4MJgross energy/kgDM) and glucose (15.7MJgross energy/kgDM) reported by Blaxter and Martin (1962) and Blaxter (1962) this related to an infusion of 0.95 and 0.97 MJmetabolizable energy/d for protein and energy infusions respectively.

Live weight averaged 49.6±0.23kg at the pre-trial laparoscopy and 50.7, 51.5, 52.8 and 53.2kg at the subsequent laparoscopies. Allowing for the energy contained in the infusions this liveweight gain (average 52g/d) suggests that the level of feeding was slightly above maintenance. This may, at least partly, explain the unexpectedly high OR observed in the CON ewes.

Protein supplementation significantly increased the EMO (P<0.05) compared to CON ewes (Table 1) agreeing with the conclusions of Nottle *et al.* (1985) and Smith (1985) but not with Teleni *et al.* (1985). However, it is possible that formaldehyde treatment of casein either over- or under-protected the protein in the latter experment, reducing the ability of the protein source to increase protein absorption. Moreover, Smith(1985) suggested the presence of a threshold requirement for protein intake which may account for the inconsistent response to increased protein intake.

TABLE 1 Ovulation rate and percentage of ewes multiple ovulating for ewes receiving diluent (CON), lactalbumin (LAC), soy protein isolate (SPI) or glucose (GLU) abomasally.

Infusate	Ovulation rate	Ewes multiple ovulating (%)
CON	1.61	55
LAC	1.77	72
SPI	1.75	74
GLU	1.72	68

Glucose infusion tended to increase EMO but was not significantly different for any treatment (P<0.05). The inability to demonstrate any statistical effect of glucose infusion may, at least partly, be due to the high OR and EMO of CON ewes (1.61 and 55% respectively), which would have decreased the potential for increased OR. This affect was shown by Smith (1985) in 2 similar experiments using Coopworth ewes. When the average EMO of control (low protein) ewes was approximately 20% the response to increased protein intake was 20% units, (average EMO approximately 40%). However, when the average EMO of control (low protein ewes was approximately 45% the response to increased protein intake was only 10% units. The EMO of CON ewes in the present experiment (55%) was higher than in these experiments so the increase in EMO in protein infused ewes (average 18% units) represents a major change which would, presumably, have been greater if the EMO of CON ewes had been lower. This would have increased the probability of quantifying statistically the effect of glucose infusion.

The pre-trial OR (1.43) was lower than that observed in subsequent cycles (1.67, 1.67, 1.80 and 1.72 respectively). Although this was mainly associated with supplementation there was also an increase in the OR of CON ewes (in all but the last cycle), when compared to the same ewes in the pre-trial laparoscopy. Although this may be largely due to random variation (2 ewes had a higher OR on CON than on any other treatment) it is probable that this reflects a seasonal shift in OR (Smith *et al.*, 1987).

It is interesting to note that 28 of the 69 ewes had the same OR on all treatments. It may, therefore, be possible to select animals which will respond to nutritional manipulation prior to the commencement of an intensive experimental program by comparing OR in 2 oestrous cycles with and without feeding a supplement such as lupin seed. This would reduce by approximately 50% the number of animals required to detect statistical significance.

These results demonstrate that short term infusion of nutrients into the abomasum can modify OR in ewes and confirms the positive effect of increased protein supply. Whereas the feeding of lupin seed for short periods has been shown to affect OR the present technique is likely to prove more valuable in elucidating the nutrients responsible for the effect and studying the role of specific nutrients in modifying OR. The main advantage of abomasal infusion is that the rumen is bypassed, removing the often drastic affect of microbial fermentation and allowing greater control over the manipulation of nutrient absorption.

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