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Ovulation rate of ewes
role of energy and protein

By E. Teleni* and J. B. Rowe, Research Officers, Sheep and Wool Branch

Western Australia's sheep farmers are familiar with the low ovulation rate of Merino ewes and how this limits the lambing performance of ewe flocks.

One way in which ovulation rate and therefore lambing percentage may be increased is to feed seed of sweet lupin (Lupinus angustifolius) to ewes at mating. However, Department of Agriculture research has found that these increases do not show up consistently, and that there is considerable variability between farms.

If improved nutrition is to be a useful way of increasing ovulation rate, the mechanism by which nutrition affects ovulation rate must first be understood. This article describes the initial stages of a Department of Agriculture research programme designed to investigate this biological phenomenon.

The question asked first was which of the many nutrients provided by lupin seed was the one responsible for the increase in ovulation rate? This was tackled by measuring the amount of each major nutrient available to sheep when lupins were given as a supplementary feed. These nutrients were then given one by one, in a purified form, to sheep to determine which nutrient resulted in increased ovulation rate.

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Research has shown that glucose plays a leading role in stimulating ovulation rate.
Digestion and use of the major nutrients

The nutritive value of a feed is largely determined by the energy and protein which are available to the animal following digestion and metabolism. Unfortunately the digestive system of the sheep is more complicated than that of pigs, poultry and humans. One of the results of this complicated system is that the nutrients in the feed are considerably modified before they become available to the animal.

The main source of energy for sheep is the volatile fatty acids (VFAs) which are produced during fermentation of the feed (mainly carbohydrate) in the rumen and in the hind gut (Figure 1). The volatile fatty acids provide about 70 to 80 per cent of the total energy available to the animal.

Of the volatile fatty acids, acetic acid is of major importance as a 'fuel' to maintain body function and also for fat production. Propionic acid on the other hand is an important building block for the production of glucose (Figure 2).

The oil present in lupin seed is absorbed from the intestines and provides energy to the animal in much the same way as acetic acid. Dietary protein is partially fermented in the rumen to produce volatile fatty acids and ammonia. However, some of the protein is not broken down and it passes from the rumen to the stomach (abomasum) and the intestines where it digested and absorbed as amino acids (Figure 1).

Urea only provides a source of ammonia in the rumen, it does not provide protein. Ammonia from protein or urea acts as a source of nitrogen from which the microbes in the rumen can produce protein.

For lupin seed, about 65 per cent of the protein is fermented in the rumen and 35 per cent is available to the animal. Amino acids absorbed from the small intestine are used for wool growth, for production and maintenance of muscle and blood and for synthesis of glucose.

Role of specific nutrients

The specific nutrients studied in our ovulation rate experiments were protein, glucose and acetate as a neutral form of acetic acid. Protein was fed to sheep as casein treated with formaldehyde to prevent any fermentation before digestion. Glucose and acetate were infused directly into the sheep's blood stream. The supply of all three nutrients increases greatly when lupin seed is fed as a supplement. However, each nutrient accounts for less than 20 per cent of the total weight of lupins fed (Table 1).
Effects on ovulation rate

Sheep were housed individually to ensure that feed intake could be controlled. To measure changes in ovulation rate between treatments at least 50 sheep received each different diet or infusion. The time of ovulation was synchronised using progestagen-impregnated sponges. Supplementary feed and infusions were given for nine days up to and including oestrus. The number of ovulations per sheep was determined using laparoscopy.

All animals were fed a daily ration of 700 g of pellets, sufficient to maintain liveweight. These pellets were made from cereal hay and straw (50 per cent), oats (45 per cent); fishmeal (4 per cent) and minerals and vitamins (1 per cent).

In addition to a control group of animals receiving only this basal diet, the following supplements were given: 750 g of lupins, 108 g of protein (as formaldehyde-treated casein), 94 g of acetate and 132 g of glucose. These levels of protein, acetate and glucose were equivalent to the amounts of these nutrients available to animals given 750 g of lupin seed a day.

The effect of these supplements and infusions on ovulation rate are shown in Table 2.

These results indicate that similar increases in ovulation rate can be achieved when sheep are fed lupin seed as a supplement or when they are given a purified source of additional glucose equivalent to that available to the animal as a result of eating lupin seed. Glucose is produced by the animal from both amino acids (protein) and from propionate produced by rumen fermentation. When extra protein only was provided the supply of glucose did not increase sufficiently to increase ovulation rate. Therefore, although protein will contribute to glucose production, it does not appear to play a direct role in stimulating ovulation. On the other hand acetate, which like glucose is an important nutrient in energy metabolism, appears to increase ovulation rate slightly.

The response in ovulation rate to nutritional changes therefore seems to be linked to energy-providing nutrients and particularly to glucose. This is a very significant finding in that it allows us to start to explore the biological pathways by which these specific nutrients affect ovulation.

The reproductive performance of ewes is sensitive to 'nutrition' and their long term 'nutritional status'. However, these terms and our understanding of them have been too general to allow this information to be useful. Now, having defined a specific nutrient which affects ovulation rate, we can investigate alternative and more economical feeding systems, and also examine the reasons for differences in responsiveness between flocks and between years. These are objectives for future research in this area.

### Table 2. Effect of supplements of lupin seed and specific nutrients provided by lupin seed on ovulation rate in ewes

<table>
<thead>
<tr>
<th>Feed and supplement</th>
<th>Ovulation rate per ovulating ewe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pellets (700 g/day)</td>
<td>1.32</td>
</tr>
<tr>
<td>Pellets + lupins (750 g/day)</td>
<td>1.65**</td>
</tr>
<tr>
<td>Pellets + protein (108 g casein/day)</td>
<td>1.42</td>
</tr>
<tr>
<td>Pellets + acetate infusion (94 g/day)</td>
<td>1.51*</td>
</tr>
<tr>
<td>Pellets + glucose infusion (132 g/day)</td>
<td>1.67**</td>
</tr>
</tbody>
</table>

* ** Ovulation rates significantly (P < 0.05 and 0.01 respectively) different from animals receiving only pellets.

Acknowledgement

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