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Effect of hormonal synchronisation and/or short-term supplementation with maize on follicular dynamics and hormone profiles in goats during the non-breeding season

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ABSTRACT

This study aimed to evaluate the reproductive response of anoestrous goats that were either hormonally treated and/or supplemented with maize for 9 days to determine which treatment combination was the most effective in enhancing follicular development and ovulation rate, and whether these responses were associated with increases in metabolic hormones. The experiment was carried out using 28 does, using a 2 × 2 factorial design with seven does in each group to test the effect of synchronisation of oestrus, supplementation with maize and their interactions. Synchronisation of oestrous cycles ($P < 0.001$) but not supplementation with maize or the interaction between the two ($P > 0.05$) increased the number of codominant follicles, the diameter of the largest follicle on Day 9 and growth rate of follicles during the period of supplementation. Compared with non-supplemented animals, supplementation with maize increased the total number of follicles observed between Days 7 and 9 ($P = 0.039$). In addition, nutritional supplementation with maize in combination with synchronisation of oestrus increased the ovulation rate by 43% ($P = 0.074$). Interactions between time and supplementation with maize showed that plasma concentrations of insulin, leptin and IGF-1 were greater in does supplemented with maize compared with non-supplemented does ($P < 0.001$). The findings show that hormonal synchronisation had the most influence on modifying follicular development and ovulation in anoestrous goats. Supplementation with maize increased the concentrations of insulin, leptin and IGF-1, which could potentially modify the sensitivity of follicles to gonadotrophins and reduce rates of atresia.

1. Introduction

Photoperiod and the availability of nutrition limit times during the year when does ovulate and conceive. Management strategies that have been used to increase the duration of the breeding season or to induce

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ovulation during the non-breeding season and hence improve productivity in goats and sheep include synchronisation of oestrus using exogenous administration of progestins (Scaramuzzi and Martin, 1984), manipulating the duration of photoperiod that does are exposed to, administration of melatonin (Chemineau et al., 1992; Delgadillo et al., 2001), exposure to bucks (López-Sebastian et al., 2007; Delgadillo et al., 2011) and nutritional supplementation (Zarazaga et al., 2005; Duarte et al., 2008). These strategies are aimed at altering the hypothalamtic-pituitary-ovarian axis to increase the likelihood that ovulation will occur during the non-breeding season.

Data supporting an increased productivity in goats and sheep following nutritional supplementation in the non-breeding season are equivocal. In Payoya goats kept under a natural photoperiod (37°15′N), the duration of non-breeding season was 32 days shorter when does were fed 1.5 times maintenance compared with those that were fed a maintenance diet (Zarazaga et al., 2005). In contrast, reproductive seasonality in goats in a subtropical environment (26°23′N) persisted independently of food availability and it was concluded that photoperiod was the key factor regulating seasonality in subtropical latitudes (Duarte et al., 2008).

Supplementation with energy rich and/or protein rich diets exerts a significant influence on reproductive function in ruminants by affecting follicular development and ovulation rate (Scaramuzzi et al., 2006; Scaramuzzi and Martin, 2008). The action of nutrition on folliculogenesis is thought to be mediated by different physiological pathways. The stimulatory effects of short-term supplementation on folliculogenesis are mediated by metabolites such as glucose and fatty acids and several metabolic hormones acting directly in the ovary (Meza-Herrera et al., 2008; Scaramuzzi et al., 2011). Changes in metabolites are thought to promote increased follicular steroidogenesis and an increase in ovulation rate, without changes in peripheral concentrations of FSH (Viñoles et al., 2005).

Exogenous administration of insulin has been shown to promote an increase in the number of small and large follicles in goats during the non-breeding season (Sarath et al., 2008). Leptin is a member of a cohort of factors, humoral and perhaps neural that influence the homeostasis of glucose in the body and GnRH-LH pulse secretion (Blache et al., 2000a; Zhang et al., 2004), thereby potentially influencing ovarian follicular development.

To the authors' knowledge, there are limited reports on the effect of a short-term supplementation with maize on follicular development, ovulation rate and metabolic hormones in anoestrous goats. Supplementation with maize is expected to increase the delivery of glucose to the small intestine (Landau et al., 1992) and increase circulating concentrations of glucose and IGF-1, which could in turn, modify the sensitivity of the ovary to gonadotrophins and increase ovulation rates. The aim of this study was to evaluate the reproductive response of seasonally anoestrous goats that were either hormonally treated and/or supplemented with maize to determine which treatment combination was the most effective in enhancing follicular development and ovulation rate and whether these responses were associated with increases in circulating concentrations of glucose, insulin, leptin and LH.

Table 1
Experimental groups and components of the ration and total energy (ME/day) administered from Days 0–9 for each group.

Variables	Experimental groups			
	Control	Maize	Synch	Synch × Maize
Animals (n)	7	7	7	7
Lucerne pellets (g/day)	820.0	820.0	820.0	820.0
Lucerne hay (g/day)	150.0	150.0	150.0	150.0
Cracked maize (g/day)	0	220.0	0	220.0
Total energy (MJ ME/day)	7.6	10.6	7.6	10.6

2. Material and methods

2.1. Location, animals and evaluation period

The experiment was carried out at James Cook University, Townsville (19°19′30″S; 146°45′44″E), which is located in a tropical region of Queensland, Australia. The experiment was conducted between October and November 2011, during the non-breeding season. A total of 28 nulliparous, anoestrous and non-pregnant female goats (20 rangeland and 8 Boer goats) were selected for this study. At the start of the study every goat was classified as being in anoestrus after (i) no corpora lutea were observed in the ovaries during two examinations that were conducted 14 days apart using transrectal ultrasonography, and (ii) oestrous behaviour was not observed in any goat following twice daily observations in the presence of two mature bucks over the same period. At the start of the experiment, the does were 1.5 ± 0.3 years old and had a live weight of 36.7 ± 0.7 kg (mean ± SEM). All experimental procedures for this study were approved by the Animal Ethics Committee of James Cook University (approval number: A1725).

2.2. Animal management and experimental design

Prior to commencement of the study, goats were adapted to housing for seven days (Days −7 to 0) by maintaining goats within single pens and supplementing them daily with a base ration consisting of lucerne pellets and lucerne hay, in order to provide nutritional requirements of 1.1 times maintenance (7.6 MJ ME/day) for a goat weighing 40 kg (NRC, 2007). Goats were then transferred to individual metabolic crates, allocated evenly to randomize the effect of breed in four groups of seven animals (Table 1) and supplemented over 9 days with the following diets: Control diet, goats were fed with a base ration of lucerne pellets and lucerne hay; Maize diet, fed with the same base ration plus supplementation with 220 g of cracked maize per day; Synch diet, fed the base ration plus treated with an intravaginal progesterone releasing device (CIDR, Eazi-Breed® CIDR®, Pfizer Australia, NSW) from Days 0–9 and eCG (250 IU IM; Folligon®, Intervet Australia, Victoria) administered on Day 7 (Fig. 1), and Synch × Maize diet, the same treatment as described for Synch group plus supplementation with 220 g of cracked maize per day.