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Body condition and protein supplementation positively affect periovulatory ovarian activity by non LH-mediated pathways in goats

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Abstract

Effects of rumen undegradable intake protein (UIP) supplementation on ovarian activity and serum insulin, GH, and LH were evaluated in goats having low or high body condition (BC). Goats with either low BC ($n = 16$, 28.7 ± 0.8 kg BW, BC = 2.1 ± 0.3) or high BC ($n = 16$, 38.4 ± 0.8 kg, BC = 3.2 ± 0.3) received, during 40-days, one of the two protein supplementation levels: without UIP or with UIP (120 g goat^{-1} d^{-1}). Oestrus was synchronized with two i.m. doses of $PGF_{2\alpha}$, and jugular blood samples were collected from 36 to 42 h after the second prostaglandin injection at 15 min intervals. Serum concentrations of insulin, LH, and GH were measured The number of preovulatory follicles and the number of corpora lutea (CL) were evaluated by transrectal ultrasonography at 1 and 4 days after the second prostaglandin dose, respectively. Does with higher BC had more CL than those in the lower condition group (2.8 ± 0.2 versus 1.8 ± 0.2, $P < 0.05$). Similarly, goats receiving UIP supplementation had more follicles (2.6 ± 0.2 versus 1.9 ± 0.2, $P < 0.05$) and tended to have more CL (2.6 ± 0.2 versus 2.0 ± 0.2, $P = 0.05$) than does not receiving UIP. Neither BCS nor UIP supplementation affected serum GH or LH concentrations, pulsatility, or area under the curve. High BC does produced more insulin (1.92 ± 0.17 versus 0.81 ± 0.17 ng/mL, $P < 0.01$ ng/mL) than lower BC goats; the same for UIP-supplemented (1.69 ± 0.18 versus 1.04 ± 0.18, $P < 0.05$). Results suggest that the increased ovarian activity observed in both UIP-supplemented and higher BC goats was not the result of changes in

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LH or GH, suggesting effects at a local level, through changes in insulin in a non-GnRH-gonadotrophin dependent manner.

Keywords: Body condition; Goat; Hormones; Ovarian activity; Rumen undegradable intake protein

1. Introduction

In mammals, nutrition exerts a significant influence on reproductive function through changes in body weight and condition (Downing and Scaramuzzi, 1991) affecting processes of follicular development and, finally, ovulation rate (reviewed by Scaramuzzi et al., 2006). Influences of body condition on ovulation rate, mainly studied in sheep models, may be classified as long-term or "static effect", in which heavy females have higher ovulation rates than light animals, and short-term or "dynamic effect", through an increase in body weight and condition by a higher feeding over 3–4 weeks before mating (Smith and Stewart, 1990; Scaramuzzi et al., 2006). These changes are obtained through supplementation with high-energy and/or high-protein diets. Protein supplementation also acts as a potent stimulator of glucose and insulin secretion (Muturi et al., 2002). The effect of nutrition on reproduction is well-known, but the exact mechanisms and mediating compounds affecting both static and dynamic changes still need further clarification (Martin et al., 2004).

It is hypothesized that nutrition can affect reproductive features by two possible pathways (for review, see Scaramuzzi et al., 2006). The first way is through acting on the endocrine system (GnRH, FSH-LH, oestradiol). In sheep, static body condition affects follicular dynamics and ovulation rate patterns through changes in FSH secretion (Viñoles et al., 2002). Energy or protein supplementation has been found, in sows, to promote the development of more antral follicles by maintaining adequate levels of both FSH and LH (Quesnel et al., 1998). On the other hand, an inadequate dietary protein results, for rats and goats, in a reduced number of antral follicles and a decreased ovulation rate (I'Anson et al., 2003; Cognie et al., 2003). This effect may be related with the fact, previously described, that nutritional deficiencies reduce synthesis and secretion of FSH and LH, preventing final maturation of the ovulatory follicle (Muller et al., 1998).

However, the effects on follicle number and ovulation rate reported may also be related to the second mechanism considered by Scaramuzzi et al. (2006); nutritional inputs would affect nutrition by directly acting on the ovary and the ovarian follicles through changes in the metabolic modulatory systems (insulin–glucose, leptin and growth hormone and growth factors). The entry of follicles into the terminal-growth stage (secondary follicular waves) is hierarchical, independent of gonadotrophins, and seems to be related to changes in the expression of the growth factor complex (McNatty et al., 1999; Webb et al., 1999). Nutrition induces changes in GH, insulin and growth factors leading to increased folliculogenesis and ovulation rate, without affecting FSH secretion (Scaramuzzi and Campbell, 1990). However, changes in metabolic hormones may also be related to changes in the endocrine system. In rats, insulin has been described to stimulate GnRH release, maintain normoglycemia, and stimulate FSH secretion, pulsatility of LH and progesterone secretion (Arias et al., 1993).

Therefore, in view of conflicting literature, the objective of this study was to elucidate the effects, in goats, of body condition (static effect) and protein supplementation (dynamic effect)