Leptin and puberty in goat

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RIASSUNTO – Leptina e pubertà nella capra. *Ventiquattro capre di razza Serrana (7,93±0,24 kg, 93±2,6 giorni di età) sono state suddivise in 3 gruppi alimentati per 11 mesi con fieno* ad libitum *e differenti quantità di concentrato (30, 50 e 70% della sostanza secca ingerita) fino alla pubertà. I tre gruppi hanno ingerito la stessa quantità di sostanza secca. Il gruppo alimentato con la dieta a maggior apporto di concentrato ha mostrato un anticipo di 30 giorni nella comparsa della pubertà, presentando un maggiore deposito adiposo sottocutaneo ed un maggiore peso vivo rispetto agli altri due gruppi. I livelli di leptina plasmatica sono aumentati significativamente nei 3 mesi prima della pubertà senza mostrare differenze significative tra i 3 gruppi sperimentali, sebbene siano risultati correlati (P<0,01) al peso corporeo ed allo spessore del pannicolo adiposo.*

Key words: leptin, puberty, goat.

INTRODUCTION – The onset of reproductive function involves activation of the hypothalamic-pituitary-gonadal axis and in female results in ovulation of mature oocytes (Gueorguiev *et al.*, 2001). This transition typically occurs at a genetically predetermined age. However, nongenetic variables as photoperiod, body weight (BW), and back fat depth (BFD) can modify the age at which puberty occurs (Cheung *et al.*, 2001; Garcia *et al.*, 2002). Furthermore, feed availability is an important environmental factor affecting the reproductive and somatotropic axis. Reduced nutrition results in the suppression of gonadal activity in sheep (Nagatani *et al.*, 2000). In mammals, leptin, a satiety signal secreted from adipocyte, has been proposed as a permissive factor that links metabolic status and reproduction (Nagatani *et al.*, 2000). Indeed, functional leptin receptor and its mRNA are present in ovary, pituitary and hypothalamus of several species and fasting reduces synthesis and secretion of leptin and frequency of LH pulses (Spicer, 2001).
The aim of this study was to investigate the relationship between leptin, the onset of puberty and the quality of the diet in goat.

MATERIAL AND METHODS – Twenty four female kids, belonging to Serrana (local Portugal goat breed), were monitored from 3 months age (December) until the onset of puberty (October). At the beginning, kids were subdivided into three groups fed on hay ad libitum and different levels of concentrate: 30, 50 and 70% of dry matter intake (DMI) of concentrate for low level (LC), medium level (MC) and high level (HC), respectively. Periodically, DMI and composition were adjusted to account for growth related changes in BW. Individual DMI was registered daily, and BW was recorded weekly. Every month BFD was measured by ultrasound at the 3rd and 4th lumbar vertebra using an Aloka SSD 500V real time instrument with a 7.5 MHz linear probe, and image analysis software NIH 1.57 (National Institutes of Health). Blood samples was collected every 10 days from the jugular vein (Vacutainer system) before feeding. The samples were centrifuged and the

plasma collected and stored at –20°C. On plasma samples, leptin (multi-species leptin RIA, Linco Res. Inc., St. Charles, MO, USA) and progesterone (progesterone RIA kit, Diagno. Prod. Corp., Los Angeles, CA, USA) were detected by radioimmunoassay. Goats were considered puberal when levels of progesterone exceeded 0.5 ng/ml. Data were analyzed using the GLM procedure of SAS (SAS, 1996). Dry matter intake, live weight, backfat depth and plasma leptin concentration were evaluated utilizing a model considering the following effects: treatments (LC, NC and HC), goat within treatments, time and the error term. Significance was declared at $P<0.05$.

RESULTS AND CONCLUSIONS – During the experimental period, the HC group grew at a higher rate, reaching a final BW higher ($P<0.001$) than the other two groups, but the total DMI did not vary between the experimental groups (Figure 1). The BFD was always significantly higher in the HC ($P<0.001$) compared with LC and MC groups (Figure 2). During the experimental period, mean concentrations of leptin did not differ due to diet; however, it significantly increased at puberty onset between August and October (Figure 2). Moreover, during this period plasma leptin levels were significantly correlated with both BW ($P<0.001$) and BFD ($P<0.01$).

Figure 1. Changes of dry matter intake (DMI: histograms) and body weight (BW: lines) in goats fed diet containing low level (LC), medium level (MC) or high level (HC) of concentrate.

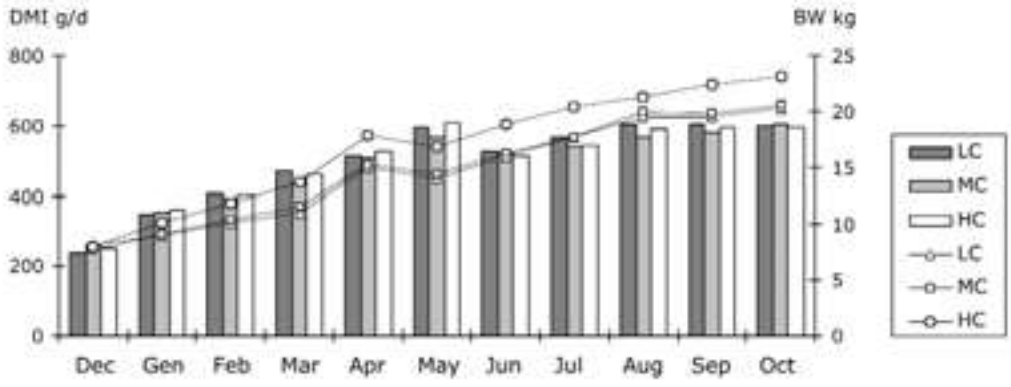
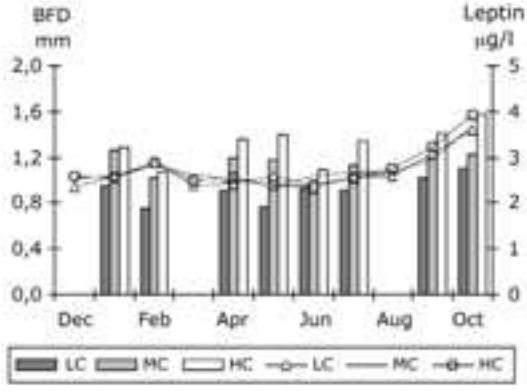


Figure 2. Changes of back fat depth BFD (histograms) and plasma leptin (lines) in goats fed diet containing low level (LC), medium level (MC) or high level (HC) of concentrate.



In ruminants, a systemic leptin level increment has been reported as puberty approaches (Spicer, 2001; Garcia *et al.*, 2003). Those authors hypothesized that this increase of leptin acts to trigger the reproductive axis at the levels of hypothalamus and pituitary. Increase in serum leptin is also reported in mature ovariectomized cows and mares during spring and summer indicating that seasonal changes in photoperiod is a factor in inducing leptin secretion (Garcia *et al.*, 2002). Those authors concluded that seasonal effects on circulating leptin could have contributed to the prepubertal rise in leptin concentration observed in developing heifers. The increase of circulating leptin observed in our study at onset of puberty might be partially due to changes in photoperiod. In the current experiment it appears that circulating leptin level was not affected by dietary treatment, although a higher not significant leptin concentration was observed in HC group in the onset of puberty. The lack of effects of the diet could depend on the absence of differences in DMI between groups, because DMI is a long-term signal that regulates plasma leptin level (Chilliard *et al.*, 1999; Marie *et al.*, 2001). But the lack of effects of the diet on plasma leptin could be due also to the effect of photoperiod that could be so strong to mask dietary effects.

Analyzing the period just before the onset of puberty, as stated by plasma progesterone levels, is noteworthy that the HC groups became sexually mature 20-27 days before, and with a BW 2 kg higher (+10%, $P<0.001$) than the other two groups (Table 1). In contrast, leptin levels recorded during the month before the onset of the puberty were not significantly different between the three groups. The overall mean of leptin during the pubertal period was 30% higher than those previous levels (3.4 *vs.* 2.45 μg/l, $P<0.001$).

Table 1. Lsmeans ± SE of body weight (BW), age at puberty, and plasma leptin in goats fed with diet containing low level (LC), medium level (MC) or high level (HC) of concentrate at onset of puberty.

Means values	Group LC	Group MC	Group HC
BW (kg)	19.5 ± 1.2^{A}	19.6 ± 1.5^{A}	22.2 ± 1.7^{B}
Age at puberty (days)	380 ± 27^{a}	387 ± 18^{a}	360 ± 16^{b}
Leptin (μg/ l)	3.2 ± 0.7	3.2 ± 0.6	3.6 ± 0.6
BFD (mm)	1.0 ± 0.2^{A}	1.2 ± 0.2^{B}	1.5 ± 0.4^{C}

a, b = $P<0.01$; A, B, C = $P<0.001$.

The results indicate that in the goats the body weight, body fat depot and quality of diet influence the onset of the puberty, but not plasma leptin levels. The increase of plasma leptin during the onset of the puberty probably acts as permissive signal for the development of the sexual maturity and it can be used as a diagnostic tool to predict the imminent approaching of the event.

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