Puberty and the induction of puberty in female boer goat kids

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Female Boer goat kids were randomly allocated (post weaning) to 2 × 3 factorial design experiments for two observation periods, to monitor puberty and the induction thereof. Treatments for each period (December and April weaning seasons respectively) included three male stimulation treatment groups, viz. a permanent ram group (permanent presence of a male), a teaser ram group (limited daily exposure to a male) and a control group (isolated from males). All does were maintained on either a high- or low-energy diet. No significant differences in age and mass at puberty were found between the two energy diets, nor between ram treatment groups. Mean masses and age at puberty were 31,1 and 27,4 kg and 157,2 and 191,1 days for kids weaned in April and December, respectively. Kids weaned in April (breeding season) exhibited oestrus significantly ($P < 0,05$) earlier than those weaned in December. The continuous presence of a male had a significantly ($P < 0,05$) beneficial effect on oestrous response. By using linear regression analysis, no significant correlation could be found between mass and age at first oestrus. It is evident from the serum LH values that the pituitary in the Boer goat is active from 13 weeks of age, irrespective of season, ram-effect or level of nutrition. Elevated serum LH values were recorded before the occurrence of first oestrus. Kids weaned in the breeding season were found to have a significantly ($P < 0,05$) higher mean LH level, which may reflect higher pituitary activity during this period. Progesterone profiles of individuals indicated a relative high incidence of silent heats. Deduced from serum progesterone concentrations, cyclic activity for kids weaned in December and April on a high- or low-energy diet, started at 7,6 ± 3,4; 9,1 ± 4,3; 7,6 ± 3,5 and 12,7 ± 6,8 weeks, respectively, following weaning. Contact with male goats had an effect upon synchronization and timing of puberty, entrained by photoperiodic stimulation, while nutrition as such played a minor role. The effect of the interaction between these factors on puberty is difficult to assess.

Jong Boerbokooitjies is net na speen ewekansig toegeken aan 2 × 3-faktoriaalontwerpproewe om puberteit en die induksie daarvan te monitor oor twee waarnemingsperiodes. Behandelings het drie manlike behandelingsgroepe ingesluit, naamlik 'n permanente-ramgroep (permanente blootstelling aan 'n ram), 'n koggelramgroep (beperkte daaglikse blootstelling aan 'n ram) en 'n kontrolegroep (geïsoleer van ramme). Bogenoemde behandelings is op ooitjies toegepas wat in Desember of April gespeen is. Alle ooie het òf 'n hoë- òf 'n lae-energierantsoen ontvang. Geen betekenisvolle verskille (vir albei waarnemingsperiodes) t.o.v. ouderdom en massa waarby puberteit bereik word, is tussen die twee energierantsoene, sowel as tussen die permanente- en koggelramgroepe binne rantsoengroepe waargeneem nie. Die gemiddelde massa en ouderdom met puberteit was respektiewelik 31,1 en 27,4 kg en 157,2 en 191,1 dae vir lammers gespeen tydens Desember en April. Ooitjies wat in April (teelseisoen) gespeen is, het estrus betekenisvol ($P < 0,05$) vroeër getoon as dié wat in Desember gespeen is. Die permanente teenwoordigheid van 'n ram het 'n betekenisvolle ($P < 0,05$) vervroeging in puberteit tot gevolg gehad. Geen korrelasie kon tussen massa en ouderdom met eerste estrus verkry word nie. Dit blyk uit die serum-LH-konsentrasies dat die hipofise reeds op 13-weke (speen)-ouderdom, ongeag die seisoen, ram-effek of vlak van voeding, aktief is. Serum-LH-pieke is waargeneem selfs voor die eerste waarneembare tekens van estrus getoon is. Die feit dat diere wat in April gespeen is, 'n betekenisvolle ($P < 0,05$) hoër gemiddelde LH-vlak gehandhaaf het, dui moontlik op hoër hipofise-aktiwiteit tydens hierdie periode. 'n Relatief hoë voorkoms van stil-estrusse is deur middel van serumprogesteroonprofiele waargeneem. Serumprogesteroonkonsentrasies toon dat die sikliese aktiwiteit van die ooitjies wat in Desember en April gespeen is en op 'n hoë- en lae-energierantsoen gevoer is, 7,6 ± 3,4; 9,1 ± 4,3; 7,6 ± 3,5 en 12,7 ± 6,8 weke na speen, respektiewelik, begin het. Dit wil voorkom of die teenwoordigheid van die ram wel 'n effek op die sinchronisasie en voorkoms van puberteit gehad het. Dit is aangehelp deur dagliglengte, terwyl voeding as sulks in hierdie geval 'n geringe rol gespeel het. Die interaksie van al hierdie faktore op puberteit is egter moeilik om te bepaal.

Keywords: Boer goat, female kids, high-/low-energy diet, puberty, ram-effect, season.

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Most investigators determine puberty in female farm animals in terms of age at first behavioural oestrus (Joubert, 1963). This event occurs as a consequence of activation of the gonadotropin surge mechanism by the positive (stimulatory) feedback action of oestradiol (Scaramuzzi, Tillson, Thorneycroft & Caldwell, 1971). The onset of puberty is related to body mass, which in turn depends on level of nutrition, age, type of birth and season of birth (Devendra & Burns, 1970; Gill & Dev, 1972; Shelton, 1978; Smith, 1978). Most of the information about puberty in the goat relates to body mass and age of the doe at first oestrus (Shelton, 1978; Smith, 1978; Prasad & Bhattacharyya, 1979a,b), while research done on ewe lambs is much more comprehensive (Dyrmundsson, 1973).

The ability of the ewe lamb to respond to positive feedback of oestradiol becomes established within a few weeks following birth (Foster & Karsh, 1975). There is some evidence that many of the endocrine mechanisms in the pre-pubertal female are functional at an early age (Gordon, 1983). In goats, this release of gonadotropin from the pituitary in the pre-pubertal kid is not as well documented as in sheep.

In general, breeding in goats is delayed until the animal has attained 60—75% of its mature body mass (Shelton, 1978; Smith, 1980). Riera (1982) reported that most goat breeds are pubertal between five and 10 months of age. He suggested that the onset of cyclic activity usually occurrs during the season of shortening days whereas the termination thereof occurs during lengthening days. It is generally accepted that the breeding season centres around the period of shortest days.

There is also evidence that the presence of the ram may modify age of puberty in the goat (Shelton, 1977) and influence oestrous behaviour in does, with some degree of synchronization of oestrus (Ott, Nelson & Hixon, 1980). Lindsay, Cognie, Pelletier & Signoret (1975) claimed that there may be two distinct physiological actions triggered by the presence of the ram, viz. a neuro-humoral action which advances the pre-ovulatory discharge of LH and a entirely neural action which gives rise to the 'ram-effect'. Skinner & Hofmeyr (1969) postulated that the ram-effect is sufficient both to synchronize and produce oestrus in the doe and that exogenous hormones are unnecessary. This stimulating effect of the presence of males may thus have practical application in terms of the induction of puberty at an earlier age.

This study was initiated to investigate the occurrence of puberty in the female Boer goat as well as factors which may play a role in the induction of puberty.

Material and Methods

Female Boer goat kids (n = 110) at weaning (range 3—3,5 months of age) were used in two 2 × 3 factorial design (Table 1) trials. Kids (n = 65) born during early spring (weaned December) and kids (n = 45) born in summer (weaned April) were used in the first and second trials, respectively. All animals were kept in well-sheltered and ventilated pens during the observation periods (144 and 190 days for the 1st and 2nd trials respectively).

All kids were randomly allocated to two nutrition regimes, viz. a high(HE)- and low(LE)-energy diet, which were offered *ad libitum* (Table 2). All kids were randomly subdivided into the following treatment groups for each trial:

Treatment 1: Permanent ram (PR) groups.

A vasectomized ram with raddle harness ('sire sine') was run permanently with the kids to act as a stimulus and to detect females exhibiting oestrus.

Treatment 2: Teaser ram (TR) groups.

A vasectomized ram was introduced to the kids twice daily (08h00 and 15h00) for 15 min, to act as a stimulus and to detect females exhibiting oestrus.

Treatment 3: Control groups.

Kids were completely isolated from males (3 km from the nearest male) for the duration of the observation period.

The live mass of each animal was monitored on a weekly basis and average daily gain was calculated. Each observation period included an adaptation period of three weeks. Blood samples (5 ml) were taken on a weekly basis (3 × at 30-min intervals) from the jugular veins of five animals per treatment group for kids weaned in December and from three animals per group weaned in April. Serum was stored at −20°C for determination of luteinizing hormone (LH) (Niswender, Reichert, Midgley & Nalbandov, 1969) and progesterone (Youssefnajadian, Florensa, Collins & Sommerville, 1972) concentrations. The inter- and intra-assay coefficients of variation for LH were 15,0% and 9,1% and for progesterone 15,6% and 8,9%, respectively.

Oestrous observations were performed twice daily (08h00 and 15h00) for the PR and TR groups. Performance of the ram was evaluated in terms of the number of females showing behavioural oestrus. The values of serum progesterone and LH were used to delineate the onset of cyclic activity in the female kid, especially in the oestrous determination of the control animals.

Data were statistically analysed (Latin-square design) by analysis of variance at the 1% and 5% levels of significance. To determine which groups performed best, the smallest significant difference was calculated. The chi-square test was implemented to compare reproductive data, e.g. oestrous response between groups (Snedecor & Cochran, 1980).

Results

Oestrus

There was a significant ($P < 0,05$) difference in the number of does exhibiting visual signs of oestrus between the PR and

Table 1 Composition of the high- and low-energy diets (pelleted) fed during the trials

	Diet	
	High-energy	Low-energy
Lucerne (%)	50,0	93,4
Maize meal (%)	38,0	–
Fishmeal (%)	10,0	–
Molasses (%)	–	5,0
Monosodium phosphate (%)	1,0	1,0
Agricultural lime (%)	0,5	–
Salt (%)	0,5	0,5
Trace element mixture (%)	0,1	0,1
Energy content (MJ/kg DM)	9,613	7,688

Table 2 Experimental design of the two trials on the female Boer goat kids

	Weaning season			
	December 1979		April 1981	
Treatment →	HE[a] diet (n)	LE[b] diet (n)	HE diet (n)	LE diet (n)
Permanent ram group	10	10	7	7
Teaser ram group	10	10	7	7
Control group (no ram)	12	13	8	9

[a] High-energy diet.
[b] Low-energy diet.

Table 3 Percentage Boer goat does exhibiting oestrus during the respective observation periods

	Weaning season				
	December		April		
Treatment →	High-energy diet	Low-energy diet	High-energy diet	Low-energy diet	Total % exhibiting oestrus
Permanent ram group	100,0[a]	75,0[a]	100,0[a]	100,0[a]	93,3[a]
Teaser ram group	37,5[b]	50,0[b]	50,0[b]	57,1[b]	48,3[b]
Total % does exhibiting oestrus	70,6[a]	62,5[a]	75,0[a]	78,6[a]	

[a,b] Values with the same superscripts do not differ significantly from each other.

TR groups (Table 3). The females which were continually subjected to the presence of the male demonstrated oestrus sooner than those in the TR group. Level of nutrition had no significant effect on the incidence of first oestrus (puberty) in either group of animals born during different seasons of the year. Values for mean age-to-first-oestrus are set out in Table 4. For the purpose of comparison, distribution of the time interval of occurrence of first oestrus is indicated. The mean age-at-first-oestrus was significantly ($P < 0,05$) earlier for all kids weane in April compared to those weaned during December (mean at 157,2 vs 191,1 days). When linear regression analysis was used, no significant correlation could be found between mass and age-at-first-oestrus.

Body mass

Significant ($P < 0,01$ and $P < 0,05$) differences in the mean percentage gain in mass between high- and low-energy diets were found for kids weaned in December and April respectively. There was no significant difference between treatment groups within the two levels of nutrition with regard to the percentage mass gained. Average daily mass gain did not differ significantly between different ram treatment groups.

No significant differences for the age and mass at which puberty was reached, were found between the two energy diets, nor between treatments (PR or TR groups weaned in December and April respectively). The mean mass at first oestrus tended to be higher for females weaned in April than for those weaned in December (mean 31,1 vs. 27,4 kg) (Table 4).

Serum luteinizing hormone levels

From the LH values given in Table 5, it is evident that LH levels between and within treatment groups and observation periods varied greatly. Significant seasonal differences (December vs. April weaning) of the mean concentrations of serum LH in the peri-pubertal goat (Figures 1—4) were present. The PR ($P < 0,01$) and TR ($P < 0,05$) April-weaned groups had a higher LH level than the December-weaned PR and TR groups, while the December-weaned control group was found to show a significant ($P < 0,01$) higher LH level than the April-weaned control group.

With regard to the effect of the two levels of nutrition, significant differences in the mean serum LH concentration were found in the PR ($P < 0,01$) and TR ($P < 0,05$) groups weaned in December (Figures 1 & 2). Similarly, significant differences in the mean LH concentration were recorded in

Table 4 Mean age mass (± *SD*) of Boer goat does at the demonstration of their first visual oestrus period

	Weaning season			
	December		April	
Treatment →	High-energy diet	Low-energy diet	High-energy diet	Low-energy diet
Permanent ram group				
Age at 1st oestrus (days)	197,9 ± 29,6[a]	203,5 ± 40,3[a]	155,8 ± 54,8[a]	153,3 ± 33,3[a]
Distribution (days)	147–234	164–268	124–268	115–202
Mass at 1st oestrus (kg)	29,0 ± 5,6[b]	23,4 ± 2,3[b]	31,3 ± 10,1[b]	28,3 ± 5,4[b]
Teaser ram group				
Age at 1st oestrus (days)	184,5 ± 50,2[a]	178,5 ± 24,5[a]	168,7 ± 53,2[a]	171,0 ± 56,8[a]
Distribution (days)	149–220	149–209	136–230	110–235
Mass at 1st oestrus (kg)	29,6 ± 5,2[b]	26,0 ± 2,6[b]	32,6 ± 7,7[b]	32,2 ± 6,8[b]

[a,b] Values with the same superscripts do not differ significantly from each other.

Table 5 Mean (± *SD*) weekly LH concentrations (ng/ml) during the respective observation periods for pre-pubertal female Boer goat kids, bred in specific seasons

	Weaning season			
	December		April	
Treatment →	High-energy diet	Low-energy diet	High-energy diet	Low-energy diet
Permanent ram group	1,78 ± 1,36[a]	1,36 ± 1,41[b]	3,89 ± 3,04[c]	4,33 ± 3,60[c]
Teaser ram group	1,42 ± 1,96[b]	2,32 ± 2,72[a]	1,98 ± 1,78[a]	3,69 ± 2,03[c]
Control group	1,97 ± 1,91[a]	2,03 ± 1,89[a]	1,16 ± 0,70[b]	1,75 ± 1,52[a]

[a—c] Values with the same superscripts do not differ significantly from each other.

the TR ($P < 0,01$) and control ($P < 0,01$) groups weaned in April (Figures 3 & 4).

Exposure to the stimulus of the ram did not result in significantly different mean LH levels for the December-weaned PR and TR groups on the HE diet. The control group, however, had a significant ($P < 0,05$) higher mean LH level than the PR and TR groups (Figure 1). In the LE groups (Figure 2), significantly ($P < 0,01$) higher mean LH levels were found in the TR and control groups, compared to the PR group. Kids weaned in April, on the other hand, showed a significant ($P < 0,01$) higher mean LH level (HE diet) in the PR group compared to the TR and control groups. The mean LH level of the TR group was also higher ($P < 0,05$) than that of the control group (Figure 3). In LE diet groups, the

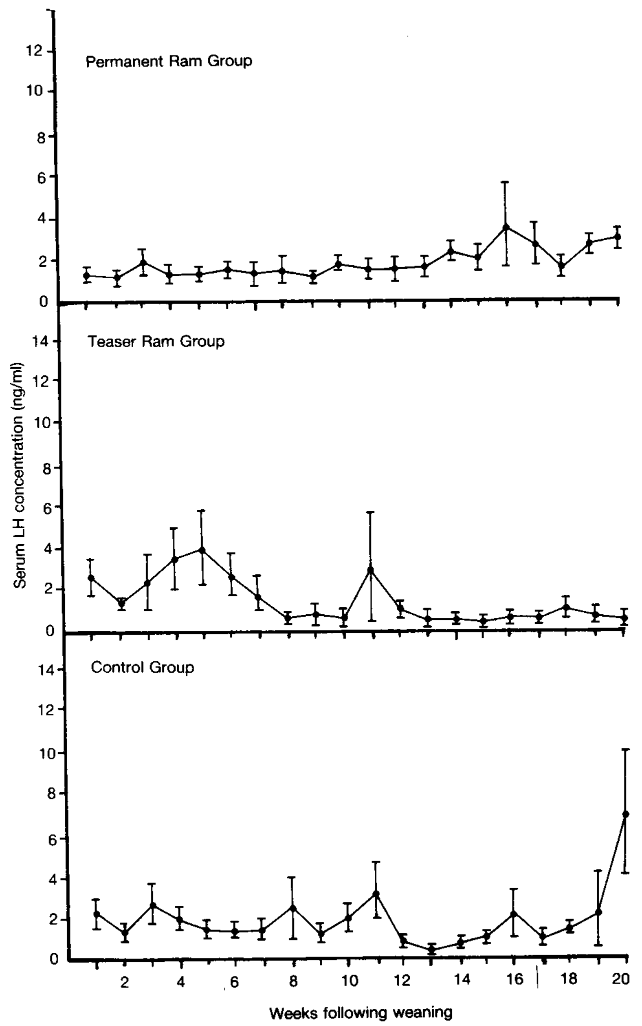

Figure 1 Serum LH concentrations (± *SE*) of December-weaned Boer goat kids on a high-energy diet, subjected to different male treatments.

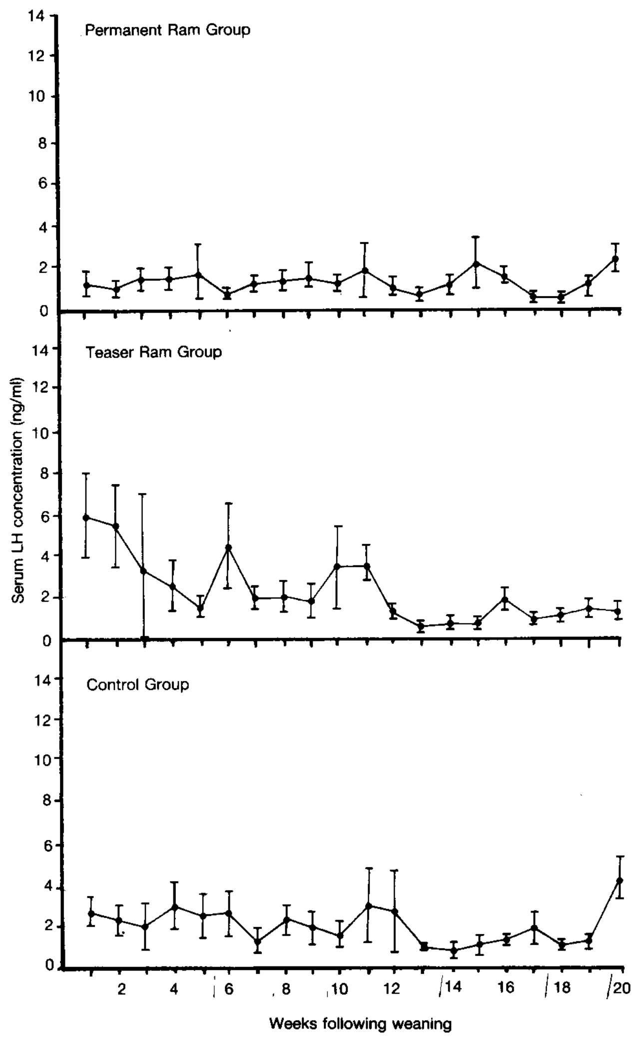

Figure 2 Serum LH concentrations (± *SE*) of December-weaned Boer goat kids on a low-energy diet, subjected to different male treatments.

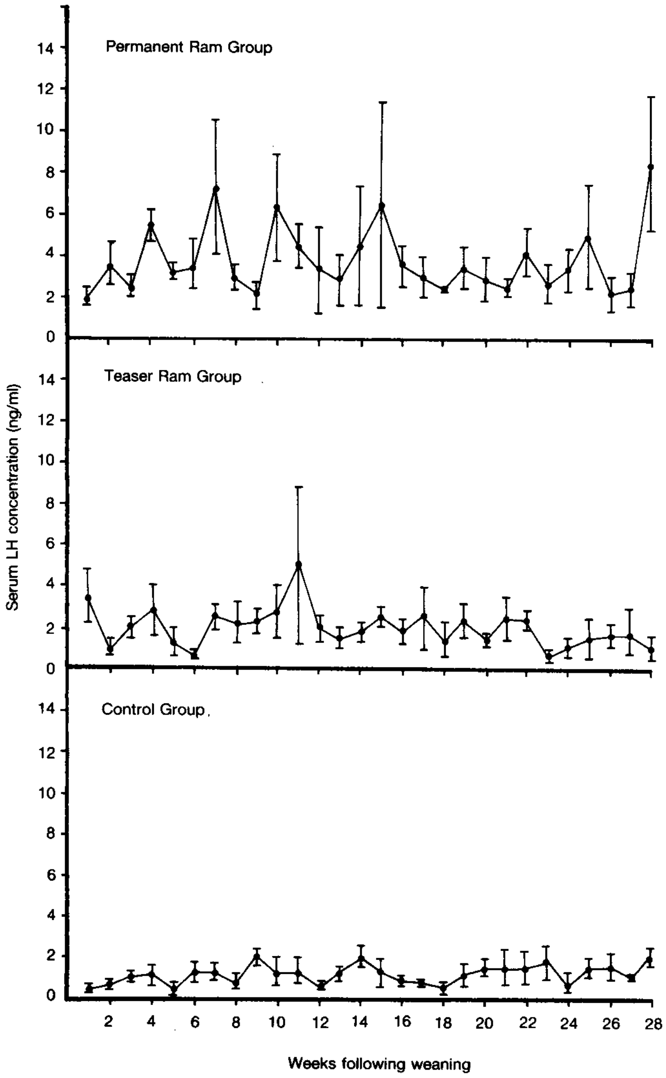

Figure 3 Serum LH concentrations (± *SE*) of April-weaned Boer goat kids on a high-energy diet, subjected to different male treatments.

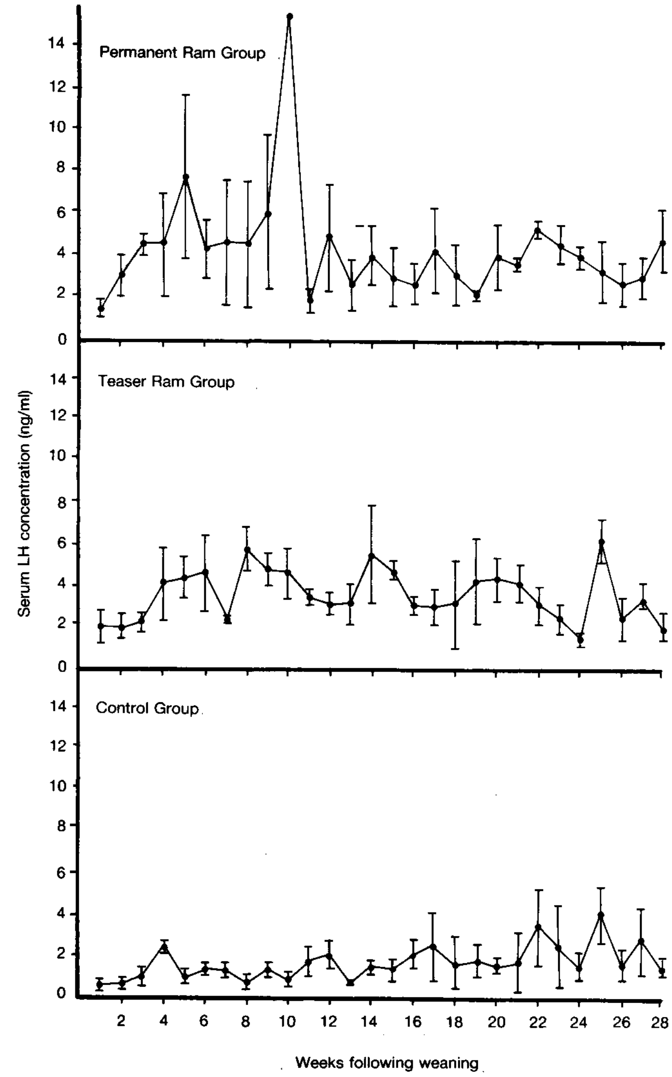

Figure 4 Serum LH concentrations (± *SE*) of April-weaned Boer goat kids on a low-energy diet, subjected to different male treatments.

mean serum LH of PR and TR groups were not significantly different, although significantly ($P < 0{,}01$) higher than that of the control group (Figure 4).

Serum progesterone levels

Most of the kids weaned in December, which did not show any external signs of oestrus, did show periodically elevated progesterone levels (> 1 ng/ml) during the observation period (Table 6). In some animals, the progesterone concentration was found to remain low throughout the observation period, similar to values found in anoestrous females. Kids weaned in April showed the same progesterone pattern as those weaned in December (Table 7). The occurrence of phenomena like silent heat and anoestrous level of progesterone was, however, less frequent. This was possibly due to the higher incidence of oestrus in animals weaned in April, compared to animals weaned in December.

Within the December weaning season, the PR group on a HE diet and TR group on a LE diet showed significant ($P< 0{,}05$) difference in their mean progesterone levels for the observation period (0,87 vs. 0,65 ng/ml respectively). Similar significant ($P < 0{,}05$) differences were found between the control (HE) and TR groups (HE) (1,01 vs. 0,75 ng/ml respectively) and also between the control (HE) and TR (LE) groups ($P < 0{,}01$) (1,01 vs. 0,65 ng/ml respectively). The control group (HE) of animals weaned during April maintained a significantly ($P < 0{,}01$) higher mean progesterone level than the corresponding TR groups (0,98 vs. 0,66 ng/ml and 0,98 vs. 0,7 ng/ml for HE and LE groups respectively). Similarly, the control group (HE) had a higher ($P < 0{,}05$) mean serum progesterone level (0,98 vs. 0,76 ng/ml) for the entire observation period, when compared to the permanent ram group (LE).

The progesterone levels maintained by the PR and control groups (HE) weaned in December, were significantly higher ($P < 0{,}05$; $P< 0{,}01$) than the mean progesterone levels in the TR group (HE) weaned in April (0,87 vs. 0,66 ng/ml and 1,01 vs. 0,66 ng/ml respectively). The control group (HE) of the December-weaned group also maintained at significantly higher mean progesterone level than either the PR group (LE) ($P < 0{,}05$); the TR group (LE) ($P < 0{,}01$), or the control group (LE) ($P < 0{,}05$) weaned in April. On the other hand, the mean progesterone levels of both TR groups weaned in December were lower than that of the control (HE) group

Table 6 Mean (± *SD*) serum progesterone concentrations (ng/ml) of female Boer goat kids on a high- and a low-energy diet, following different ram treatments — from weaning in December to April

	Serum progesterone concentration (ng/ml)					
	High-energy diet			Low-energy diet		
Weeks following weaning	Permanent ram group	Teaser ram group	Control group	Permanent ram group	Teaser ram group	Control group
1	0,44 ± 0,32	0,33 ± 0,15	0,60 ± 0,20	0,34 ± 0,08	0,38 ± 0,14	0,37 ± 0,17
2	0,61 ± 0,26	0,33 ± 0,13	0,90 ± 0,07	0,28 ± 0,06	0,39 ± 0,13	0,70 ± 0,33
3	0,49 ± 0,22	0,67 ± 0,57	0,48 ± 0,18	0,31 ± 0,11	0,70 ± 0,43	0,51 ± 0,26
4	0,27 ± 0,10	1,10 ± 0,48	0,72 ± 0,05	0,47 ± 0,31	0,45 ± 0,30	0,45 ± 0,37
5	0,31 ± 0,09	0,88 ± 0,89	0,38 ± 0,18	0,62 ± 0,28	0,28 ± 0,04	0,36 ± 0,11
6	0,42 ± 0,26	0,77 ± 0,38	0,93 ± 0,18	0,50 ± 0,25	0,44 ± 0,21	0,54 ± 0,31
7	0,49 ± 0,34	0,66 ± 0,19	1,10 ± 0,57	0,44 ± 0,26	0,73 ± 0,45	0,88 ± 0,44
8	0,90 ± 1,01	1,35 ± 1,05	0,64 ± 0,20	0,40 ± 0,19	0,52 ± 0,31	0,95 ± 0,74
9	0,37 ± 0,16	0,53 ± 0,29	0,35 ± 0,0	0,56 ± 0,28	0,70 ± 0,41	1,18 ± 1,30
10	0,51 ± 0,44	1,47 ± 0,57	0,45 ± 0,0	0,63 ± 0,35	1,36 ± 1,56	1,09 ± 0,58
11	1,23 ± 0,96	1,12 ± 1,06	0,40 ± 0,0	0,46 ± 0,16	0,46 ± 0,28	1,33 ± 1,05
12	0,68 ± 0,41	0,54 ± 0,52	0,80 ± 0,0	0,69 ± 0,60	0,82 ± 0,44	0,68 ± 0,55
13	1,36 ± 0,70	0,74 ± 0,76	0,60 ± 0,0	1,14 ± 0,86	0,90 ± 0,96	0,38 ± 0,16
14	1,91 ± 1,65	0,57 ± 0,34	1,78 ± 1,41	0,90 ± 0,57	0,65 ± 0,29	0,95 ± 0,74
15	0,88 ± 0,45	1,10 ± 0,92	4,00 ± 1,63	1,09 ± 1,28	0,45 ± 0,28	1,45 ± 1,09
16	2,88 ± 1,24	0,36 ± 0,30	0,68 ± 0,0	0,93 ± 0,65	0,96 ± 1,22	0,54 ± 0,41
17	1,38 ± 0,60	0,53 ± 0,46	0,75 ± 0,0	1,56 ± 1,10	0,37 ± 0,15	0,61 ± 0,29
18	0,69 ± 0,51	0,61 ± 0,58	0,97 ± 0,02	2,14 ± 1,29	1,15 ± 0,89	0,81 ± 0,72
19	1,01 ± 1,17	0,63 ± 0,29	0,67 ± 0,0	1,78 ± 1,10	0,90 ± 1,30	1,05 ± 0,72
20	0,61 ± 0,25	0,59 ± 0,39	3,08 ± 1,17	1,18 ± 0,93	0,52 ± 0,40	1,15 ± 1,06

weaned in April ($P < 0,05$ and $P < 0,01$ for HE and LE diets respectively).

Only 50% of the male-stimulated pre-pubertal female kids (for both levels of nutrition) weaned in December, compared to 83,3% of the April-weaned females, demonstrated at least one oestrous period during the observation period.

Discussion

Puberty is the commencement of a circannual rhythm of reproductive periodicity that may be entrained by photoperiodic stimulation, should this be perceived at the appropriate time, but it will occur in the absence of day-length change (Amoah & Bryant, 1984b). It would seem that the age at onset of puberty in Boer goat doe compares well with and, in fact, is somewhat earlier than in most goat breeds, e.g. the Saanen (217,9 days), Angora (240 days), Black Bengal (196,5 days) and Barbari nannies (213 days) (Riera, 1982; Amoah & Bryant, 1984b; Bhattacharyya, Sanwal, Pande & Varshney, 1984).

Values for mean mass and age of the Boer goat doe at first oestrus recorded in these experiments are in agreement with results obtained elsewhere on goats (Riera, 1982). The mean masses at first oestrus for Boer goat kids born in January and August were 31,1 kg and 27,4 kg respectively, compared to 30,0 kg for Saanen kids born in March/April (Amoah & Bryant, 1984a). In the present study, kids weaned in April (during the normal breeding season) exhibited oestrus significantly ($P < 0,05$) earlier than those weaned in December. This phenomenon cannot be ascribed to a higher mean live mass within the respective kidding seasons, the level of nutrition or the ram-effect. It would seem as if season of birth is the main cue for the onset of puberty. According to Quirke (1979), once ewe lambs have attained a critical body mass necessary for attainment of puberty, differences in live body mass have little influence on the time of onset of puberty. There is, however, good evidence that inadequate nutrition may adversely affect pituitary function (Lamming, 1969).

Emanating from the oestrous response, it is evident that the permanent presence of a male did have a marked ($P < 0,05$) beneficial effect on the number of animals exhibiting oestrus, in both seasons. Amoah and Bryant (1984a) suggested that contact with the male goat does have an effect on the timing of puberty and is associated with rapid and highly synchrous attainment of puberty in the majority of kids.

The long inter-sampling period (weekly), as well as the variation in serum LH levels obtained between individuals within groups, tend to complicate the interpretation of these hormone levels recorded. The LH pattern in the pre-pubertal female goat is characterized by pulsatile or episodic LH releases. In the ewe lamb, these rhythmic LH elevations first appear between 4 and 11 weeks of age. The transition of the adult ewe from anoestrus into the breeding season, is associated with a marked reduction in response to oestradiol — much the same as in the lamb during puberty (Foster & Ryan, 1979). From serum LH concentrations recorded in the Boer goat, it is evident that the pituitary is active from 13 weeks of age (weaning) irrespective of season, ram-effect or level of nutrition. Although the time interval between

Table 7 Mean (± *SD*) serum progesterone concentrations (ng/ml) of female Boer goat kids on a high- and a low-energy diet, following different ram treatments — from weaning in April to October

	Serum progesterone concentration (ng/ml)					
	High-energy diet			Low-energy diet		
Weeks following weaning	Permanent ram group	Teaser ram group	Control group	Permanent ram group	Teaser ram group	Control group
1	0,45 ± 0,18	0,40 ± 0,09	0,25 ± 0,07	0,38 ± 0,11	0,42 ± 0,17	0,43 ± 0,15
2	0,55 ± 0,30	0,68 ± 0,13	0,40 ± 0,14	0,37 ± 0,16	0,55 ± 0,17	0,66 ± 0,29
3	0,55 ± 0,39	0,48 ± 0,25	0,55 ± 0,0	0,44 ± 0,17	0,58 ± 0,16	0,51 ± 0,14
4	0,59 ± 0,53	0,52 ± 0,16	1,15 ± 0,28	0,46 ± 0,05	0,65 ± 0,31	0,48 ± 0,19
5	0,73 ± 0,63	0,48 ± 0,22	1,78 ± 0,39	0,44 ± 0,02	0,65 ± 0,35	0,45 ± 0,18
6	0,77 ± 0,81	0,47 ± 0,33	2,15 ± 2,62	0,63 ± 0,18	0,62 ± 0,35	0,59 ± 0,04
7	0,51 ± 0,20	0,30 ± 0,05	0,47 ± 0,33	0,77 ± 0,16	0,53 ± 0,14	0,53 ± 0,23
8	0,80 ± 0,35	0,57 ± 0,18	2,28 ± 2,72	0,82 ± 0,60	0,74 ± 0,24	0,53 ± 0,23
9	0,74 ± 0,35	0,46 ± 0,15	0,78 ± 0,60	0,48 ± 0,16	0,80 ± 0,04	0,78 ± 0,45
10	0,55 ± 0,30	0,76 ± 0,34	0,83 ± 0,18	0,32 ± 0,16	1,01 ± 0,49	0,71 ± 0,17
11	1,02 ± 0,56	1,11 ± 0,55	0,44 ± 0,26	0,84 ± 0,32	0,77 ± 0,44	0,66 ± 0,20
12	1,07 ± 1,03	0,40 ± 0,19	0,40 ± 0,07	0,75 ± 0,43	0,78 ± 0,29	1,11 ± 1,12
13	0,44 ± 0,14	0,59 ± 0,23	0,42 ± 0,19	1,69 ± 0,60	0,51 ± 0,12	0,81 ± 0,39
14	0,63 ± 0,41	0,77 ± 0,26	0,33 ± 0,11	0,18 ± 0,79	0,57 ± 0,31	0,63 ± 0,08
15	0,45 ± 0,15	0,69 ± 0,34	0,48 ± 0,25	0,75 ± 0,21	0,69 ± 0,48	0,77 ± 0,42
16	0,82 ± 0,74	0,62 ± 0,20	0,73 ± 0,67	0,46 ± 0,05	0,68 ± 0,20	1,22 ± 0,91
17	0,57 ± 0,34	0,56 ± 0,21	2,33 ± 0,95	0,79 ± 0,37	0,67 ± 0,03	0,46 ± 0,14
18	0,67 ± 0,35	0,78 ± 0,18	1,80 ± 1,06	1,02 ± 0,45	1,07 ± 0,35	0,47 ± 0,19
19	0,64 ± 0,25	0,53 ± 0,16	0,88 ± 0,67	0,87 ± 0,89	0,75 ± 0,18	1,19 ± 1,09
20	0,44 ± 0,14	1,04 ± 0,55	0,68 ± 0,09	0,45 ± 0,05	0,49 ± 0,24	0,64 ± 0,38
21	0,57 ± 0,23	0,69 ± 0,25	0,88 ± 0,88	1,14 ± 0,86	0,73 ± 0,25	0,88 ± 0,79
22	0,74 ± 0,59	0,46 ± 0,21	2,05 ± 0,71	0,82 ± 0,14	0,39 ± 0,10	0,60 ± 0,13
23	0,89 ± 0,45	0,53 ± 0,25	1,18 ± 0,18	0,87 ± 0,29	0,56 ± 0,26	1,00 ± 0,30
24	1,23 ± 0,80	1,84 ± 2,31	0,53 ± 0,32	0,78 ± 0,47	0,78 ± 0,53	1,25 ± 0,79
25	2,53 ± 2,46	1,10 ± 0,54	1,55 ± 1,34	0,87 ± 0,60	0,68 ± 0,16	0,38 ± 0,08
26	0,53 ± 0,20	0,70 ± 0,26	0,50 ± 0,21	0,62 ± 0,52	0,51 ± 0,81	0,49 ± 0,32
27	0,72 ± 0,50	0,58 ± 0,21	1,51 ± 0,98	1,05 ± 0,53	1,00 ± 0,48	2,05 ± 0,77
28	1,13 ± 1,19	0,48 ± 0,10	0,30 ± 0,0	1,34 ± 0,50	1,43 ± 0,91	0,70 ± 0,13
						1,37 ± 0,52

blood sampling was too long to obtain reliable pre-ovulatory peak LH values, it is evident that elevated LH values did occur in some animals prior to the demonstration of first oestrus. This serves as an indication of the possible occurrence of ovulation. The fact that animals weaned in April maintained a significant ($P < 0,05$) higher mean LH level than animals weaned in December, may indicate greater pituitary activity during the breeding season (April).

The possible high occurrence of silent heats or oestrus without ovulation is emphasized by individual serum progesterone profiles recorded during the respective observation periods. Several kids have been found to show elevated progesterone levels (> 1,0 ng/ml) for one or more consecutive weeks, without any overt signs of oestrus. This occurrence of silent heats or oestrus without ovulation is a phenonemon which also frequently occurs in ewe lambs at, and following puberty (Edey, Kilgour & Breamer, 1978). From the serum progesterone values obtained, it seems that ovarian activity started in the high- and low-energy diet groups at approximately 7,6 ± 3,5 and 9,1 ± 4,3 weeks following weaning for kids weaned in December and at 7,6 ± 3,5 and 12,7 ± 6,8 weeks after weaning for the kids weaned in April. These values correspond well to the mean age at which first oestrus was recorded in the Boer goat. No specific trend could be identified regarding mean progesterone levels for the respective observation periods, although some significant differences did occur between groups (different energy levels and ram treatments) and between seasons. The mean progesterone values obtained at first oestrus in the present study are in agreement with that recorded in pre-pubertal sheep, viz. 0,3 ng/ml (Berardinelli, Dailey, Butcher & Inskeep, 1980) and with those recorded in goats, viz. 0,2—0,4 ng/ml (Amoah & Bryant, 1984a) and 0,29—0,53 ng/ml (Bhattacharyya *et. al.*, 1984).

Contact with male goats did have a beneficial effect on synchronization and timing of puberty, entrained by photoperiodic stimulation, while nutrition, as applied in this experiment, played a minor role. The effect of the interaction between these factors on puberty is, however, difficult to assess. It would appear that during the peri- and post-pubertal period, cyclic activity of the young animal is rather erratic and irregular and breeding at such an age is impractical and not advisable. Further research is needed to elucidate the relative importance of male stimulation on the initiation of puberty, especially in relation to other environmental (season and nutrition) cues.

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