Synchronization of oestrus in the Boer goat doe: Dose effect of prostaglandin in the double injection regime

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The administration of different doses (62,5; 125 or 250 µg per injection) of a prostaglandin analogue (cloprostenol) 14 days apart (in the double injection regime), proved that oestrus can be synchronized very efficiently in the Boer goat doe, at all the doses. Of the does 77,1% responded with oestrus to the first cloprostenol injection. An increase in the dose of cloprostenol was not accompanied by a significant increase in oestrous response (93,8%, 87,5% and 100,0% for the three doses, respectively). The time from prostaglandin administration to oestrus was significantly ($P < 0,05$) shorter following the double injection prostaglandin regime when compared to the time after a single injection (mean 55,3 and 62,4 h respectively). A significant ($P < 0,01$) difference in oestrus duration was found between the first and second injections of prostaglandin (mean of 30,9 and 41,9 h respectively). The mean serum progesterone concentration fell rapidly (± 70%) within the first 6 h following the second prostaglandin injection. The mean serum LH concentration following the second injection of prostaglandin varied between 0,23 ng/ml and 10,1 ng/ml for the three treatment groups. A mean conception rate of 58,1% was achieved following AI for the different treatment groups. This study emphasizes the potential of this prostaglandin analogue as a synchronizing agent in Boer goat does.
S. Afr. J. Anim. Sci. 1986, 16: 146 – 150

Die toediening van verskillende dosisse (62,5; 125 of 250 µg per inspuiting) prostaglandienanaloog (cloprostenol) met 'n 14-dae-interval (die dubbele inspuitingsprogram), het bewys dat estrus baie effektief in Boerbokooie gesinkroniseer kan word by alle dosisse. Van die bokooie het 77,1% gereageer op die eerste prostaglandien-inspuiting in terme van estrusmanifestasie. 'n Verhoging in die prostaglandiendosis het geen betekenisvolle verhoging in estrusrespons tot gevolg gehad nie (93,8%, 87,5% en 100% vir die drie behandelings respektiewelik). Die tydsduur van behandeling tot estrus was betekenisvol korter ($P < 0,05$) na die dubbele inspuiting met prostaglandien, vergeleke met die tydsduur na 'n enkele inspuiting (gemiddeld 55,3 en 62,4 h respektiewelik). 'n Betekenisvolle ($P < 0,01$) verskil in die lengte van die estrusperiode is gevind na een en twee inspuitings respektiewelik. Die gemiddelde serum-progesteroon-konsentrasie het vinnig gedaal (± 70%) binne 6 h na die tweede prostaglandieninspuiting. Die gemiddelde serum-LH-konsentrasie na die tweede prostaglandieninspuiting het tussen 0,23 ng/ml en 10,1 ng/ml gevarieer vir die drie groepe. 'n Gemiddelde konsepsiesyfer van 58,1% is met KI verkry vir die behandelings-groepe. Hierdie studie bevestig die potensiaal van hierdie prostaglandienanaloog as 'n sinkroniseermiddel by Boerbokooie.
S.-Afr. Tydskr. Veek. 1986, 16: 146 – 150

Keywords: Synchronization, oestrus, goats, prostaglandin, progesterone, LH

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Received 5 November 1985

The efficiency of synchronizing the oestrous cycle with two intramuscular injections of prostaglandin has been clearly established in sheep (Greyling, 1978; Haresign, 1978; Hunter, 1980; Fukui & Roberts, 1981) and only more recently in goats (Bosu, Serna & Barker, 1978; Ott, Nelson & Hixon, 1980). It has been demonstrated that the effectiveness of prostaglandins for oestrous synchronization in does and ewes depends on the presence of one or more functional corpora lutea (Bosu, *et al.*, 1978) and to overcome this refractory period of the ovary to prostaglandin, two injections of prostaglandin are administered 8 – 14 days apart (Fairnie, Cumming & Martin, 1976; Haresign, 1978). With the Boer goat having an oestrous cycle of 21,8 ± 1,7 days (Greyling, unpublished) this refractory period of the ovary to prostaglandin is as yet unknown.

This study was initiated to determine the effectiveness of different doses of cloprostenol (sufficient to induce luteolysis and acceptable post-treatment fertility) in Boer goat does with the double prostaglandin injection regime.

Procedure

Forty-eight Boer goat does, ranging from multiparous to maiden, were randomly allocated midway through the breeding season (May, 1982) to three treatment groups of 16 does, each receiving two intramuscular injections of 62,5; 125 or 250 µg of the prostaglandin analogue 14 days apart. The three treatment groups thus received similar treatments, except that the dose of cloprostenol varied.

From 28 days prior to the commencement of the prostaglandin treatment all does were tested twice daily (08h00, 15h00) for oestrus with the aid of vasectomized rams, in order to pre-determine the stage of the oestrous cycle when prostaglandin treatment was first administered. In this way, the sensitive period of the doe's corpus luteum to prostaglandin (seen in terms of oestrous response) could be determined. Does were initially injected at random and following each injection of the prostaglandin analogue all does were tested daily at 07h00, 12h00 and 17h00 for oestrus with the aid of vasectomized rams. After the first injection of cloprostenol the percentage of does exhibiting oestrus in response to only one injection of prostaglandin was established, and after the second injection the oestrous response and the time of insemination was measured. Venous blood (10 ml) was collected from 15 does (five per group) on a daily basis. Sampling commenced immediately prior to the first injection of prostaglandin and ceased after the oestrous period following the second injection of prostaglandin. For the 14-day period between the two prostaglandin injections blood was sampled

daily (08h00) and following the second injection twice daily (08h00 and 15h00). Serum was recovered and stored at −20°C. Serum progesterone concentrations were determined by the non-extraction radioimmuno-assay technique (RSL (^{125}I) progesterone kit), as supplied by Radio-assay Systems Laboratories, Inc., California. The inter- and intra-assay coefficients of variation were 10,6 and 6,1%, respectively. The serum LH concentrations were measured according to the double-antibody technique as described by Niswender, Reichert, Midgley & Nalbandov (1969), and anti-LH (ovine) supplied by Dr. J. Morgenthal (University of Stellenbosch) was used. The inter- and intra-assay coefficients of variation for LH were 15,2 and 9,5% respectively. The labelling of LH was performed according to the method described by Hunter & Greenwood (1962). Does were inseminated with fresh, undiluted semen (0,05 ml) 12 h after the onset of oestrus following the second injection of prostaglandin, and again at 12-h intervals for as long as they remained in oestrus.

Results

The oestrous response and duration of oestrus following the different treatments are presented in Table 1 and Figure 1.

Following the first injection of prostaglandin between 75 and 81,3% of the does exhibited oestrus. Four does first treated at days 2, 4, 17 and 19 of the oestrous cycle in Group 1, four does first treated at days 1, 4, 18 and 22 of the oestrous cycle in Group 2, and three does first treated at days 2, 3 and 18 of the oestrous cycle in Group 3 failed to exhibit oestrus. It thus appeared that corpora lutea between days 0 and 4, and between days 17 and 22 of the oestrous cycle were not always sensitive to cloprostenol. The efficiency of synchronization (as measured by the oestrous response) was not influenced by the dose of cloprostenol. Similarly the difference in oestrous response following one or two injections of cloprostenol was not significant (a mean response of 77,1% following one injection and a mean response of 93,8% following two injections). The interval between injection of cloprostenol and the onset of oestrus differed significantly ($P < 0,05$) between the first and second injection (a mean of 62,4 h and 55,3 h respectively) for all the treatment groups and the does exhibited oestrus sooner after two injections of cloprostenol than with a single injection (Figure 1). Dose of cloprostenol had no significant effect on the duration of the induced oestrus following the second injection of prostaglandin although the oestrous periods were significantly shorter ($P < 0,05$) following a single injection of cloprostenol (a mean of 30,9 h for a single injection vs 41,9 h for two injections). Changes in the mean serum progesterone concentrations are summarized in Figure 2. From this figure, it is apparent that the different doses of cloprostenol caused rapid luteolysis in the does in the double injection regime, with no significant difference between the treatment groups. The mean serum progesterone concentration dropped rapidly following the first injection of prostaglandin within a 6-h period (a mean drop in progesterone concentration of approximately 65% for all groups). Similarly the progesterone concentration dropped, following the second prostaglandin injection within a 6-h period (a mean drop in progesterone concentration of approximately 71% for all groups).

A typical response of a doe (doe A), first injected on day 2 of the oestrous cycle (follicular phase) during the refractory period, when the corpus luteum is relatively insensitive to the luteolytic action of prostaglandin, is illustrated in Figure 3.

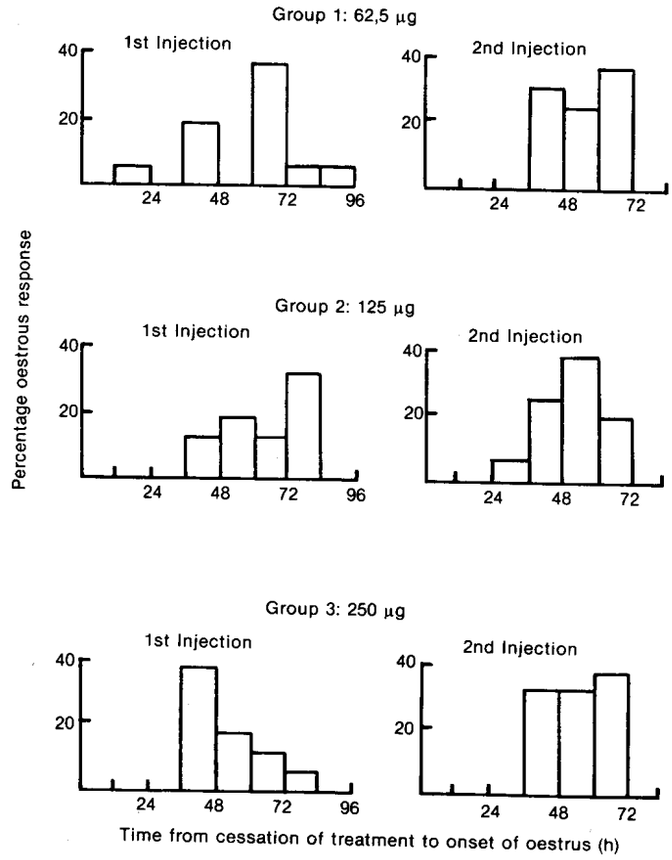

Figure 1 The distribution of the occurrence of oestrus in Boer goat does, following treatment with different doses of cloprostenol in the double injection regime.

Table 1 The oestrous response of Boer goat does treated with different doses of cloprostenol in the double injection regime to synchronize oestrus

Measurement	Dose of cloprostenol (µg)					
	62,5		125		250	
	1st Inject.	2nd Inject.	1st Inject.	2nd Inject.	1st Inject.	2nd Inject.
Oestrous response (%)	75,0	93,8	75,0	87,5	81,3	100,0
Interval from cessation of treatment to onset of oestrus (h)	62,6 ± 19,1	57,3 ± 11,1	64,7 ± 11,8	52,1 ± 11,8	60,0 ± 20,3	56,6 ± 10,9
Range (h)	22 – 94	46 – 70	48 – 77	26 – 70	46 – 117	46 – 70
Duration of oestrus (h)	31,2 ± 10,5	42,7 ± 8,2	27,8 ± 12,1	40,8 ± 9,0	33,9 ± 14,0	42,1 ± 11,1
Mean serum progesterone concentration at onset of oestrus (ng/ml)	0,3 ± 0,1	0,2 ± 0,1	0,3 ± 0,1	0,7 ± 0,5	0,3 ± 0,2	0,3 ± 0,1

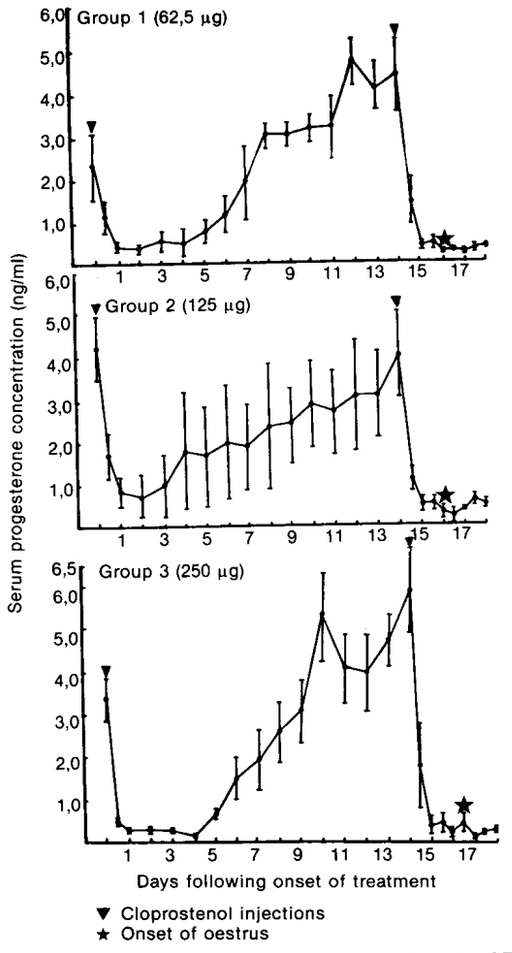

Figure 2 The mean serum progesterone concentrations (± *SE*) in Boer goat does receiving two injections (62,5; 125 or 250 µg) of cloprostenol 14 days apart.

This doe did not respond to the first injection of prostaglandin, but exhibited oestrus after the second injection of prostaglandin and conceived. In the group treated with 125 µg of cloprostenol, a doe (doe B) did not exhibit oestrus in response to both injections of prostaglandin (day 22 following last oestrous period) and it would appear as if the doe did not ovulate because LH concentrations were not elevated (Figure 3). Another doe in this group (first treated on day 4 of the oestrous cycle) exhibited basal serum progesterone concentrations throughout the sampling period. The relatively low progesterone level in this doe was similar to the level reported for anoestrous does (Thorburn & Schneider, 1972). In the group treated with 125 µg of cloprostenol per injection is an excellent example of a doe (doe C) which experienced a 'silent heat' following the first injection of cloprostenol (Figure 3). The progesterone concentration decreased to a basal level at 24 h after the first injection, remained relatively low for approximately 72 h and then commenced increasing. Figure 3 also illustrates progesterone levels in a doe (doe D) which responded to both injections of prostaglandin (62,5 µg per injection) and which exhibited oestrus following both injections.

The serum LH concentration following the second injection of cloprostenol was determined in order to gauge the approximate time of ovulation and in fact to establish whether the animals possibly had ovulated or not. The intervals between consecutive blood samples were too long (8 – 16 hours) for an accurate determination of the LH peak (Lishman, Stielau, Dreosti, Stewart & Botha, 1974). It is of interest to note how the position of the LH peak varies relative to the onset of oestrus (Figure 4).

The reproductive performance achieved in does following

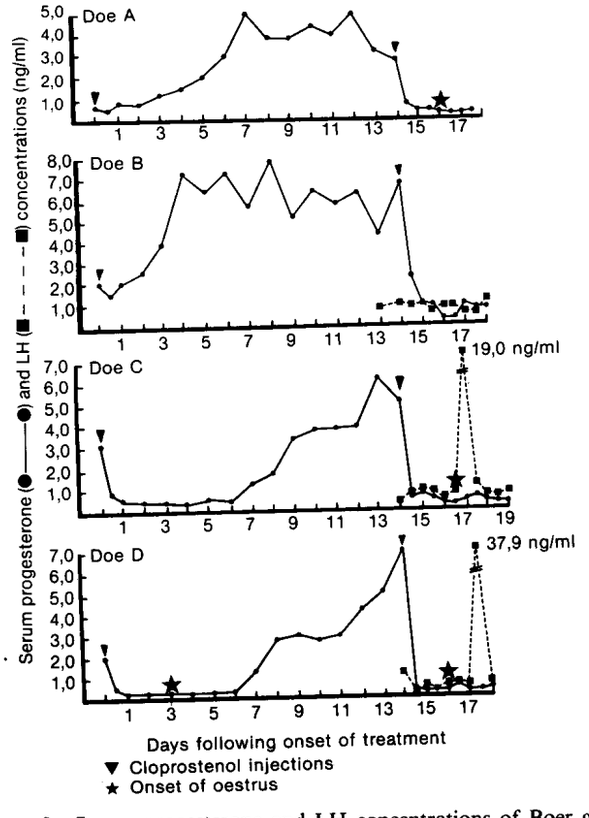

Figure 3 Serum progesterone and LH concentrations of Boer goat does receiving two injections of cloprostenol 14 days apart.

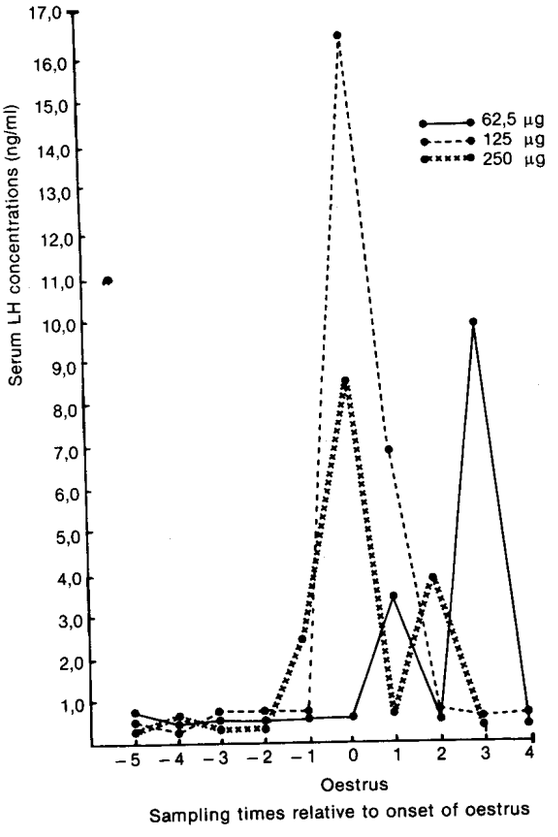

Figure 4 Mean serum LH levels, relative to the onset of oestrus in Boer goat does receiving different doses of cloprostenol as part of the double injection regime.

Table 2 The effect of different doses of prostaglandin $F_{2\alpha}$ (cloprostenol) on the reproductive performance of Boer goat does treated with the double injection regime

Measurement	Dose of cloprostenol (μg)		
	62,5	125	250
No does treated	16	16	16
No does inseminated	15	14	16
Conception rate (%) in does inseminated	73,3	57,1	43,8
Kids born/does treated (%)	24 (150,0)	17 (106,3)	17 (106,3)
Kids born/doe kidded	2,2	2,1	2,4

the different levels of cloprostenol administration are presented in Table 2.

No significant differences in the reproductive efficiency could be established between treatments, probably as a result of the limited number of animals. It is, however, apparent that as the dose of cloprostenol increased from 62,5 to 250 μg per injection, the conception rate decreased correspondingly.

Discussion

From the results recorded during this experiment it is evident that oestrus in the Boer goat can be synchronized very efficiently by using two injections of cloprostenol (62,5 μg – 250 μg each), 14 days apart. Following the first injection of cloprostenol the group receiving 250 μg per injection responded more rapidly and luteolysis appeared more complete. The number of does which did not respond to one injection of cloprostenol (a mean of 22,9% for all treatment groups) in this study indicates that the prostaglandin analogue caused luteal regression between days 5 and 16 of the oestrous cycle. Corpora lutea outside of this stage of the cycle may not always be sensitive to cloprostenol, that is, they occur during the refractory period of the corpus luteum to prostaglandin in the Boer goat doe. This is in accordance with results obtained by Ott, *et al.* (1980), who found that the period when the corpus luteum of the goat is sensitive to prostaglandin is from day 4 to 16 of the oestrous cycle. Ott (1980) recorded a 85% oestrous response in does following one injection of prostaglandin ranging between days 4 and 18 of their oestrous cycle.

The day when the animals were first treated showed no significant effect on the pattern of serum progesterone decline. Unfortunately only five animals per group were sampled, but treatment between days 5 and 16 of the oestrous cycle evoked a rapid fall in serum progesterone concentrations similar to that reported by Acritopoulou & Haresign (1980) who found basal values smaller than 0,5 ng/ml within 24 h following a single injection of prostaglandin in sheep. The time interval from the first prostaglandin injection to the onset of oestrus appeared longer for groups treated at mid-cycle (days 8 or 11) in sheep compared to early or late in the oestrous cycle (Acritopoulou & Haresign, 1980), but this trend was not so clear in the Boer goat, especially in the goats receiving 250 μg cloprostenol. No significant effect was noted in all three groups regarding the duration of the induced oestrous period following the first treatment and the stage of the oestrous cycle. The significant ($P < 0,05$) shorter interval from cessation of treatment to the onset of oestrous following the double injection of prostaglandin compared to a single injection and the shorter ($P < 0,05$) duration of the induced oestrous period following only a single injection of prostaglandin can probably be attributed to the responsiveness of the corpus luteum to prostaglandin and the degree of luteolysis at the stage of cloprostenol administration.

Peripheral serum progesterone concentrations in the does decreased rapidly following both injections of prostaglandin and concentrations of below 1 ng/ml were recorded within 24 h. The serum progesterone levels obtained in this study, compare well with those obtained by Thorburn & Schneider (1972) who measured a mean luteal concentration of 4,0 ng/ml and values at oestrus of 0,2 ng/ml, while they were lower than those measured by Heap & Linzell (1966) who obtained values of 3,4 ng/ml at oestrus. These low progesterone levels following treatment demonstrate the efficiency of prostaglandin for controlling oestrus in the goat.

The serum LH concentrations following the second injection of cloprostenol was determined to observe the approximate time of the LH surge relative to oestrus. As there is a pulsatile release of LH and such fluctuations in hormone levels can have an important influence on the results obtained, findings based on samplings repeated several times each day and continued over a number of days would be preferable (Lishman, *et al.*, 1974) to long inter-sampling periods. The intervals between blood samplings in this study were too long (8 – 16 h) for an accurate determination of the LH peak and the approximate peak was taken as the highest measured LH value (which varied from 5,8 ng/ml to 47,5 ng/ml for the individual animals). According to Hopkinson & Pant (1973) the increased LH secretion commences between 0 and 10 h following the onset of oestrus, whilst Lishman (1972) showed that an early LH peak is not abnormal and often occurs prior to the onset of oestrus in sheep. The mean serum LH concentration at the onset of oestrus for all the treatment groups was 0,5 ng/ml (excluding one animal that had an elevated LH level of 47,5 ng/ml at the onset of oestrus). The decrease in LH peak values following synchronization with exogenous hormones in sheep indicate that the concentration of LH secreted in these cases may be insufficient for optimum fertility when compared to normally cycling ewes (Baumgartner, Lishman, Louw & Botha, 1974).

Pregnancy rates in goats achieved after the use of the double prostaglandin regime (Ott, *et al.*, 1980) was 70,6% (first service conception), compared to a mean conception rate of 58,1% achieved with the Boer goat. A factor possibly contributing to this relatively poor fertility was the fact that none of the six (12,5%) maiden does (two does per group) used in these trials conceived following synchronization and AI. Similarly, although non-significant, it is of interest to note that as the dose of cloprostenol increased, so the conception rate correspondingly declined in this experiment. The reason for this phenomenon remains obscure.

From the fertility results obtained and from a financial point of view, it would seem that the lowest dose of cloprostenol (62,5 μg per injection) investigated, is the most suitable for synchronization in the double injection regime.

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