age of cow, date of calving, and body mass). The high management level and low stocking rate, resulting in a high recalving rate in the present study, may be the reason for this contradictory result. In light of this high recalving rate, it could be argued that the situation at the Mara Research Station is not comparable to the whole region, where lower recalving rates are normally obtained. This probably indicates that under favourable conditions, recalving is not restricted by breeds, body mass or age of cow.

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Synchronization of oestrus in sheep: Use of different doses of progestagen outside the normal breeding season

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One hundred and thirty Merino ewes were used to test the efficiency of different doses of medroxyprogesterone acetate (MAP) progestagen to synchronize oestrus outside the breeding season. Three treatments, consisting of intravaginal progestagen doses (60 mg, 40 mg and halved 60 mg MAP sponges) were applied for 14 days. Each ewe (35 per treatment) received an intramuscular injection of 300 IU PMSG at sponge withdrawal. The fourth group ($n = 25$) served as a control. No significant difference was found in the oestrous response and the duration of the induced oestrous period between the different treatments following sponge withdrawal. The mean length of the induced oestrous period for all treatments did not differ significantly from the natural oestrous period (29.4 ± 7.6 vs. 25.9 ± 6.8 h, respectively). The mean serum LH and progesterone concentrations for the observation period did not differ significantly between the 60 mg, 40 mg and halved-sponge treatments (6.95 ± 8.74 and 0.28 ± 0.33; 9.17 ± 13.38 and 0.33 ± 0.47; 6.83 ± 6.09 and 0.20 ± 0.16 ng/ml, respectively). For the respective treatments, the mean position of the LH peak was 45.6, 46.8 and 42.0 h following sponge withdrawal, and 4.8, 3.6 and 0 h (oestrus) following the onset of oestrus, compared to 6.0 h for the control. MAP absorption over the 14-day period was 20.4% for the 60 mg treatment, 41.5% for the 40 mg treatment and 41.2%

for the halved-sponge treatment. The conception and lambing rates did not differ significantly between treatments with 75.0 and 79.2%; 62.5 and 70.8%; 65.2 and 95.7%; 72.7 and 90.9% for the 60 mg, 40 mg, halved-sponge and control groups, respectively. Fecundity was significantly ($P < 0.05$) higher in ewes subjected to the halved sponges than in those which received 60 mg of progestagen (1.47 vs. 1.06). Reducing the dose of MAP outside the breeding season held no advantages, and no detrimental side-effects were monitored with the administration of excess progestagen.

Eenhonderd en dertig merino-ooie is buite die teelseisoen met verskillende dosisse medroksiprogesteroonasetaat (MAP) progestagene behandel om die effektiwiteit daarvan op sinkronisasie van estrus te toets. Drie intravaginale progestageendosisse (60 mg, 40 mg en gehalveerde 60 mg MAP-sponse) is vir 14 dae ($n = 35$/groep) toegedien met 'n 300 IU DMSG binnespierse inspuiting na sponsonttrekking. 'n Vierde groep ($n = 25$) het as kontrole gedien. Geen betekenisvolle verskil in die estrusrespons en tydsduur van die geïnduseerde estrusperiode tussen groepe is verkry nie. Die gemiddelde tydsduur van die geïnduseerde estrusperiode van al die behandelingsgroepe was nie betekenisvol verskillend van die natuurlike periode (29.4 ± 7.6 vs. 25.9 ± 6.8 h respektiewelik) nie. Die gemiddelde serum-LH- en progesteroonkonsentrasies tydens die waarnemingsperiode het nie betekenisvol vir die onderskeie behandelings (60 mg, 40 mg en gehalveerde sponse) verskil nie (6.95 ± 8.74 en 0.28 ± 0.33; 9.17 ± 13.38 en 0.33 ± 0.47; 6.83 ± 6.09 en 0.20 ± 0.16 ng/ml respektiewelik). Vir die onderskeie behandelingsgroepe was die gemiddelde posisie van die LH-piek 45.6, 46.8 en 42.0 h na sponsonttrekking en 4.8, 3.6 en 0 h (estrus) na die aanvang van estrus, vergeleke met 6.0 h vir die kontrolegroep. Die persentasie MAP-opname was 20.4% vir die 60 mg-, 41.5% vir die 40 mg- en 41.2% vir die gehalveerdespons-groep. Die konsepsiesyfer en lampersentasie het nie betekenisvol tussen die groepe verskil nie, met 75.0 en 79.2%; 62.5 en 70.8%; 65.2 en 95.7%; 72.7 en 90.9% vir die 60 mg-, 40 mg-, halwespons- en kontrolegroepe, respektiewelik. Die fekunditeit was betekenisvol ($P < 0.05$) hoër in die halwesponsgroep, vergeleke met dié in die 60 mg-groep (1.47 vs. 1.06). Die vermindering van die dosis MAP buite die teelseisoen het geen betekenisvolle voordele ingehou nie en oormatige toediening van progestagene het geen nadelige newe-effekte tydens sinkronisasie tot gevolg gehad nie.

Keywords: Anoestrous, dose, progestagen, sheep, synchronization.

Attempts to control oestrus and ovulation in sheep with progestagens are based on simulating the activity of the corpus luteum in cycling sheep (Gordon, 1983). Robinson (1979) suggested that the dose of progestagen employed to control oestrus in sheep is probably too low to simulate the activity of the corpus luteum. Allison & Robinson (1970) found an increase in the incidence of oestrus and ovarian response when the dose of progestagen was increased. This is contrary to Faure *et al.* (1983), who found optimal fertility in synchronized sheep treated with minimal doses of progesterone and Smith (1978) who found no significant difference in conception rate and lambing percentage when different doses of progestagen were administered. Of the factors leading to a depression in fertility following the use of synthetic progestagens, perhaps the most important are dose level and method of preparation. This depression is related to the pattern of absorption of progestagen from the pessaries (Haresign, 1978). Studies have been directed mainly at comparing different types of progestagens (McKonnen *et al.*, 1988; Crosby *et al.*, 1991). However, the dose of progestagen impregnation, especially that of medroxyprogesterone acetate (MAP) sponges, may be rather limited (Boshoff, 1980; Faure *et al.*, 1983). The present study compares the rate of progestagen absorption, efficiency of synchronization and reproductive performance in Merino ewes subjected to different doses of MAP, outside the normal breeding season.

One hundred and thirty multiparous Merino ewes outside the normal breeding season (October/November 1991) were randomly allocated to four groups, viz.:

Treatment 1: 60 mg MAP intravaginal sponges (Repromap, Upjohn) plus 300 IU PMSG (Fostim, Upjohn) (intramuscular: i.m.) at sponge withdrawal ($n = 35$).

Treatment 2: 40 mg MAP intravaginal sponges, plus 300 IU PMSG (i.m.) at sponge withdrawal ($n = 35$).

Treatment 3: Halved 60 mg (approximately 30 mg) MAP intravaginal sponges, plus 300 IU PMSG (i.m.) at sponge withdrawal ($n = 35$).

Treatment 4: Control group ($n = 25$).

Oestrus in the control group was synchronized by inserting MAP sponges the cycle earlier, while all observations were taken from the subsequent or natural oestrous cycle. All sponges were inserted for 14 days. Oestrus was tested at 6-h intervals from sponge withdrawal, with the aid of vasectomized rams, up to the end of the induced oestrous period or for the total observation period of 108 h. Concurrent with oestrous detection, venous blood (10 ml) was sampled from five animals per group for determination of serum progesterone, MAP and LH concentrations. Serum was recovered and stored at –20 °C until assayed. The control group was monitored and sampled from the onset of oestrus.

From each treatment, the sponges of six animals were withdrawn at fixed intervals (Days 2, 5, 7, 9, 12 and 14 following sponge insertion) to monitor the progestagen (MAP) absorption rate from the intravaginal sponges. Ewes from which sponges were withdrawn earlier than Day 14 were not included. Following drying, sponges were stored at –20 °C until assayed. AI was performed at a fixed time (48 and 60 h following sponge withdrawal) in the treated animals using fresh, undiluted semen (0.05 ml), whereas the control animals were inseminated (0.05 ml) 12 and 24 h after the onset of oestrus.

Serum progesterone concentrations were determined using the Coat-A-Count solid-phase radioimmunoassay (RIA) kit (Coat-A-Count, Progesterone, Diagnostic Products Corporation) with inter- and intra-assay coefficients of variation of 8% and 7%, respectively. Serum LH concentrations were determined according to the RIA double antibody technique by Millar & Aehnelt (1977). Purified LH was radio-iodinated (^{125}I) by the method of Hunter & Greenwood (1962). Inter- and intra-assay coefficients of variation for LH were 15% and 9%, respectively. Serum MAP concentrations were determined according to the RIA technique as modified by Boshoff (1980). The MAP antibody used in the assays showed no significant cross-reaction with progesterone. Inter- and intra-assay coefficients of variation were below 10% in both

instances. Following drying of the intravaginal sponges and extraction of the residual MAP with chloroform, the MAP concentrations were determined according to the method of Upjohn as revised by Houtman & Taraszka (1971). The inter-assay coefficient of variation was 10.7%.

All data were statistically evaluated using the analysis of variance test at the 1% and 5% levels of significance. Differences in reproductive responses between groups were tested using the chi-square test (Snedecor & Cochran, 1980). The oestrous response, mean intervals from cessation of treatment to oestrus, duration of the oestrous period and changes in serum MAP concentrations for the different treatments during the observation period are set out in Tables 1 and 2.

One ewe in each of Treatments 1 and 2, and two ewes in Treatment 3 lost their sponges and were removed from the trial. All ewes exhibited oestrus within 48 h following synchronization, except for 1 ewe in Treatment 2 which exhibited oestrus only after 78 h. No significant difference was found in the oestrous response between the different treatments. The length of the induced oestrous period and the time from sponge withdrawal to oestrus did not differ significantly between the treatments (Table 1). Three ewes in Treatment 4 (control) did not exhibit oestrus.

The mean serum LH and progesterone concentration for the observation period did not differ significantly between Treatments 1, 2 and 3. Of the animals from which blood was sampled, two in the group which received half-sponges did not respond to treatment. One ewe lost its sponge and the other exhibited silent heat.

The position of the LH peak (maximum recorded level) relative to the onset of oestrus or sponge withdrawal did not differ significantly between treatments. For Treatments 1, 2 and 3 the mean position of the LH peak was 45.6 ± 8.1, 46.8 ± 6.6 and 42.0 ± 6.0 h following sponge withdrawal, while the mean position of the LH peak relative to the onset of oestrus varied from 6.0 h following the onset of oestrus for Treatment 4 to 4.8 h, 3.6 h, and 0 h for Treatments 1, 2 and 3, respectively. The peak LH values ranged between 11.8 ng/ml and 76.0 ng/ml (Treatment 1) for individually treated animals, whereas these values varied between 9.9 and 67.8 ng/ml in the control ewes.

The mean serum MAP concentration did not decline significantly between Days 2 and 13 after sponge insertion for the three doses of progestagen. A mean decrease of 30.8% was recorded over all treatments over the entire synchronization period (Table 2). From the data it is evident that at the end of sponge treatment (Day 13) there was still a detectable concentration of MAP in the serum (mean of 0.12 ng/ml). The loss of progestagen from the sponge, as determined by the residual progestagen, did not show any specific trend. According to the

Table 1 Oestrous response, interval from treatment to oestrus and the duration of the induced oestrous period (mean ± *SD*) following different progestagen doses

	60 mg MAP	40 mg MAP	Half sponges ± 30 mg MAP	Control
Number of ewes	24	24	23	22
Oestrous response (%)	100.0*	100.0	91.3	
Interval to oestrus (h)	43.0 ± 2.8*	44.4 ± 10.4	42.3 ± 1.3	
Range (h)	36–48	24–78	42–48	
Duration of oestrus (h)	31.4 ± 7.4*	29.0 ± 7.9	27.7 ± 7.7	25.9 ± 6.8

* No significant differences between treatments.

Table 2 Mean (± *SD*) serum MAP concentration (ng/ml) and MAP concentration (mg/ml) in the intravaginal sponges at different stages during synchronization of Merino ewes

Serum MAP concentration:

	Days after sponge insertion						
Treatments	2	3	5	7	9	11	13
60 mg*	0.38 ± 0.15	0.24 ± 0.1	0.25 ± 0.13	0.25 ± 0.04	0.36 ± 0.09	0.21 ± 0.08	0.14 ± 0.07
40 mg*	0.48 ± 0.19	0.31 ± 0.11	0.28 ± 0.07	0.35 ± 0.07	0.24 ± 0.15	0.11 ± 0.06	0.11 ± 0.09
Half sponges*	0.31 ± 0.12	0.19 ± 0.05	0.21 ± 0.06	0.23 ± 0.09	0.21 ± 0.08	0.02 ± 0.08	0.11 ± 0.06

Intravaginal MAP concentration:

	Control	Days after sponge insertion					
Treatments	sponges	2	5	7	9	12	14
60 mg*	49.1 ± 1.2	44.6 ± 2.5	46.5 ± 0.2	46.9 ± 0.1	40.5 ± 0.3	46.6 ± 0.9	39.1 ± 0.9
40 mg*	35.9 ± 7.9	31.7 ± 0.2	22.8 ± 1.3	27.4 ± 2.1	24.8 ± 0.2	26.1 ± 0.6	22.8 ± 0.8
Half sponges*	25.0 ± 0.8	14.2 ± 0.9	20.0 ± 1.8	15.9 ± 0.9	14.3 ± 0.4	16.4 ± 0.2	14.7 ± 0.5

* No significant difference between treatments.

quantity MAP in the sponge (Table 2), only 20.4% of the MAP in Treatment 1 (60 mg) was absorbed during the 14-day treatment period, compared to 41.5% for Treatment 2 (40 mg) and 41.2% in Treatment 3 (halved sponges). The variation in hormone concentration of the unused (control) sponges, especially in the 60 mg MAP sponge, is given in Table 2.

The reproductive performance of the three treatments is set out in Table 3. The conception and lambing rate showed no significant difference between the treatments. Fecundity (lambs born per ewes lambing) differed markedly ($P < 0.05$) only between Treatments 1 and 3. The fecundity of ewes in Treatment 3 (1.47) was substantially higher than that of ewes in Treatment 1 (1.06).

Table 3 Reproductive performance of sheep following different synchronization treatments

	Treatment groups			
	MAP 60 mg	MAP 40 mg	MAP halved 60 mg	Control
Number of ewes	24	24	23	22
Conception rate (%)	75.0	62.5	65.2	72.7
Lambing rate (%)	79.2	70.8	95.7	90.9
Fecundity	1.06	1.13	1.47*	1.25

* $P < 0.05$.

From the oestrous response of all the treatment groups, it is evident that the dose of progestagen in the sponge played no significant role in the synchronization of oestrus in the ewes outside the normal breeding season. The minimum dose of progestagen in the half-sponge was sufficient for efficient synchronization. This is in accordance with results by Walker *et al.* (1989), and Crosby *et al.* (1991), who found no differences in oestrous response for different types and doses of progestagens. The interval between progestagen withdrawal and the onset of oestrus for the 60 mg and half-sponge treatments was substantially shorter in the Merino (43.0 ± 2.8 and 42.3 ± 1.3 h respectively), compared to that in the Karakul breed (57.4 ± 8.8 and 51.0 ± 10.8 h, respectively; Faure *et al.*, 1983). Dose of progestagen exerted no effect on the response time. This shorter interval obtained in the Merino ewes holds in serious implications if the animals are to be inseminated at a fixed time after sponge withdrawal. A possible reason for this shorter response time could have been the good body condition (mean body weight of 48.9 ± 5.1 kg) of the ewes, and the quality of the natural pastures. The ram effect could also have played a role with the frequent teasing with vasectomized rams. The duration of the induced oestrous period did not differ significantly from that of the natural oestrous period, and is in line with results by Boshoff (1980) for ewes synchronized outside the breeding season (28.6 ± 5.31).

The position of the LH peak relative to oestrus did not differ significantly between treatments. There was a trend that as the progestagen dose increased, the position of the LH peak also changed and occurred nearer to the natural pre-ovulatory LH peak position (6 h after the onset of oestrus). It seems as if the dose of progestagen does not cause any drastic hormonal imbalances as far as pre-ovulatory LH peak is concerned. In this trial, the mean peak LH level following an induced oestrous cycle did not differ significantly from the mean obtained at the natural oestrous cycle (53.7 ± 23.2 vs. 46.2 ± 23.8 ng/ml, respectively). The progesterone concentration showed a gradual decline from sponge insertion to withdrawal (except in the half-sponge group where two ewes did not exhibit oestrus) and remained at a basal level following sponge withdrawal, with no significant differences between the treatments.

Serum MAP concentration and MAP concentration in the sponges were determined to assess the rate of absorption of progestagen from the sponges. From the results obtained, it would seem as if the dose of progestagen, even in the halved sponges, was adequate. A mean of 67.4% of the original progestagen dose was present in the sponge following a 14-day treatment, which is in agreement with that found by Boshoff (1980), and it suggests that the original dose of progestagen in the sponge may be reduced. The initial dose of progestagen could influence the residual MAP following sponge withdrawal. No significant quadratic linear decrease in MAP concentration was observed in the serum or sponges as was quoted by MacDonnell (1985). There was a tendency for a slowing down in the rate of absorption of progestagen towards the end of treatment. The level of serum MAP was relatively constant, with a slow, gradual serum MAP decrease of 31.3% during the treatment period for all groups. It is presumed that the clearance of serum MAP is stepped up once the source of exogenous progestagen is removed (sponge withdrawal), and oestrus is induced within 24 h. The fact that only a small fraction of the exogenous progestagen is detected in the serum, could suggest that only a limited quantity of progestagen is absorbed by the epithelium or that the clearance rate of the serum MAP is high. Boshoff (1980) recorded a mean of 33% absorption of MAP in Karakul ewes. The rate of absorption of MAP by the vaginal epithelium was reflected by higher levels of serum MAP (mean of 390.4 ± 83.3 pg/ml for all the treatments) during the first two days of treatment, whereafter the level dropped to a mean of 118.5 ± 15.5 pg/ml, one day prior to sponge withdrawal. The absorption rate by the epithelium is not constant and could not be correlated to the initial dose of progestagen in the sponge. The gradual decrease in the daily absorption of MAP could imply the development of an insensitivity of the epithelium to progestagen.

The only significant ($P < 0.05$) difference obtained in reproductive performance was in the fecundity (mean of 1.47) of the ewes treated with halved sponges. This could be attributed to the fact that this group had the lowest exogenous progestagen dose (less negative feedback) prior to PMSG administration. Conception and lambing rates found in this study are in line with those obtained by Faure *et al.* (1983) and no clear evidence of any relationship between conception rate of ewes and the dose level of progestagen was evident.

In conclusion, although the dose of progestagen impregnated in the sponges is in excess, no significant detrimental side effects were observed. It appears as if the reduction of the exogenous progestagen in the sponge outside the normal breeding season holds no real advantages for the efficiency of synchronization or economic implications in Merino ewes.

From this trial, the use of different doses intravaginal progestagen in synchronization in different seasons of the year seems unnecessary.

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Incidence of UMP synthase deficiency in South African Holstein cattle

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Deficiency of uridine monophosphate synthase (DUMPS) is an inherited, recessive metabolic defect identified in Holstein cattle. Since heterozygous carriers transmit the defective gene 50% of the time, one fourth of the offspring from matings between two carriers are expected to be homozygous for DUMPS. This is a lethal condition where embryos die early in gestation. Offspring produced from the imported semen of an American carrier bull showed a carrier frequency of 54%. Among 277 South African AI bulls active during 1991 and 1992, no incidence was observed.

Defek vir uridienmonofosfaatsintase (DUMPS) is 'n oorerflike, resessiewe metaboliese afwyking wat in Holsteinbeeste geïdentifiseer is. Omdat heterosigotiese draers die defekte geen in 50% van alle parings oordra, kan verwag word dat een kwart van die nageslag van parings tussen twee draers homosigoties vir DUMPS sal wees. Dit is 'n letale toestand waar die embrio vroeg afsterf. Nageslag afkomstig van ingevoerde semen van 'n Amerikaanse draerbul het 'n draerfrekwensie van 54% getoon. Van die 277 Suid-Afrikaanse KI-bulle wat gedurende 1991 en 1992 gebruik en vir die voorkoms van DUMPS getoets is, is geen draers geïdentifiseer nie.

Keywords: Holstein cattle, UMP synthase deficiency.

A deficiency of UMP (uridine-5′-monophosphate) synthase in cattle has been rediscovered in the late 1970s. It is suspected that DUMPS (deficiency of uridine monophosphate synthase), an inherited condition, has been present for 40 years and that the first known carrier, which was used extensively for artificial insemination (AI) purposes, was born in 1957 in America. Cattle have numerous different enzymes that are involved with metabolism, growth, movement, reproduction, lactation and other biological processes. Defects in any of these enzymes may cause moderate to severe physiological problems. In cattle, seven inherited enzyme deficiencies are known, with DUMPS being one of the most important (Shanks & Robinson, 1987).

UMP synthase, a bifunctional enzyme, is present in all body cells and is transmitted as an autosomal recessive trait (Robinson *et al.*, 1984), like pink tooth (Nicholas, 1987) and other enzyme disorders known in cattle. Therefore, matings between a normal individual and a carrier would be expected to produce one half normal and one half carrier offspring, regardless of sex. In matings between two carriers, one fourth of the offspring are expected to be normal, one half are expected to be carriers, and one fourth are expected to be