

Assessment of different selection criteria for reproduction rate in Dormer and S.A. Mutton Merino sheep. 2. Luteinizing hormone concentrations in the serum of prepubertal lambs

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Data of all the lambs born to the Elsenburg Dormer ($n = 303$) and S.A. Mutton Merino ($n = 325$) flocks during the 1977 and 1978 lambing seasons as well as their female relatives were used to study various aspects regarding the use of prepubertal serum LH levels as a possible physiological selection criterion for reproduction rate in sheep.

Results obtained showed a significant effect ($P \leq 0,01$) of breed and sex on the serum LH levels of lambs at different ages. Correlations between serum LH measurements at 30, 60 and 90 days of age, however, were low and insignificant, indicating that this parameter is of low repeatability and of little or no value, if the age at which measurements are taken is not defined.

Neither sire nor birth type had any significant effect on the prepubertal serum LH levels for either of the two breeds and no positive relationship between serum LH levels of lambs and the reproductive performance of their female relatives or between serum LH levels of ewe lambs and their own subsequent reproductive performance could be established. It thus seems that prepubertal serum LH levels in lambs offer little, if any, advantage as a selection criterion to improve the reproductive performance of sheep.

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Gegewens van alle Elsenburg Dormer ($n = 303$) en S.A. Vleismerino-lammers ($n = 325$) gebore gedurende die 1977 en 1978 lamseisoene asook dié van hul vroulike verwantes is gebruik ten einde verskeie aspekte rakende die gebruik van prepubertale serum-LH-vlakke as moontlike fisiologiese seleksiemaatstaf vir reproduksietempo in skape te bestudeer.

Verkreë resultate dui op 'n betekenisvolle ($P \leq 0,01$) invloed van ras en geslag op die serum-LH-vlakke van lammers op verskillende ouderdomme. Korrelasies tussen serum-LH-konsentrasies op onderskeidelik 30-, 60- en 90-dae-ouderdom was egter laag en nie betekenisvol wat daarop dui dat hierdie parameter laag herhaalbaar is en van min of geen waarde is nie, indien die ouderdom waarop bepalinge geskied, nie spesifiek gedefinieer word nie.

Ten opsigte van albei die genoemde rasse het nog vaar, nog geboortestatus enige betekenisvolle effek op die prepubertale serum-LH-konsentrasies gehad en geen positiewe verwantskap tussen serum-LH-vlakke van lammers en die reproduksieprestasie van hul vroulike verwantes of tussen serum-LH-vlakke van ooilammers en hul eie latere reproduksieprestasie kon gevind word nie. Prepubertale serum-LH van lammers blyk dus weinig, indien enige, voordeel in te hou as 'n seleksiemaatstaf vir verhoogde reproduksietempo by skape.

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Introduction

Aspects responsible for the relatively slow genetic improvement in reproduction rate of sheep through conventional selection criteria were described by Land (1974). These include, amongst others, the fact that reproduction is a threshold character which hampers identification of superior animals; the low repeatability of the various components of reproduction which makes accurate determination of the genetic merits of individual animals at an early age almost impossible; the low heritability of these components; and the fact that reproduction is a sex-limited character (only manifested in female animals) which limits selection for this trait to female animals only.

Based on the physiological pathways which control reproduction in the ewe (Land, 1974), a physiological approach to the genetic improvement of reproduction rate was a logical consideration to overcome the above-mentioned problems. In such an approach emphasis is placed on the identification of physiological traits which are not only important components of reproduction, but simultaneously provide a more reliable measure of the genetic merits of the animal than the actual reproduction trait itself (Land, 1978).

Various aspects of ovarian activity, particularly ovulation rate, proved beneficial as physiological selection criteria for reproduction rate in sheep (Land, 1975; 1978). Like reproduction, all these criteria, however, are sex-limited to the female animal which adversely affect selection intensity. The possible use of endocrine traits in young animals of both sexes as a measure of future reproduction in this regard thus offers an exciting approach to the early identification of genetically superior animals even within male animals and has in recent years been investigated by several research workers.

Following the indication by Thimonier, Pelletier & Land (1972) that the prepubertal LH levels in plasma of ram lambs of two different fertility breeds were related to the reproduction rate of their female relatives, evidence of genetic variation in plasma LH concentration of both ewe and ram lambs as well as a positive association with reproduction rate were demonstrated both between (Bindon, Ch'ang & Evans, 1974; Carr & Land, 1975) and within breeds (Bindon, 1973; Bindon & Turner, 1974; Bindon *et al.*, 1974).

To date conclusions on the usefulness of prepubertal plasma LH levels in lambs as a selection criterion for reproduction rate were based on results from different breeds which differ largely in reproduction rate or on results with previously

selected fertility groups within a specific breed. This study was thus conducted to assess the practical feasibility of this criterion within existing flocks (Elsenburg Dormer and S.A. Mutton Merino) as a means to improve reproductive performance. Together with the study of Echternkamp & Laster (1976) this investigation is, to the authors' knowledge, the only one in which hormone levels in young animals were correlated with their own future reproductive performance.

Experimental procedure

Animals used in this experiment originated from the Elsenburg Dormer and S.A. Mutton Merino flocks as described by Kritzinger, Stindt & Van der Westhuysen (1984) and included data of all the Elsenburg Dormer ($n = 303$) and S.A. Mutton Merino ($n = 325$) lambs born during the 1977 and 1978 lambing seasons as well as the reproduction data of their female relatives.

From each lamb five blood samples were collected via the *vena jugularis* at the exact age of 30 days with 20 min intervals between subsequent samplings. The blood was centrifuged and the serum stored at -20°C until assayed. LH concentrations were determined in duplicate by a modified radioimmunoassay of Niswender, Reichert, Midgley & Nalbandov (1969) as described by Kritzinger (1982). The sensitivity of the assay in which 200 μl serum was used was $0,352 \pm 0,046$ ng NIH-LH-S17/ml (mean \pm SE, $n = 15$) while the within and between assay coefficients of variation for a standard serum sample containing 1,68 ng LH/ml were 4,37 and 6,13% respectively.

Additional blood sampling was also performed on approximately 15% of the lambs born during 1977 at exact ages of 60 and 90 days. According to Van der Westhuysen & Dierkse (1977) the arithmetic mean of the five LH concentrations was used as measure of LH status of each individual lamb.

Analyses of variance were used to study the effects of breed, season, sire, sex and birth type on the prepubertal serum LH concentrations of lambs, while the effect of live mass was calculated by correlation.

Repeatability of LH measurement was estimated by correlation between LH concentrations in serum of prepubertal lambs at ages of 30, 60 and 90 days.

The relationship between LH status for both ram and ewe lambs and their dam's reproductive performance was determined in two ways: Firstly, by correlation of the LH status of individual lambs with their dam's reproductive performance (expressed as the average number of lambs born per mating after the first three breeding seasons); and secondly by comparison between lambs previously selected on LH status (high vs low LH groups). The association between LH status of ewe lambs and their own future reproductive performance was determined in a similar manner.

Results

LH levels in subsequent blood samples from individual lambs indicated a pulsatile release of this hormone as reported by Bindon & Turner (1974), Carr & Land (1975) and Van der Westhuysen & Dierkse (1977). Disappearance of these peaks occurred at a rate which was in accordance with the reported 28 min half-life of LH (Foster, Cruz, Jackson, Cook & Nalbandov, 1972).

Analyses of variance (Tables 1, 2, 3 and 4) showed that only breed and sex significantly ($P \leq 0,01$) affected prepubertal serum LH levels in lambs, while significantly ($P \leq 0,05$) positive correlations between serum LH levels and livemass

Table 1 Analysis of variance for the effect of breed on the 30-day serum LH concentration in Dormer and S.A. Mutton Merino lambs

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-value
Breed	1	16,77	16,77	16,059 ^a
Error	626	653,95	1,04	

^a $P \leq 0,01$

Table 2 Analysis of variance for the effect of season on the 30-day serum LH concentration in Dormer and S.A. Mutton Merino lambs

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-value
Years	1	0,0035	0,0035	0,003
Error	626	670,72	1,07	

Table 3 Analysis of variance for the effects of sire, sex and birth type on the 30-day serum LH concentration in S.A. Mutton Merino lambs

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-value
Sire	11	6,84	0,62	0,889
Sex	1	69,38	69,38	99,208 ^a
Sire \times Sex	11	7,44	0,68	0,976
Birth type	1	0,005	0,005	0,007
Sire \times Birth type	11	7,33	0,67	0,952
Sex \times Birth type	1	0,05	0,05	0,078
Error	288	201,40	0,70	

^a $P \leq 0,01$

Table 4 Analysis of variance for the effects of sire, sex and birth type on the 30-day serum LH concentrations in Dormer lambs

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-value
Sire	12	8,02	0,67	0,930
Sex	1	81,54	81,54	113,414 ^a
Sire \times Sex	12	6,48	0,54	0,751
Birth type	1	0,04	0,04	0,060
Sire \times Birth type	12	4,48	0,37	0,519
Sex \times Birth type	1	0,13	0,13	0,177
Error	263	189,09	0,72	

^a $P \leq 0,01$

of lambs of respectively 0,17 ($n = 162$) and 0,29 ($n = 166$) for S.A. Mutton Merino ewe and ram lambs, and 0,19 ($n = 159$) and 0,21 ($n = 166$) for Dormer ewe and ram lambs were demonstrated. The average (mean \pm s.d.) 30-day serum LH concentration (ng/ml) of S.A. Mutton Merino ewe and ram lambs were $1,62 \pm 1,15$ and $0,43 \pm 0,35$ respectively, while those of Dormer ewe and ram lambs were $1,90 \pm 1,03$ and $0,73 \pm 0,53$ respectively, contributing in all cases to a particularly large coefficient of variation.

From the average LH concentrations in the blood serum

of ewe and ram lambs for each breed at different ages (Table 5), it is evident that age exerts a major effect. For both breeds the 30-day serum LH of ram lambs was consistently lower than that of ewe lambs. These differences between sexes, however, tend to decrease with increasing age. It is also evident that breed had a definitive effect on the age at which the highest LH levels in serum were measured. S.A. Mutton Merino ewe lambs reached highest LH concentration at a much earlier age than Dormer ewe lambs did.

Table 5 Effect of breed and sex on the average serum LH concentration (Mean \pm S.D.) in Dormer and S.A. Mutton Merino lambs at various ages

Breed and sex	Serum LH concentration (ng/ml)		
	30 days	60 days	90 days
Dormer male ($n = 13$)	0,47 \pm 0,29	2,35 \pm 1,68	1,26 \pm 0,93
female ($n = 16$)	1,71 \pm 0,76	2,57 \pm 1,13	1,84 \pm 0,84
S.A. Mutton Merino male ($n = 11$)	0,53 \pm 0,33	0,91 \pm 0,63	1,49 \pm 1,24
female ($n = 11$)	2,06 \pm 1,96	1,80 \pm 1,33	1,47 \pm 0,70

No significant correlation between serum LH at ages of 30, 60 or 90 days for any breed and/or sex could be demonstrated.

The correlation between the serum LH levels in ram and ewe lambs with their dam's reproductive performance for both breeds proved extremely low and non-significant (Table 6) while no significant difference between dam's reproductive performance of lambs with either a high or low plasma LH level was found (Table 7).

Table 6 Correlation coefficients between serum LH of Dormer and S.A. Mutton Merino lambs and dam's reproductive performance

Breed and sex	Correlation coefficient (r)
Dormer ewe lambs ($n = 162$)	0,0308
ram lambs ($n = 166$)	0,0747
S.A. Mutton Merino ewe lambs ($n = 159$)	0,0939
ram lambs ($n = 144$)	0,0781

Table 7 Dam's reproductive performance of Dormer and S.A. Mutton Merino lambs grouped according to 30-day serum LH

	Dam's reproductive performance	
	High serum LH group	Low serum LH group
Dormer	1,25 \pm 0,44	1,21 \pm 0,51
S.A. Mutton Merino	1,62 \pm 0,40	1,65 \pm 0,46

Likewise no significant correlation between serum LH levels of ewe lambs and their own reproductive performance after two or three lambing seasons (Table 8) and no significant difference between the reproductive performance of ewe lambs selected on plasma LH levels (Table 9) could be demonstrated for any of the two breeds.

Table 8 Correlation coefficients between serum LH of Dormer and S.A. Mutton Merino ewe lambs and their own reproductive performance after either two or three breeding seasons

Breed	Correlation coefficient (r)
Dormer after two seasons ($n = 74$)	0,0428
after three seasons ($n = 35$)	0,1248
S.A. Mutton Merino after two seasons ($n = 53$)	0,0374
after three seasons ($n = 24$)	0,0434

Table 9 Reproductive performance of Dormer and S.A. Mutton Merino ewe lambs grouped according to 30-day serum LH

Breed	Reproductive performance	
	High serum LH group	Low serum LH group
Dormer		
after two seasons	1,26 \pm 0,51	1,20 \pm 0,46
after three seasons	1,12 \pm 0,48	1,23 \pm 0,39
S.A. Mutton Merino		
after two seasons	1,69 \pm 0,62	1,74 \pm 0,51
after three seasons	1,91 \pm 0,42	1,64 \pm 0,54

Discussion

Results regarding the effect of breed on the serum LH of lambs at various ages were in agreement with findings of Blanc, Courot, Pelletier & Thimonier (1975) who demonstrated that, owing to an age-dependent peak in prepubertal plasma LH levels of different breeds, the relative order of rank largely depended on the age at which maximum LH concentrations were reached as well as the age at which breeds were compared.

If it is assumed that 30-day plasma LH levels may be considered as the best selection criterion for reproduction rate of sheep (Bindon, 1976), the low and non-significant correlation between LH levels at ages of 30, 60 and 90 days clearly indicates that LH measurement at the latter two ages cannot be used as a measure of reproduction rate. Similar results were reported by Bindon & Turner (1974) who investigated the relationship between plasma LH levels at 30 and 100 days and the reproduction rate of female relatives within the Merino breed. These authors found a significant positive correlation only between 30-day plasma LH levels and reproduction rate. Likewise, Echtenkamp & Laster (1976) attributed their inability to demonstrate positive associations between plasma LH and ovulation rates within and between breeds to a possible too late age at which plasma LH levels were measured.

The highly significant effect of sex on the 30-day serum LH-levels is in agreement with results of Bindon (1973) and Hanrahan, Quirke & Gosling (1977). The findings of Thimonier *et al.* (1972) and Hanrahan *et al.* (1977) that plasma LH levels of ram lambs tended to increase between four and eight weeks of age while that of ewe lambs, depending on the genotype, tended to decrease, were also to a certain extent confirmed in the present study.

Contrary to results of Bindon (1973) and Bindon & Turner (1974) no significant effect of sire or birth type on the serum LH levels was found. Of particular importance is the fact that,

despite a fairly large coefficient of variation in serum LH levels, no significant positive association between either serum LH levels of lambs and their dam's reproductive performance or between serum LH levels of ewe lambs and their own reproductive performance could be demonstrated. These findings are in contrast with the positive within-breed association between prepubertal plasma LH and reproduction rate reported by Bindon (1973) and Bindon & Turner (1974), but are in agreement with results reported by Echterkamp & Laster (1976) who could not demonstrate, within breeds, any positive relationships between prepubertal plasma LH concentration of ewe lambs and their own ovulation rate later in life. It must be emphasized, however, that the former research workers experimented on either selected flocks within a breed, or selected groups of animals within a flock. Our findings may thus be explained by a possibly much smaller genetic variation in either reproduction rate or LH status of the two breeds under investigation.

Conclusions

Results obtained indicate that the use of prepubertal plasma LH levels in lambs, at least in flocks where a small genetic variation in reproduction rate exists, offers little, if any, advantage as a selection criterion to improve the reproductive performance of sheep. Possibly the main reason may be a much larger non-genetic contribution towards the total variation in plasma LH levels as until now assumed, while the irregular releasing pattern of this hormone hampers accurate measurement of the individual's genetic merit.

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