The effect of the F gene on characteristics of Booroola x Romney ram sperm

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ABSTRACT

Although the Booroola F gene increases litter size in the ewes by one lamb there have been no unequivocal reports of its expression in the ram. In this report the presence of the F gene in the ram has been shown to increase sperm swimming speed and a sperm activity index as measured by a dual and single beam laser respectively. The lambing rate of ewes artificially inseminated with sperm from rams with the FF genotype was slightly higher than those inseminated with sperm from rams without the F gene.

Keywords Booroola; F gene; laser; sperm swimming speed; activity index; ewe fertility

INTRODUCTION

The Booroola F gene is a single Mendelian gene. The heterozygous ewe (F+) is recognised conventionally by an ovulation rate of 3 or 4 while the homozygous ewe (FF) is recognised by an ovulation rate of 5 or greater. The other homozygote (+ +) is recognised by the lack of a recorded triplet ovulation. At present, there is no physical method for distinguishing between the F genotypes in the ram. Availability of some physical characteristic that would discriminate between the 3 F genotypes in rams would eliminate the need for expensive and time-consuming progeny tests.

In this study, differences between sperm characteristics in the 3 F genotypes were studied with the aim of finding a method of distinguishing between them. Sperm swimming speed and activity and the ability of the sperm to obtain single and multiple pregnancies were studied. Differences betwen ram selection lines in the fertility and prolificacy of the ewes to which they were mated have already been shown (Moore, 1981; Moore and Whyman, 1980).

METHODS AND MATERIALS

In all studies reported here, semen was collected only once per day using an artificial vagina. In June 1985, 147 Waihora (+ +) ewes were artificially inseminated (AI) with fresh semen (200 million sperm) diluted with caprogen. The semen was obtained from 2-4 rams of the 3 genotypes on 6 collection days over a period of 14 days. In May 1986, 439 ewes made up of ewes of the following genotypes; (+ +) Waihora Romney, (F+) and (+ +) Booroola x Perendale, (F+/+ +) (Booroola x Coopworth) x Romney, were divided within breeds, genotypes and age groups into 2 matched groups and inseminated with semen obtained from 12 rams of the (FF) and (+ +) genotypes on 8 collection days over a period of 22 days. The statistical analyses of the proportions of ewes pregnant and multiple pregnant were carried out by the logit method with respect to breed and genotype of the ewe and genotype of the ram.

Ejaculates were split during the 1985 AI and part of the semen was used for measurements of sperm swimming speed by the dual beam laser

(Wilson and Harvey, 1983) at sperm concentrations of 10 million per ml in caprogen, at 39°C.

During the 1986 AI, part of the ejaculate was used for measurements of sperm activity (HF%) using a single beam laser designed by one of us (J.K.W.). HF% is a composite figure depending on the live to dead ratio of the sperm suspension and the rotational frequency of the live fraction. High percentages of live sperm increase HF% as do high frequencies of rotation. HF% of the same rams was also measured in August 1987 and July 1988 on 8 collection days over a period of 14 days. During the last occasion, HF% was measured with and without the addition of caffeine, a stimulant of sperm activity (Garbers and Kopf, 1980). All the above measurements of HF% were carried out at sperm concentrations of 10 million per ml in caprogen, at 37°C.

The swimming speed and sperm activity data were analysed with respect to ram genotype by analysis of variance using the means of individual rams weighted by the number of ejaculates per ram. Standard error of differences was calculated using between-ram variation.

RESULTS

TABLE 1 Effects of ram genotype on number of ewes lambing (EL), number of ewes lambing multiples(ELM) among ewes inseminated (EI).

Genotype of ram	No. of rams	EI	EL/EI (%)	ELM/EL (%)
June 1985				
FF	2	21	49	0
F+	3	112	37	5
++	4	56	26	0
May 1986				
FF	12	219	49	54
++	12	220	41	41

In June 1985 there were differences ($P<0.1$) in the percentages of ewes lambing but no differences in ewes lambing multiples, due to the genotype of the ram semen (Table 1). In May 1986 there were differences in both the percentage of ewes lambing and ewes lambing multiples (both $P<0.1$) due to ram genotype (Table 1). There were differences due to ewe genotype in the percentage of ewes lambing multiples but no differences in the percentage of ewes lambing.

TABLE 2 Effect of ram genotype on sperm swimming speed (μ/s) (June 1985, 2-6 ejaculates/ram). Maximum SED = 14.8.

Genotype	No. of ram	Means	Range of ram means
FF	2	178	173 - 185
F+	3	143	125 - 158
++	4	153	124 - 170

In June 1985 the differences in sperm swimming speed were not statistically significant, but the range of the means of the FF rams did not overlap the F+ and + + rams (Table 2).

TABLE 3 Effect of ram genotype on HF%.

Genotype	No. of rams	Mean	Range of ram means
May 1986, 1-5 ejaculates/ram			
FF	12	41.0	39.2 - 44.1
++	12	37.7	33.3 - 40.3
SED		1.4	
August 1987, 6-8 ejaculates/ram			
FF	10	34.8	28.6 - 38.4
++	9	32.2	27.3 - 37.3
SED		1.6	
July 1988, no caffeine, 1-8 ejaculates/ram			
FF	9	38.0	30.4 - 39.0
++	10	33.0	15.7 - 40.9
SED		2.5	
July 1988, with caffeine, 1-8 ejaculates/ram			
FF	9	44.0	41.7 - 45.1
++	10	40.5	33.8 - 45.4
SED		1.2	

In May 1986 there were highly significant differences ($P<0.01$) in HF% between the FF and + + genotypes, only 3 out of 12 of the ram means of the + + rams overlapped the range of ram means of the FF rams (Table 3). In August 1987 there was no difference between the 2 genotypes, the ranges overlapped. In July 1988 there was a significant difference between the FF and + + rams ($P<0.05$) in the absence of caffeine, while there was no difference between the ram genotypes at the top of the range, the + + ram

means were much lower at the bottom of the range. Caffeine decreased the range and variation within both genotypes, and the difference between the genotypes became highly significant ($P < 0.01$).

DISCUSSION

There were differences between the FF and + + genotypes in sperm characteristics during the breeding season, these differences included direct effects on ewe fertility and prolificacy,and differences in swimming speed and HF%.

HF% became less effective as a means of discriminating between the FF and + + genotypes outside the breeding season. This was associated with an increase in the range and variation in HF% within genotypes.

HF% levels fell outside the breeding season, associated with a decrease in sperm activity. This can be inferred by the effects of caffeine which increased the August HF% levels to those slightly higher than May levels.

Work is presently under way to compare sperm swimming speed and HF% as discriminants of the F genotypes throughout the year.

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