A STUDY OF UTERINE CAPACITY IN MEISHAN AND LARGE WHITE PIGS

G.J. Lee[1], M. Ritchie[1] and M. Thompson[1], A.A. Macdonald[2], A. Blasco[3], M.A. Santacreu[3], M.J. Argente[3] and C.S. Haley[1]

[1]Roslin Institute (Edinburgh), Roslin, Midlothian, EH25 9PS, UK;
[2]Dept. of Preclinical Veterinary Studies, University of Edinburgh, Edinburgh, EH9 1QH, U.K. and
[3]Departamento de Ciencia Animal, Universidad Politecnica de Valencia, 46071 Valencia, Spain

SUMMARY

Estimated uterine capacity in the highly prolific Chinese Meishan (MS) was compared with that in Large White (LW) and crossbred pigs using unilateral hysterectomy-ovariectomy (UHO) methods. In UHO females ovulation rate was similar to that found in intact females, being 6-7 eggs higher in the MS than in the LW and the MS also had 6 more viable embryos at 30 days of pregnancy. Crossbred sows were intermediate for ovulation rate and similar to the MS for number of embryos. Uterine capacity was estimated from the number of piglets subsequently born to be 2 piglets higher in MS sows than in LW and 2 piglets more in crossbred animals than in MS. In sows slaughtered at 30 days of pregnancy, MS were found to have smaller within litter variability in embryo size traits, especially in the distance between embryo sites. Crossbred litters were intermediate between the purebreds in means and variability of embryo traits, but crossbred sows had significantly longer uteri than both purebreds. Differences between the genotypes in uterine capacity may contribute to their differences in prolificacy and be particularly important in determining heterosis for litter size in crossbred females.

INTRODUCTION

The Chinese Meishan pig is known to be one of the most prolific breeds in the world. Probably the major factor underlying this high performance is enhanced prenatal survival compared to European breeds (Bolet *et al.*, 1986; Haley *et al.*, 1994). Even though differences in embryo survival appear to exist in early pregnancy, it is also likely that the Meishan sow has a greater ability to maintain higher numbers of foetuses to farrowing, since European breeds when subjected to super-ovulation tend to lose a high proportion of foetuses in late pregnancy, presumably because of the effect of overcrowding in the uterus (Wrathall, 1971).

The ability to maintain foetuses in late pregnancy, or "uterine capacity", is difficult to measure, since in breeds of moderate prolificacy there may be insufficient foetuses to challenge it in many normal pregnancies. Christenson *et al.* (1987) have argued that the use of unilateral hysterectomy-ovariectomy (UHO) offers a means to estimate uterine capacity. In this technique, one uterine horn and ovary are removed at the bifurcation. Ovulation rate is little affected by the removal of one ovary, so that the number of viable embryos exceed the capacity of the remaining horn, which thus becomes the critical factor limiting foetal development and subsequent litter size.

MATERIALS AND METHODS

The left ovary and uterine horn were removed at the bifurcation from 20 Large White (LW), 20 Meishan (MS) and 20 crossbred (LWxMS) gilts in the post-pubertal period. Each gilt was then mated to either an LW or MS boar to farrow normally for the first and second parities (mating at an average age of 252 days and 437 days, respectively). Ovulation rate (number of corpora lutea), the subsequent litter size of each pregnant sow and the birth weight of each piglet were recorded. At the third parity, the sows were mated as normal, but were slaughtered at around 30 days of pregnancy. The number of corpora lutea was recorded. The uterus was removed, stretched out and measured. It was then opened and the number of embryos, viable and degenerating and the distance between embryo sites was recorded. Each embryo was then removed and its weight and length (crown rump) were measured.

The data were analysed using the GENSTAT statistical package (GENSTAT 5 committee 1993). The first two generations were analysed in a REML analysis, fitting a hierarchical model, in which the individual sow was fitted as a random effect nested within her dam, nested in turn within sires. Fixed effects fitted were genotype of sow, parity and age at the recorded ovulation, nested within parity. Traits analysed were ovulation rate for all sows and embryo survival, subsequent litter size, litter weight and mean piglet weight for sows which conceived. The third parity data were analysed using a linear model, fitting day of pregnancy and weight of the sow at ovulation as linear covariates and the genotype of the sow and her mate with their interaction as classified factors. Traits analysed were the number of corpora lutea and live embryos (and thus embryo survival to 30 days), the length of the right horn and the number of viable embryos within it. The mean and standard deviation of embryo weight and crown rump length of viable embryos and of distance between intermediate embryo sites were calculated for the right horn of each uterus and analysed along with the distance from the bifurcation to their first embryo and from the last embryo to the tip of the right horn. One or two embryos were found in the severed stump of the left horn in most sows, but these were excluded from the calculations of means and standard deviations

RESULTS

The results for the first two parities are shown in Table 1. MS sows produced more than 4 extra eggs and had one extra live piglet compared to the LW. Prenatal survival tended to be higher in the MS after adjustment for ovulation rate. Crossbred sows had ovulation rates intermediate between the two pure breeds, but prenatal survival and hence their litter sizes exceeded both pure breeds LW sows produced heavier piglets and had heavier litters than MS sows. Piglet and litter weights from crossbred sows were on a par with those from purebred LW sows. Breed of mate had no effect on any of the traits studied.

Table 2 shows that at the third parity, the pure breed difference in ovulation rate was even greater at around 7 eggs, but despite this, embryo survival tended to be greater in the MS. Crossbred sows were again intermediate for ovulation rate, but their embryo survival was on a similar level to the MS.

The results of the analyses of right horn length and litter means and standard deviations of embryo traits are shown in Table 3. There was no difference in the length of the right horn between the two purebreds, but crossbred sows had significantly longer horns.

Table 1. Reproductive performance at the first two parities

Trait	Genotype of sow		
	LW	MS	LW x MS
Number of records	32	26	28
Ovulation rate (OR)	15.0±0.7	19.4±0.7	18.6±0.7
Number of live piglets	6.0±0.6	7.0±0.6	8.2±0.6
Prenatal survival (%)	41.2±3.8	37.6±4.0	47.6±4.4
Prenatal survival (%) adjusted for OR	36.8±3.6	42.0±3.8	49.2±3.9
Litter weight at birth (kg)	7.22±0.54	5.47±0.57	7.79±0.61
Litter mean piglet weight (kg)	1.17±0.07	0.78±0.08	1.06±0.08

Table 2. Embryo survival to 30 days of pregnancy at the third parity

Trait	Genotype of sow		
	LW	MS	LW x MS
Number of pregnant sows	12	9	16
Ovulation rate	18.4±1.2	25.3±1.4	21.5±1.0
Number of viable embryos (total)	10.0±1.3	15.9±1.6	14.5±1.2
Embryo survival	53.2±6.0	63.2±7.2	69.0±5.1
Embryo survival[1]	51.4±6.7	65.3±8.0	69.2±5.1

[1] adjusted for ovulation rate

Table 3. Right horn means and standard deviations for embryo traits at 30 days of pregnancy

Trait	Genotype of sow		
	LW	MS	LW x MS
Length of right horn (cm)	234.3±15.5	220.7±15.9	267.2±13.4
Number of viable embryos	9.6±1.3	14.6±1.6	13.2±1.1
Embryo weight mean (g)	1.55±0.09	1.21±0.11	1.46±0.08
SD	0.30±0.03	0.20±0.04	0.23±0.03
Crown rump length mean (mm)	26.0±0.5	24.6±0.6	25.8±0.4
SD	2.3±0.3	1.8±0.3	1.8±0.2
Distance between embryo sites (cm)	22.6±1.8	15.4±2.1	18.9±1.6
SD	8.6±0.9	3.6±1.0	6.7±0.8

The mean embryo weight and distances between intermediate embryo sites tended to be lower in MS sows, but the main feature was the reduced standard deviations for all three traits, but especially for the distance between embryo sites. The genotype differences in within litter standard deviations were shown to be unrelated to the litter mean values, by fitting the litter means as covariates in additional analyses. The distances to the first site and from the last site to the tip of the horn were in all genotypes within one standard deviation of the mean intermediate distance suggesting that embryos were evenly spaced along the whole length of the horn. The breed of mate had no significant effect on any of the embryo traits.

DISCUSSION

The ovulation rates reported here are similar to those from two ovaries of normal pigs of the two breeds (Haley *et al.*, 1994). MS sows at the third parity produced 7 more eggs than LW sows and had 6 more embryos at day 30 of pregnancy. The number of embryos at 30 days in the third parity is far in excess of the litter sizes at the first two parities. It is therefore reasonable to assume that the relatively low litter sizes of the first two parities were the result of limited uterine capacity. Thus the capacity of a normal two-horned LW uterus can be taken to be twice that of the right horn at 12 piglets, that of the MS to be 2 higher at 14 piglets and that of a crossbred to be 2 higher again at 16 piglets. The main feature of the MS, which might explain this superiority is the greater uniformity within litters of the embryo traits, particularly the distance between embryo sites, suggesting that there is a greater degree of organisation in a MS uterus, even though it is a similar physical size to that of the LW. In contrast, the crossbred sows were intermediate between the pure breeds in within litter variability, but had physically longer uteri, which could explain their greater ability to maintain foetuses in late pregnancy. Thus it appears that the additive genetic effect leading to the superior uterine capacity of the MS over the LW and the heterosis effect giving higher performance in the crossbred sow have arisen through different physiological pathways.

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