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THE EFFECT OF BREED ON THE ONSET OF PUBERTY IN HEIFERS

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SUMMARY

235 heifers from six breed groups (Angus, Jersey, Friesian, Angus-Friesian, Angus-Jersey, and Angus-(Friesian-Jersey)) were observed from approximately 8 months until 16 months of age to determine the onset of puberty through a combination of observation of behavioural oestrus using KAMAR® Heatmount Detectors, transrectal ultrasonography of ovaries, and measurement of plasma progesterone levels. Jersey heifers were the first to reach puberty and reached puberty at the lightest live weight, whilst Angus heifers reached puberty at the greatest age and live weight. There was no effect of age at puberty on the probability of conceiving, or on the probability of conceiving in the first 21 days of joining.

INTRODUCTION

The Productivity and efficiency of beef breeding cows can be measured as kilograms of calf weaned per kilogram of cow, annually, and by number of calves reared in a cow's lifetime. Efficiency of production can be increased by increasing calf weaning weights or by achieving similar weaning weights with lighter cows. Productivity can be increased by calving at two instead of three years of age, which requires heifers to reach puberty before 15 months of age. Additionally, calving early within their first calving season can increase lifetime productivity, and help maintain a pattern of earlier calving for the lifetime of the cow, thus allowing her to rear calves to greater live weights at weaning and allowing sufficient time for the postpartum anoestrus interval to be completed prior to the subsequent joining period (Lesmeister *et al.* 1973).

Past studies have shown that crossbred progeny of Jersey or Friesian parentage reached puberty at an earlier age than straightbred Angus cattle (Morris *et al*. 1986) and thus, may be more likely to calve, or to calve early, at two years of age. The onset of puberty is dependent on many factors including genotype, nutritional management (particularly its effects on live weight as a percentage of mature live weight) and environmental conditions.

In this experiment, six breed groups were observed (straightbred Angus (AA), straightbred Jersey (JJ), straightbred Friesian (FF), Angus x Friesian (AF), Angus x Jersey (AJ), and Angus x (Friesian x Jersey) (AK)) to determine age and live weight at the onset of puberty, and pregnancy rate to first joining.

METHODS AND MATERIALS

Animals. Semen from four Angus sires was used to generate straightbred AA and crossbred progeny from commercial herds. Straightbred JJ and FF heifers were sourced from commercial herds and are progeny of several sires. The experiment included a total of 235 heifers (68 AA, 43 AF, 53 AJ, 31 AK, 20 JJ, and 20 FF), grazed under commercial farming conditions in four herds balanced for breed and initial live weight in April 2009.

Measurements. This experiment was conducted from 8 April 2009, following weaning of the AA heifers from their dams, through until the beginning of the joining period on 8 December 2009. Behavioural oestrus events were identified using KAMAR® Heatmount Detectors, which were fitted, checked weekly and replaced as necessary. Vasectomised bulls were run with the heifers at a rate of 1:30 for the duration of the oestrus observation period. Seven days after each of the second and third visual oestrus events were detected (0-6 days after the actual oestrus event), heifer ovaries were scanned using a rectal ultrasound probe to detect the presence of a corpus luteum. At this time, a 5 ml blood sample was collected via coccygeal venipuncture into an EDTA vaccutainer® and centrifuged at 1500 rpm for 15 minutes. Plasma was frozen at -20°C and then assayed for progesterone concentration via double antibody radioimmunoassay (Institute of Food, Nutrition & Human Health, Massey University). Oestrus was defined to have occurred when a positive KAMAR® was observed, followed one week later by a corpus luteum visualised via transrectal ultrasonography and plasma progesterone levels ≥ 1.0 ng/ml similar to Byerley *et al.* (1987) for the second and third oestrus events. Three consecutive visual oestrus events, of which the second and third were confirmed by progesterone assay, indicated regular cyclic ovarian activity, and the first event was defined as the date of "puberty". Oestrus events were no longer observed or recorded after three consecutive oestrus events were detected or beginning of joining on 8 December 2009.

Live weight was recorded monthly from April to December, and body condition score was recorded in April, August, and November 2009. Individual birth weights were not recorded but the heifers were known to be born in August and September 2008. A universal birth date of 1 August 2008 was assigned to the heifers in order to calculate age at puberty, which may lead to an over-estimation of age at puberty. Live weight at puberty was interpolated from the live weight recorded prior to the first oestrus event plus the number of days since the previous weighing multiplied by the average daily gain between the previous and subsequent live weight, to estimate live weight on the day of puberty.

Ethical Approval. This research was conducted with approval from the Massey University Animal Ethics Committee.

Statistical Analysis. Data were analysed using SAS v 9.2 (SAS Institute Inc., 2000) using a general linear model to calculate least squares means of age and live weight at puberty. Differences between the means of the crossbred groups and the means of the parental breeds were detected using a t-test to determine the presence of heterosis. Logistic regression was used to assess the effect of breed or age at puberty on the likelihood of conceiving in the first 21 days (one oestrous cycle) of exposure to the bull, or on the likelihood of a heifer becoming pregnant by the end of the joining period. Logistic regression was used to determine the effect of live weight at various time points on the probability of conceiving during the joining period. Differences among breeds in cumulative percentage of pubertal heifers were assessed using chi-squared analysis in a generalised model.

RESULTS AND DISCUSSION

Puberty occurred but the date was not identified for 26 heifers (13 AA, 2 AF, 3 AJ, 2 AK, 5 FF, 1 JJ) due to loss of KAMAR® Heatmount Detectors or disagreement between ultrasonographic ovarian scanning and progesterone assay levels and were excluded from analysis. Eight heifers (5 AA, 1 AF, 2 AJ) did not meet the criteria established for reaching puberty during the study period and these heifers were included in the proportion of heifers that reached puberty, but not in the comparisons of age or live weight at puberty.

JJ heifers were the lightest breed group at puberty ($P<0.001$), AJ heifers were next lightest ($P<0.05$), but there was no difference between AF, AK, and FF heifers (Table 1). AA heifers reached puberty at the greatest live weight ($P<0.001$). There was no difference between the expected live weight at puberty based on additive merit and the actual live weight at puberty of the crossbred heifers for any of the breed groups.

Table 1. Age and live weight at puberty and pregnancy rate for the six breed groups, different superscripts show statistical differences at P<0.05.

Breed	Age at puberty (days)	LW at puberty (kg)	Pregnancy rate
JJ	294±11 [a]	189±7 [a]	85%
AJ	383±7 [bc]	242±5 [b]	92%
AA	395±7 [c]	297±4 [d]	87%
AF	388±7 [bc]	274±5 [c]	95%
FF	364±12 [b]	265±8 [c]	85%
AK	385±9 [bc]	263±5 [c]	90%

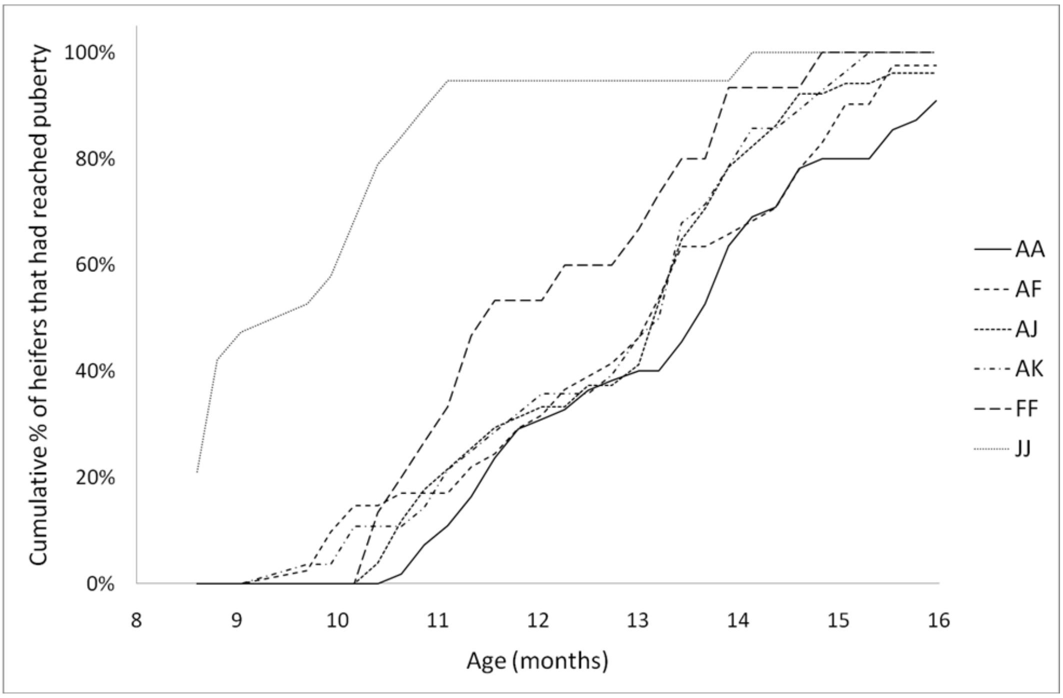

Figure 1. Cumulative percent of heifers that had reached puberty between 8 and 16 months of age for the six different breed groups.

JJ heifers reached puberty younger than any of the other breed groups, with FF heifers the second youngest and AA last ($P<0.05$) (Table 1). There was no difference amongst the crossbred groups and the AA or FF heifers in age at puberty. Age at puberty was greater than the expected additive performance for AJ ($P<0.001$) and AK heifers ($P<0.05$) but not different to the expected value for AF heifers. This is probably a reflection of the AJ and AK heifers taking a longer period to reach the necessary live weight to allow puberty, but the reason for their slower growth was not clear.

A greater proportion of JJ heifers had reached puberty than any other breed ($P<0.001$), and a lesser proportion of AA had reached puberty than FF ($P<0.05$) by 12 months of age. At 14 months of age, a lesser proportion of AA had reached puberty than either JJ or FF ($P<0.05$), and a lesser proportion of AF had reached puberty than JJ ($P<0.05$), however, there was no difference amongst the proportion of JJ, FF, AJ, and AK groups that reached puberty. JJ and FF heifers reached puberty younger (Figure 1), however, the pregnancy rate did not differ among breeds (Table 1). Crossbred heifers were not only more likely to reach puberty by 14 months, but also achieved more oestrous cycles prior to joining with the bull than AA heifers. These results are fairly consistent with Morris *et al.* (1986), except that the prior study reported that the proportion of pregnant AJ heifers was intermediate between AA and FF crosses.

Byerley *et al.* (1987) reported that heifers were more likely to get pregnant in later oestrous cycles than the puberal oestrus; however, in this experiment, there was no effect of breed or age at puberty on the probability of getting pregnant in the first cycle of exposure to the bull or by the end of the joining period. The majority of heifers in the current study exhibited a puberal oestrus prior to exposure to the bull. The probability of getting pregnant was not affected by live weight in April, June, September or December. These results suggest that the majority of heifers may have reached some critical minimum weight or body composition threshold and thus their ovarian activity and fertility were not significantly different among the different groups at joining (Schillo *et al.* 1992).

Although in this experiment the bulls were joined with the heifers at 16 months, according to the cumulative percentage of heifers reaching puberty, it would be expected to achieve similar pregnancy rates if the joining date had been advanced to 15 months. However, if the joining date were advanced much earlier than 15 months, a lower pregnancy rate for the AA and the AF heifers would be expected, as well as fewer pregnancies in the first cycle. Therefore in systems where earlier pregnancy in heifers is desirable, the addition of Jersey genetic influence may allow for a greater pregnancy rate and thus increase overall productivity. Further research into the impact on other productive traits (particularly carcass composition) of the inclusion of dairy-breed genetics into a breeding cow herd is warranted before such a breed shift is advocated.

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