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REPRODUCTIVE PERFORMANCE OF HOLSTEIN-FRIESIAN COWS GENETICALLY SELECTED FOR HEAVY OR LIGHT MATURE BODYWEIGHT

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ABSTRACT

Over recent years, concern has developed over the declining fertility and survival of New Zealand dairy cows in parallel with the increasing proportion of US Holstein-Friesian genetics in the national herds. A long-term trial at Massey University has shown that in a spring-calving pastoral systems cows selected for high mature bodyweight (H), which have a high proportion of US Holstein genetics, had lower first service conception rate (FSCR) than cows selected for low mature bodyweight (L), which have a low proportion of US Holstein genetics. The experiments in this thesis were conducted to examine whether differences in the activity of the central and peripheral reproductive endocrine axes during the postpartum periods of H and L cows might underlie the different FSCR between strains. Analysis of herd records over 3 years showed that L cows had higher (P<0.05) FSCR (60%) than H cows (47%), but there was much variation in FSCR in H between years. No differences were found between strains in the intervals from calving to first ovulation and calving to first behavioural oestrus.

Experiment 1 examined the endogenous LH and FSH secretion patterns in H and L cows (n=7/group) on Days 14, 21, 28 and 35 after calving, in order to evaluate the time-course of postpartum restoration of the hypothalamo-pituitary axis. The overall mean amplitudes of LH episodes were greater (P<0.01) in H (0.33 \pm 0.02 ng/ml) than L cows (0.27 \pm 0.02 ng/ml). In anoestrous cows, LH concentrations and episode amplitudes were greater in H than L cows. However, patterns of LH secretion were identical between strains during the mid luteal phase.

Changes in LH responses to a GnRH agonist (buserelin) were studied in mixed age and 2 year-old cows after calving (Experiment 2). LH responses to buserelin $(10\mu g/iv)$ on Days 21, 28, 35 and 42 after calving were greater (P<0.001) in L than H cows, but that there was no change in responses with time (Experiment 2a). Responses to buserelin were therefore studied on Days 7, 14, 21 and 28 after calving using mixed-age H and L cows (Experiment 2b, n=7/group) and first calved 2 year-old L and H cows (Experiment 2c; H: n=6 and L: n=7). LH responses increased significantly (P<0.01) as time postpartum increased, but there were no differences between LH responses in L and H cows in either Experiment 2b or 2c.

The positive feedback effect of oestradiol benzoate (1 mg, i/m) upon LH was examined in groups of 12 L and H cows on Days 7 and 21, or on Days 14 and 28 after calving (Experiment 3). LH responses to oestradiol increased (P<0.05) and FSH responses (P=0.07) tended to decrease as time postpartum advanced, but there were no significant differences between strains in the responses. The results from Experiments 1-3 showed that the intrinsic activity of the hypothalamo-pituitary axis is similar between strains during the postpartum period.

Patterns of ovarian activity were examined by determining progesterone concentrations in thrice weekly milk samples collected between calving and the end of the mating period (Experiment 4). The percentage of cows that started to cycle within 21 days after calving was significantly (P<0.05) higher in Year 2 (78%) than in Year 1 (28%), but there were no differences between strains. No were there any differences between strains in the incidence of atypical ovarian patterns. Between Days 1 and 7 after insemination, progesterone concentrations were identical in H and L cows that conceived (P) or failed to conceive (NP). Progesterone concentrations in non-pregnant, H (HNP) cows declined earlier than in L cows during the late luteal phase. Progesterone concentrations were significantly (P<0.05) lower in HNP cows on Day 16 than in all other animals and lower in HNP than HP cows on Day 14 (P<0.05). This decline may be the result of either premature luteolysis or luteal inadequacy.

Studies of follicular and luteal activity between Day 5 postpartum and the second behavioural oestrus or the planned start of mating (i.e. during the pre-mating period: Experiment 5) showed that large follicles emerge earlier in H than in L cows, corresponding to the earlier resumption of oestrous cycles found in Experiment 4. H cows tended to have more cycles in which the interval from heat to ovulation was \geq 48 h (P=0.06) and fewer cycles with three follicular waves (P=0.12) than L cows. CL size increased significantly with time after ovulation (P<0.001), and tended (P=0.08) to be smaller in the mid luteal phase of H than L cows. Progesterone concentrations and luteal size of H cows reached maxima earlier (Day 11.4) than in L cows (Day 12.6); as also occurred in Experiment 4. Progesterone concentrations declined 1.3 days earlier in H cows than L cows, and more H cows had progesterone concentrations suggest that there are differences in the timing of the onset of luteolysis between strains, which may significantly affect the fertility in H cows.

In conclusion, the results from this thesis suggest that differences in fertility between strains probably do not lie in the areas of the hypothalamo-pituitary function, although the finding that follicular activity commences earlier in H cows may be related to the higher levels of endogenous LH secretion in anoestrous H than L cows. There were, however, differences in ovarian and luteal function between H and L cows which could explain the observed differences of fertility. The mechanisms by which these differences of ovarian and luteal function contribute to the differences in fertility between the strains and the way such mechanisms relate to the genetic differences between the strains, requires further investigation.

DEDICATION

I dedicate this thesis to my mother, the late Sew Kim Thiengtham, who had gone through lots of difficulties just to provide me with a sound fundamental education. She did not hold any university degree, but totally believed in the value of education for a better future of her children.

Her persistence and determination in all what she did always inspire me in pursuit of the excellence. Her unconditional love, example, attitude and good memories about her have been pushing me and providing strength for me to press on.

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LIST OF ABBREVIATIONS

AI	artificial insemination
AP	the anterior pituitary
AUC	area under the curve
BCS	body condition score
bTP-1	bovine trophoblastic protein
CL	corpus luteum
d	day
DF	dominant follicle
E ₂	Oestradiol-17B
FSCR	first service conception rate
FSH	Follicle stimulating hormone
GnRH	Gonadotrophin releasing hormone
Н	Heavy strain
h	hour
hCG	human chorionic gonadotrophin
IFN-τ	Interferon-tau
IGF-I	Insulin-like growth factor I
L	Light strain
LH	Luteinising hormone
LLC	large luteal cells
LW	liveweight
mg	milligram
min	minute
ml	millilitre
mm	millimetre
NEB	negative energy balance
ng	nanogram
NZ	New Zealand
OHF	overseas Holstein Friesian
OT	oxytocin
OTR	oxytocin receptor
P ₄	Progesterone
PG	Prostaglandins
PGE ₂	Prostaglandin E ₂
$PGF_{2\alpha}$	Prostaglandin $F_{2\alpha}$
PGI ₂	Prostaglandin I ₂
SLC	small luteal cells
wk	week
μl	microlitre

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