REPEATABILITY OF CONCENTRATION OF PLASMA IGF-1 IN TWO CONSECUTIVE LACTATIONS IN PASTURE-FED HOLSTEIN-FRIESIAN COWS

T.E. Moyes[1], F.Y. Obese[1], C.R. Stockdale[2], S. Humphrys[3] and K.L. Macmillan[1]
[1]The University of Melbourne, Department of Veterinary Science, Werribee, Victoria 3024
[2]Department of Primary Industries, Kyabram Dairy Centre, Kyabram, Victoria 3620
[3]Primego Limited, Thebarton, South Australia 5031

SUMMARY

Plasma IGF-1 concentrations were measured in 28 multiparous Holstein-Friesian cows at start-of-mating date in two consecutive lactations. The study was conducted in the Northern Irrigation Region of Victoria. Cows grazed pasture at an allowance of 35kg dry matter/cow/day and received either 1kg or 6kg grain supplement in Year 1, and 6kg grain supplement in Year 2. Plasma IGF-1 concentration was significantly lower in Year 1 compared to Year 2, partly due to the higher average grain intake in Year 2. There was a significant positive correlation in plasma IGF-1 concentrations between the two years for each cow (Pearson's correlation coefficient 0.65, Spearman's correlation coefficient 0.59; P<0.001). This means that comparative ranking for plasma IGF-1 concentration was similar between the same cows in two consecutive lactations, so that, regardless of diet, cows with relatively high plasma IGF-1 in Year 1 also had high IGF-1 in Year 2.

Keywords: Insulin-like growth factor-1, Holstein-Friesian, Dairy Cows

INTRODUCTION

Insulin-like growth factor-1 (IGF-1) is a small peptide that controls the growth and differentiation of many cell types through stimulation of the cell cycle (Rechler and Nissley 1990). IGF-1 has been implicated as being involved in many biological processes including pre and post-natal growth, lactation, reproduction, and immune function. In the dairy industry, most breeding programs use indices that weight milk yield and type traits more than fertility traits. This practice has resulted in substantial genetic progress for yield, but is likely to be associated with reduced fertility, given the reported negative genetic correlation between fertility and yield (Dematawewa and Berger, 1998; Hansen, 2000). A correlated trait is needed that is easy to measure on large numbers of cattle prior to the time when the major selection decisions are made. This is already being investigated for the beef and pig industries, where there is increasing evidence of the suitability of circulating plasma IGF-1 concentration as a genetic predictor of some economically important traits.

Herd *et al.* (2002) presented evidence for genetic variation in circulating levels of IGF-1 in young Angus cattle, and that selection against IGF-1 should lead to increased growth rate, improved feed efficiency, lower subcutaneous fat thickness and improved maternal nutrition to the calf before birth. Likewise, Luxford *et al.* (1998) has shown that IGF-1 can be used as an indirect selection criterion for improving feed efficiency in pigs. IGF-1 is inexpensive to measure when compared to carcase and feed intake traits. Opportunities exist in beef cattle to use this early life measure as a selection criterion for the genetic improvement of feed efficiency and carcase traits (Johnston *et al.* 2002).

In the beef and pig industries, selection for IGF-1 concentration is expected to reduce fatness and to improve feed efficiency. However, a high concentration of IGF-1 is desirable in the dairy cow, especially in relation to fertility, because cows with high IGF-I levels have been found to initiate oestrous cycling earlier during the post-partum period than anoestrous cows that have lower IGF-I concentrations (Thatcher *et al.* 1996). The genetic associations remain to be determined.

Heritability estimates of between 31 and 59% have been reported for IGF-1 concentrations in beef and dairy cattle (Herd *et al.* 1995; Davis and Simmen 1997; Johnston *et al.* 2001). Studies by Obese *et al.* (2002) have shown a high repeatability of plasma IGF-1 concentrations within individual cows within season, for Holstein-Friesian cows on a pasture based diet in early lactation, also suggesting a high level of heritability.

The objective of this study was to test the repeatability of concentrations of plasma IGF-1 in the same cows at start-of-mating date in two consecutive lactations. The hypothesis was that comparative IGF-1 concentrations would be similar between the same cows in two consecutive lactations. The potential value of the research is to develop a routine test for IGF-I to identify those animals most at risk of anoestrus and to select animals for improved efficiency on a pasture based diet. This would be a useful test for use in herd management and sire selection programs.

MATERIALS AND METHODS

Location. The study was conducted at the Kyabram Dairy Centre in the Northern Irrigation Region of Victoria. Cows used in the study were part of a larger study conducted in two consecutive years (2001 and 2002) to look at the effects of pre-partum feeding on production and reproduction during lactation.

Cows. All cows were high producing multiparous Holstein-Friesians. They weighed approximately 600kg at calving, and body condition scores ranged from 4 to 6, on the 8 point scale of Earle (1976). The same 28 cows were studied in both years.

Management. All cows received a total mixed ration of maize silage, crushed barley, canola meal and barley straw during the dry period, at about 1.6% of liveweight. They calved during August and then grazed pasture at an allowance of approximately 35kg dry matter (DM)/cow.day. They were also offered grain concentrates each day, which was fed immediately after milking at 0600 and 1530 hours. In Year 1, cows were offered either 1 or 6kg DM grain supplement per day. In Year 2 every cow was fed 6kg DM concentrates per day. Cows were fed these diets until the start of mating at the end of October. The average interval from calving to start-of-mating date was 77 days (± 6 standard deviation (sd)) for Year 1 and 72 days (±10 sd) for Year 2. Blood samples were collected at this time and plasma IGF-1 compared between the two years.

Sample Processing. 10ml blood samples were collected via venipuncture from a coccygeal (tail) vessel into heparinised vacutainer tubes. They were placed on ice immediately, centrifuged as soon as possible (3000 rpm for 15min at 4°c), and frozen at -20ºc until assays are undertaken. Samples were assayed using the DSL non-extraction IGF-1 Enzyme-Linked Immunosorbent Assay kit (Diagnostic Systems Laboratories Incorporated, Webster, Texas USA).

Statistical analysis. Results were analysed using SPSS 11.5 for Windows. An analysis of variance showed no significant affect of body condition score on IGF-1 in either Year 1 or Year 2, allowing it to be omitted from further analyses. Cows were separated into two groups according to their Year 1 supplement group. Group 1 comprised cows offered 1kg grain supplement (n=14) and Group 2 comprised cows offered 6kg grain supplement (n=14). The primary goal was to estimate a correlation between the two years. To do this, paired sample t-tests and Pearsons and Spearman's ranked correlation tests were performed on each group separately then on the pooled data set. A regression equation was generated relating plasma IGF-1 concentrations between the two years.

RESULTS AND DISCUSSION

Mean plasma IGF-1 for cows in Group 1 was significantly lower ($P<0.05$) in Year 1, when 1kg grain was offered compared to Year 2 when 6kg grain was offered (see Table 1). Therefore, as expected, an increase in total energy intake increased plasma IGF-1 concentrations. This agrees with a well reported positive correlation between increased grain feeding and/or total energy intake and plasma IGF-1 concentrations, (Spicer *et al.* 1990; Obese *et al.* 2002 and Fahey *et al.* 2003). A comparison of the rankings of individual cows between the two lactations within Group 1, gave correlation coefficients of 0.60 (Pearsons) and 0.61 (Spearmans), both at a significant level ($P<0.05$), indicating that, on the same dietary treatment, cows are likely to maintain a constant comparative rank in IGF-1 in two consecutive lactations.

Mean plasma IGF-1 for cows in Group 2 was significantly lower ($P<0.001$) in Year 1 than in Year 2 (see Table 1). Cows in this group received 6kg grain supplement in both years. Pasture intake was higher in Year 2 than Year 1, that may partly explain the difference between the two, but further variation may be due to a combination of a number of unmeasured factors which normally vary between seasons. A comparison of the rankings between Years 1 and 2 within Group 2 cows gave correlations similar to those in Group 1, being 0.57 (Pearsons) and 0.60 (Spearmans), both at a significant level ($P<0.05$). This indicates that a cow's comparative rank position for IGF-1 was likely to be maintained despite significant differences in absolute values.

Mean plasma IGF-1 for the pooled data (n = 28) indicated a significant difference in plasma IGF-1 concentrations between the two consecutive lactations, with that from 2002 being greater ($P<0.001$) (see Table 1). This is thought to be due to a combination of differences in postpartum diets and other seasonal factors. However, despite these differences, both Pearsons and Spearmans correlation tests indicated significant correlations ($P<0.001$) in IGF-1 for individual cows, between the two consecutive lactations, with correlation coefficients greater than 0.59 in both cases. The regression equation was $y = 1.17x + 21.75$ ($R^2 = 0.42$), where 'x' equals plasma IGF-1 (ng/mL) in Year 1 and 'y' equals plasma IGF-1 (ng/mL) in Year 2. This indicates that a correlation exists between the two consecutive lactations where, regardless of differences in diet and other factors that alter the absolute concentration of IGF-1, the relative ranking amongst study animals remained consistent over the two lactations.

This means that a cow with high plasma IGF-1 in one lactation, is likely to have high plasma IGF-1 in the following lactation, relative to others in the herd, under the same conditions. Given the relationship between IGF-1 and fertility, this may be an appropriate factor to be incorporated into breeding programs, and further investigation, with a larger sample size, and in consequent lactations, is warranted.

Table 1. A comparison of means and correlation coefficients between plasma IGF-1 concentration in the same cows in two consecutive lactations for dietary treatment Groups 1(1kg grain supplement Year 1), Group 2 (6kg grain supplement Year 1) and Overall

	Mean IGF-1 (ng/mL) ± s.e.m		Correlation coefficient Year 1 v Year 2	
	Year 1	*Year 2*	*Pearsons*	*Spearmans*
Group 1	65^{a}(±6)	92^{b}(±12)	0.60	0.61
Group 2	88^{a}(±7)	129^{b} (±13)	0.57	0.60
Overall	76^{a} (±5)	111^{b} (±9)	0.65	0.59

***Values in rows followed by different letters are significantly different (p<0.05)**

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