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Supplementing mature cows with either cereal or lipid-based supplements had no effect on the post-partum anoestrous interval.

S MEIER, P GORE, E MINNEE AND N THOMSON

Dexcel Limited, Private Bag 3221, Hamilton, New Zealand

ABSTRACT

An extended period of reproductive inactivity (anoestrus) is part of the normal recovery process in dairy cows, following calving. Low body condition at calving and long periods of negative energy balance affects the length of the post-partum anoestrous interval (PPAI). This study examined the effect of feeding two different supplementary feeds through early lactation, on the length of the post-partum anoestrous period. Forty-five mature dairy cows were allocated to either pasture (P; pasture allowance of 35 kg DM/cow/day), pasture plus a cereal (P+C; 3.0 kg/cow/day maize & barley; 50%: 50%) or pasture plus a lipid supplement (P+L; 1.8 kg/cow/day lipid-based supplement, plus 180 ml/cow/day oil drench 33% fish oil: 67% linseed oil), starting in the first week post-calving and continuing for at least 7 weeks (range 7 to 15 weeks). The length of the anoestrous period was measured using twice weekly milk progesterone analyses, ending on the 8th October, 2004. An animal was identified as having ovulated when milk progesterone concentrations reached a threshold ($>3\text{ng/ml}$), this event was categorised as the initial ovulatory event (IOE). There was no effect on the interval from calving to IOE (35.7 ± 3.9 days, 32.8 ± 2.9 days, and 35 ± 3.9 days; $\text{mean}\pm\text{SEM}$) for P, P+C and P+L groups, respectively. There was no effect of supplementation on either live-weight and body condition changes through early lactation. This study showed that when mature cows are fed a generous allowance of pasture post-calving, providing a cereal or lipid-based supplement during early lactation did not reduce the length of the PPAI.

Keywords: anoestrus; nutrition; cereal; lipid; dairy cow

INTRODUCTION

New Zealand's dairy industry is based on a seasonal dairy production system using grazed pastures. The seasonal pasture system aims to synchronise pasture growth with feed requirements, which is achieved by all cows calving within a defined period, and therefore becoming pregnant during a relatively short mating period (Holmes, 2001). To maintain this seasonality, it is expected that cows calve on a yearly basis. With a gestation length of 282 days, a cow has 83 days to recover from the previous calving, and resuming normal reproductive activity. During this recovery period, animals will undergo a period of reproductive inactivity (the post-partum anoestrous interval; PPAI) however an extended PPAI is a major risk factor to poor reproduction performance (see review by Rhodes *et al.*, 2003).

Low body condition at calving and periods of negative energy balance affects the length of the PPAI. Grainger *et al.*, (1982) showed that with each reduction in body condition score at calving, the PPAI was extended by 5 to 7 days. Feed restrictions in pre-calving will also delay the onset of ovulation (Burke *et al.*, 1995; Chagas *et al.*, 2001; McDougall, 1992). A number of studies have shown that the level of pre-partum nutrition will

reduce the PPAI when animals have restricted feeding pre-calving (Burke *et al.*, 2005; Chagas *et al.*, 2001).

Work has been carried out to examine the effect of additional nutritional supplementation to lactating cows post-calving. When pasture or pasture silage is supplemented post-calving, no effect on the PPAI was observed (Burke *et al.*, 2005; McDougall *et al.*, 1995). Studies have also been carried out where post-partum supplementation has been based on either starch (cereal) or fat-based supplements (Van Kneusel *et al.*, 2005). The study by Gong *et al.*, (2002) showed a significant increase in the number of animals that had cycled by 50 days post-calving when fed a diet high in starch. The anoestrous interval was also reduced when moderate amounts of fat (5.7%) in the form of tallow and yellow grease, were included in the post-calving diet of lactating dairy cows (Beam & Butler, 1997; see review by Staples *et al.*, 1998). Therefore, the effectiveness of post-calving supplementation in reducing the PPAI will be dependent on the type of supplement selected, the metabolic status of the animals used, and the relative feed deficit that the animal is under.

Therefore, the hypothesis that was tested in this study was that supplementing with either a

cereal or lipid-based supplement in early lactation can reduce the PPAI of mature dairy cows.

MATERIALS AND METHODS

This study was conducted at No 5. Dairy, Hamilton. Forty-five mixed aged cows calved between July and September (2004), were allocated to one of three treatments at calving (n=15 cows/treatment). The treatments were allocated in a sequential manner as cows calved to ensure the calving date and lactation days were similar across each treatment.

The three treatments consisted of either pasture (P), pasture plus a cereal (P+C; 3.0 kg/cow/day maize & barley; 50%: 50%) or pasture plus a lipid supplement (P+L; 1.8 kg/cow/day lipid-based supplement, plus 180 ml/cow/day oil drench 33% fish oil: 67% linseed oil), starting in the first week post-calving and continuing for a minimum of 7 weeks (average 10 weeks). The time between calving and the initial ovulatory event (IOE) was measured using twice-weekly milk progesterone analyses, ending on the 8th October.

Supplements provided equivalent rates of metabolisable energy (35 MJME/cow/day). Pre- and post-grazing herbage mass was 3100 and 1700 kg DM/ha, respectively, providing an average pasture allowance of 35 kg DM/cow/day of high quality pasture (average 12.4 MJME/kg DM). The three treatment groups were grazed as one herd throughout the study. The control cows were held back after the morning milking and returned to pasture along with the two supplemented groups.

Weekly monitoring of live-weight and body condition score (scale 1 to 10; Macdonald & Macmillan, 1993), were initiated at 5-weeks pre-calving and continued throughout the study period. Weekly blood samples were taken on the same day. Blood samples were taken from the coccygeal vessels into heparin vacutainers. The samples were immediately placed in iced water and centrifuged within 2 hours of being taken. Plasma samples were stored at -20°C until required for analysis.

Milk progesterone was measured twice weekly in samples taken at the AM milking on Tuesday and Fridays. Progesterone was measured using an ELSIA Kit (Ridgeway Sciences, Gloucestershire, UK), validated for use in cattle (Sauer *et al.*, 1986). An animal was identified as having ovulated when one milk sample was found to be elevated (>3ng/ml) and was followed by regular pattern consistent with oestrous cycling.

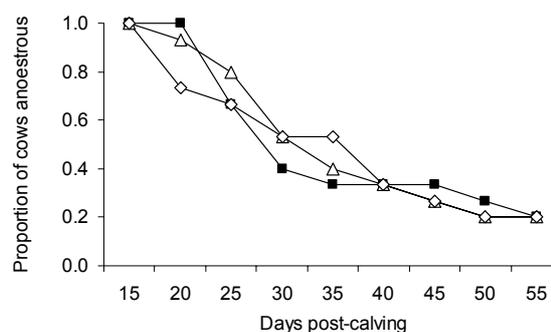
Data was analysed by general linear model ANOVA using REML using Genstat 8. Statistical analysis of post-partum interval was carried out

using CENSOR procedure, with censored data being included for animals that had no post-partum interval. Data for the IOE included censored data from 9 individual cows, which were anoestrous up until the final milk progesterone (8th October). Cox proportional hazards models were used to examine the correlations between live-weight and body condition score on either IOE at two-time points pre-partum (week -5 and -1) and two time points post-partum (week 1 and 5). The relationship between the change in live-weight & BCS between weeks -5 to -1 and weeks 1 to 5 to the IOE was also examined. Data is presented as the mean \pm SEM.

RESULTS

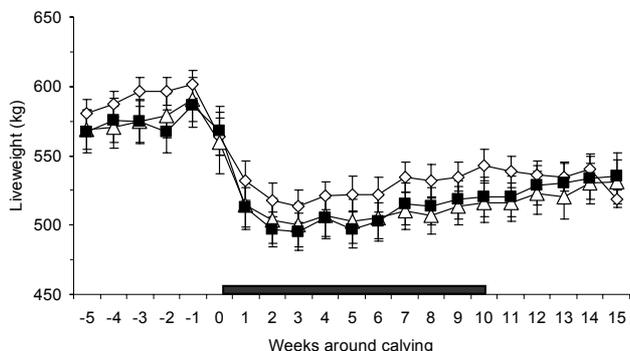
There was no effect of treatment on the PPAI (35.7 \pm 3.9 days, 32.8 \pm 2.9 days, and 35 \pm 3.9 days for P, P+C and P+L groups, respectively). There was no difference in the proportion of animals that were anoestrous between the three treatments (20% anoestrous; 3 out of 15 cows) at the time of the last milk progesterone sample (8th October). The proportions of animals, which were anoestrous throughout the first 8 weeks post-calving, are shown in Figure 1.

FIGURE 1: Proportion of cows not cycling from 15 to 55 days post-calving, in the pasture (■, n=15), pasture+cereal (◇, n=15), and pasture+lipid (△, n=15) treatment groups.



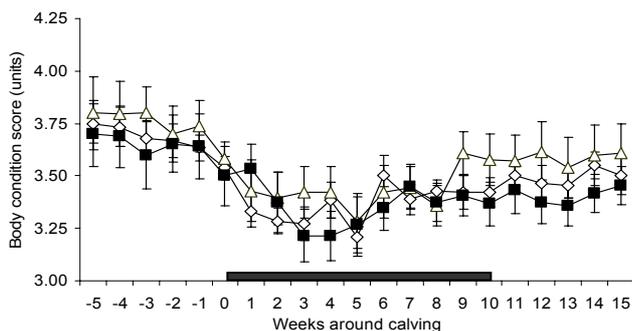
Treatment had no effect on the average live-weight or body condition or the change in live-weight and body condition throughout early lactation (Figure 2 & 3). The peak live-weight was at 4 weeks pre-calving with an average of 576 \pm 16 kg, 587 \pm 9 kg and 571 \pm 15 kg, for P, P+C, and P+L groups, respectively. The live-weight nadir was reached around 3 weeks post-calving, with animals losing 90 \pm 14 kg of live-weight over this period (Figure 2).

FIGURE 2: Changes in live-weight, 5-weeks pre-partum to 15 weeks post-partum, in the three treatment groups, pasture (■), pasture+cereal (◇), and pasture+lipid (△). The solid bar represents the average treatment length. Data represents the raw means (±SEM).



The average cow body condition 4-weeks pre-calving was 3.7±0.2, 3.7±0.1 and 3.8±0.1, for the P, P+C, and P+L groups, respectively. The nadir in body condition occurred between weeks 2 and 3 with body condition declining to 3.2±0.1, 3.3±0.1 and 3.4±0.1 BCS units over this period (Figure 3). There was no relationship between live-weight or body condition at either week -5, -1, or 5 and the PPAI.

FIGURE 3: Changes in body condition score, 5-weeks pre-partum to 15 weeks post-partum, in the three treatment groups, pasture (■), pasture+cereal (◇), and pasture+lipid (△). The solid bar represents the average treatment length. Data represents the raw means (±SEM).



DISCUSSION

Providing a cereal or lipid-based supplement during early lactation, to mature cows allocated a generous pasture allowance (35 kg DM/cow/day), had no effect on the PPAI. This is similar to the results found previously where post-calving supplementation with pasture-based supplements did not reduce the PPAI (Burke *et al.*, 2005; Kolver *et al.*, 2005; McDougall *et al.*, 1995).

A large number of factors have been found to influence the post-partum interval. Among these are numerous factors that link to the nutritional balance of the animal including feeding, stocking rate, energy balance, and body condition (Beam & Staples, 1997; Rhodes *et al.*, 2003). The effects of a range of body condition scores and levels of feeding have been examined and modelled (Grainger *et al.*, 1982; McGowan, 1981). These results and those of others have shown that body condition at calving will affect the anoestrous period (Burke *et al.*, 2005; Chagas *et al.*, 2001; McDougall, 1994), as well as overall reproductive performance (Buckley *et al.*, 2003). In the current study the animals were in low body condition at calving (average 3.7 body condition units with the generous feed allowance offered (35 kg DM/cow/day) the average daily milk production of these animals was between 2.2 to 2.4 kg MS/cow/day indicating that these animals were well fed to maintain high milk-solids production (>2.2 kg MS/day; Thomson, 2005). This suggests that these animals were in good condition resulting in high milk production, it is therefore possible that these animals showed normal PPAI for their phenotype, and may not have been at risk of an extended PPAI, therefore the additional feeding was ineffective in reducing PPAI further.

To fully understand the mechanisms that determine the PPAI in lactating cows, and thus strategically use supplementary feeding to reduce PPAI, there is a need to understand the relationships between the PPAI, the metabolic conditions under which PPAI is extended and mechanisms that result in some supplements able to reducing PPAI in the lactating cow. A recent review by Van Kneegsel *et al.*, (2005) outlined the effect of dietary energy source on reproduction in lactating cows. In three out of four studies using glycogenic energy supplements the PPAI was reduced (Van Kneegsel *et al.*, 2005). Gong *et al.*, (2002) found a similar effect, where feeding a starch-based diet, designed to increase circulating insulin levels. The effect of lipogenic nutrients on PPAI is less consistent than those seen with glycogenic nutrients. The responses vary from an increase in PPAI in six out of 12 studies (Van Kneegsel *et al.*, 2005) and no effect or a slight decrease in PPAI in the remaining studies (Staples *et al.*, 1998; Van Kneegsel *et al.*, 2005).

Understanding the differences in metabolic responses to glycogenic and lipogenic supplements may provide an indicator of the key nutritional components involved in modulating PPAI. Glycogenic nutrients tend to increase plasma glucose and plasma insulin levels and decrease plasma non-esterified fatty acids and growth

hormone levels, whereas the lipogenic nutrients tend to result in the reverse with decreasing plasma glucose and insulin and increases in plasma non-esterified fatty acids and growth hormone levels (Van Knegsel *et al.*, 2005). From this data it is clear that the mechanisms whereby nutrition modulates reproduction are complex, however supplements that aim to increase glucose and insulin levels may be able to facilitate the reduction in PPAI better than supplements that do not. A key to developing supplements that consistently reduce PPAI will be a better understanding of the mechanisms underpinning the effect of specific nutrients (glycogenic versus lipogenic) on ovarian function and ovulation, and the interaction with cow nutritional status both pre- and post-calving.

The current study is one of the first to compare the effects of a cereal and lipid-based supplement on PPAI, in pasture fed animals in New Zealand. Even though the number of animals used is limited, the current study indicates that in a situation where cows calve in low body condition and fed a generous allowance of pasture post-calving, supplementary feeding through early lactation does not shorten the PPAI. If we endeavour to reduce PPAI we need to gain a better understanding of the responses of the at risk cows to strategic supplementation at both experimental and farm systems level, thus allowing use to use these strategies more effectively.

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