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A case control study of anoestrum in New Zealand dairy cows

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ABSTRACT

Dairy cows are in negative energy balance in the early postpartum period. It was hypothesised that cows that had not resumed ovulating by 1 week before the planned start of mating (PSM) were in negative energy for a longer period and/or to a greater depth than cycling cows. This case-control study compared the condition score, concentrations of selected blood metabolites and milk production in each of 90 pairs of anoestrous and cycling dairy cows on 8 farms. Anoestrous cows had a lower condition score (0.3 units), a higher urea concentration (0.3 mmol/l) and a lower glucose concentration (0.11 mmol/l) than their cycling pair. There was no difference in milk volume, milk fat, protein or length of lactation between cycling and anoestrous cows. The hypothesis that anoestrous cows are in lower energy balance than cycling cows is supported.

Keywords: Dairy, cow, anoestrum, case-control, blood metabolite.

INTRODUCTION

Post-partum anoestrum (PPA) can be defined as a failure of a cow to be detected in behavioural oestrus by the PSM. PPA may be due to a failure of detection of oestrus by the farmer, to the cow not expressing behavioural oestrus though cycling ('silent' ovulations) or to a failure to undergo cyclic activity (anovulatory anoestrus, AA; Radostits and Blood, 1985). Detection of a corpus luteum (CL) during rectal palpation has been used to distinguish between PPA cows that have ovulated (that is, a CL is present) and those that have not (no CL present). The sensitivity and specificity of rectal palpation for the presence of a corpus luteum are reported as 89% and 97%, respectively (Dawson, 1975).

Early in the postpartum period the energy requirements for milk production and maintenance exceed energy intakes and the cow is in negative energy balance. Body tissue is mobilised to provide substrates for gluconeogenesis at this time. The period of negative energy balance lasts for 4 to 14 weeks postpartum and varies in depth among cows. The average energy balance over the first 20 days postpartum is well correlated with the interval from calving to first ovulation. Cows resume cyclic activity about 10 days after the lowest negative energy balance is reached (Butler *et al.*, 1981). Energy balance is difficult to determine in pasture fed cows due to problems in measuring the feed intake of individual cows. This has lead to attempts to find indirect measures of energy balance including body condition score and the concentration of various blood metabolites (Payne *et al.*, 1970; Payne and Payne, 1987; Canfield and Butler, 1991).

Cows which undergo an extended period of negative energy balance have extended periods of PPA. The concentrations of metabolites associated with tissue mobilisation (ß-hydroxy butyrate (BOH), non-esterified fatty acids (NEFA) and urea) may be higher and glucose concentration lower in these cows. Condition score (CS) is a subjective measure of body tissue reserves (Ruegg, 1991) and may act as a crude marker for tissue mobilisation. CS may be expected to be lower in cows with an extended period of negative energy balance.

Hypotheses

That anovulatory anoestrous cows have:

1. lower condition scores, lower glucose concentrations and higher urea, BOH, and NEFA concentrations than cycling controls; and
2. similar milk production to cycling controls.

METHOD

Cows from eight (two research and six commercial) spring calving (28 June to 10 July commencement of calving) herds in the Waikato region were used. The herds were selected on the basis of co-operation of the herd owner and the herd owners ability and commitment to keep detailed reproductive records.

Any cow not detected in oestrus by 3 weeks before the PSM had 10 mls of sera removed from the ventral coccygeal vein into plain evacuated glass tubes (Vacutainer, Salmond Smith Biolab, Auckland, New Zealand) at 3, 2 and 1 weeks before the planned start of mating (PSM) for progesterone concentration determination. Any cow detected in oestrus between 3 and 1 weeks before the start of mating was removed from analysis and the blood samples discarded. Oestrous detection was performed by the herd owners and their staff on a twice daily basis. The breed and age data as well as calving and oestrous dates were collected for all cows 10 days before

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the PSM. At this time each anoestrous cow was matched to a cyclic cow on the basis of breed (Friesian, Jersey, Friesian x Jersey), age (2, 3, >3 years) and calving date (±7 days). One week before the PSM, the reproductive tract of all anoestrous and cycling pairmates was palpated by 1 of 3 experienced veterinarians for the presence of a corpus luteum (CL) and any reproductive tract pathology (ie. pyometron, endometritis, ovarian cysts or adhesions). Body condition score (cs) was assessed on a 1 to 10 scale. Additionally, 10 mls of blood was drawn from the coccygeal vessels into a plain and an EDTA containing evacuated glass tubes for analysis of ß-hydroxy butyrate (BOH), glucose, non-esterified fatty acid (NEFA) and urea concentrations. Analysis was performed on an Hitachi 717 auto-analyser at the Animal Health Laboratory, MAF, Ruakura. The between assay variation was below 2%. Progesterone concentration was determined in a commercial, solid phase, I^{125} assay (Coat-a-Count, DPC, Los Angeles, Calif., USA). Two quality control pools were run in sextuplet in each assay and the within-assay and between-assay variation were 5.3% and 15.2%, and 6.0% and 9.0% from samples of mean concentrations of 3.7 and 1.7 ng/ml, respectively, over four assays. The sensitivity (estimated as 90% of B/Bo) was 0.08 ± 0.02 ng/ml. One ng/ml was selected as the discriminant point between cycling and non-cycling animals.

Milk volume (litres; l), milkfat (kg), protein (kg) and length of lactation (days in milk; DIM) data for the entire season were collected. Milk samples were collected twice in a 24 hour period (evening and next morning) for estimation of milk production on a weekly (two herds), 6 weekly (one herd) or 8 weekly basis (three herds). Two herds did not routinely estimate milk production. The total seasons' milk production was estimated using a 'test interval centering method'. The fat and protein concentration were estimated by infrared spectrophotemetry (Milko-scan 133B, A/S N. Foss Electric, Hillerod, Denmark). The number of days in milk (DIM) was calculated by subtracting the dry off date from the calving date which were supplied by the herd owner.

Cases (AA) were defined as cows not having been detected in behavioural oestrus, not having a CL or palpable reproductive tract pathology, having serum progesterone less than 1 ng/ml at 3, 2 and 1 weeks before PSM, and who had been calved at least 45 days, 1 week before the PSM. Cycling (C) cows had at least 1 oestrus by 1 week before PSM, had no palpable reproductive tract pathology and had a serum progesterone >1 ng/ml 1 week before the PSM.

ANALYSIS

The value for the C cow was subtracted from the value of the AA cow, within each pair, for each of the independent variables. This difference was then analysed by students t-Test. This case-control design was used to remove the known affects of breed, age and time of year on the concentration of blood metabolites (Lee *et al.*, 1978). This approach reduced the variation between cycling and anoestrous pairs, allowing any difference among these groups to be examined.

RESULTS

Initially 275 non-cycling cows who had been calved more than 45 days were examined. Ninety anoestrous cows remained after removal of cows that were cycling (n=136 were detected as having a CL upon palpation and an additional 28 had an elevated progesterone concentration at one of the three samplings), that had reproductive tract pathology (n=7) or that were removed for miscellaneous reasons (n=14, eg. due a blood sampling being missed or the anoestrous cows assigned cycling partner being found to have reproductive tract pathology; Table 1).

AA cows had a lower body condition score, higher urea and lower glucose concentration than C cows. There was no difference between the AA and C cows in the NEFA or BOH concentrations, in the absolute amount of milk produced (volume, milkfat, or protein) or the number of days in milk (DIM, Table 2).

TABLE 1: The herd size, the percentage of cows not observed in oestrus (NDO), with uterine or ovarian pathology (Path), with a corpus luteum (CL +ve) with elevated progesterone concentration but without a CL (P4), defined as anovulatory anoestrus (AA), removed for miscellaneous reasons (Misc), the mean and standard error of the mean (sem) of these percentages and the number of pairs (Pr) of cows from each of 8 herds.

Herd num	Size	NDO %	Path %	Anoestrus CL +ve %	P4 %	AA %	Misc %	Pr n
1	355	29.3	0.3	20.5	1.3	7.2	0.3	21
2	170	8.6	0.0	0.7	1.4	6.4	0.0	9
3	103	21.3	1.3	10.0	0.0	10.0	1.3	7
4	218	23.2	1.6	4.9	3.2	14.0	1.6	20
5	95	17.9	0.0	4.5	4.5	9.0	0.0	6
6	226	14.7	0.5	6.2	0.5	7.6	0.5	11
7	146	17.7	0.9	11.5	1.8	3.5	0.9	3
8	283	23.4	0.0	12.1	4.7	6.5	0.5	13
mean	199.5	19.5	0.6	8.8	2.2	8.0	0.6	
sem	31.7	2.2	0.2	2.2	0.6	1.0	0.2	

TABLE 2: The units, mean concentration of anoestrous (AA) and cycling (C) cows, the normal range or regional average, the difference and standard error of the difference (SED) between 90 cycling and 90 anoestrous pairmates for condition score, metabolic and production parameters and the statistical significance of this difference (P).

	Unit	Mean AA	Mean C	Normal	Diff	SED	P
CS	-	4.0	4.3	-	0.3	0.06	0.00
BOH	mmol/l	0.62	0.60	-	-0.02	0.04	0.66
Glucose	mmol/l	3.25	3.37	-	0.11	0.06	0.05
NEFA	mmol/l	0.34	0.35	-	0.02	0.04	0.63
Urea	mmol/l	7.25	6.95	2.7-12.3[1]	-0.30	0.15	0.06
Volume	l	3786	3765	3360[2]	-20.0	126	0.87
Milkfat	kg	187.3	187.2	162[2]	-0.06	5.6	0.99
Protein	kg	124.9	132.8	124[2]	7.9	4.1	0.65
DIM	days	237.0	244.7	226[2]	7.76	5.0	0.13

[1]Normal range value, Animal Health Laboratory, Ruakura

[2]Auckland region averages from 'Dairy statistics 1991/92', Anon, Livestock Improvement Corporation, 1992

DISCUSSION

The lower condition score, higher urea concentration and lower glucose concentration are consistent with the hypothesis that anoestrous cows are in lower energy balance than their cycling herd mates.

When in negative energy balance cows may increase feed intake, increase mobilisation of body tissue or reduce production to return to energy balance. The milk production did not differ between AA and C cows in this experiment. Feed intake of anoestrous cows is lower than that of cycling herd mates (Lucy *et al.*, 1991). Thus, AA cows may have had a both reduced feed intake and mobilised more body tissue reserves than cycling cows.

Restriction of nutrient intake reduces blood glucose concentration (Jackson *et al.*, 1968; Tilakaratne *et al.*, 1980). Low glucose concentration and hence low energy balance has been hypothesised as being important in delaying resumption of cyclic activity and lowering conception rates (McClure, 1970; Butler and Smith, 1989). Luteinising hormone is essential in follicle development and ovulation. Its concentration is depressed by reduced feed intake which indicates a direct mechanism by which underfeeding may influence the reproductive system (McCann and Hansel, 1986; Rutter and Manns, 1987).

Urea concentration is a reflection of dietary intake of proteins and non-protein nitrogen, the degree of protein catabolism occurring in the body, and the excretion of urea in the urine (Oldham and Parker, 1981; Lean *et al.*, 1992). In well fed cows, protein catabolism produces only a small proportion (13%) of the nitrogen in the urea pool, the rest being from dietary sources (Oldham and Parker, 1981). However, in the poorly fed cow, protein catabolism may be increased, hence contributing a larger proportion to the urea pool. As cows with longer postpartum intervals to ovulation eat less than herd mates cycling earlier postpartum (Lucy *et al.*, 1992) the higher urea concentrations observed in the AA cows are probably due to increased protein catabolism rather than a higher intake of dietary protein.

In summary, anoestrous cows have a lower blood glucose, a higher urea concentration and a lower condition score than cycling herdmates which is consistent with the hypothesis that they are in lower energy balance than cycling cows.

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