Available online at www.sciencedirect.com
ScienceDirect
The Veterinary Journal 175 (2008) 234–239
The Veterinary Journal
www.elsevier.com/locate/tvjl

Effect of pre-calving zeolite, magnesium and phosphorus supplementation on periparturient serum mineral concentrations

Anders Pallesen, Flemming Pallesen, Rolf J. Jørgensen *, Trine Thilsing

Cattle Production Medicine Research Group, Department of Large Animal Sciences, Royal Veterinary and Agricultural University, Denmark

Accepted 14 January 2007

Abstract

The objective of this study was to test whether supplementing dry cow rations with phosphorus (P) and magnesium (Mg) would interfere with the beneficial effect of zeolite supplementation on the periparturient blood calcium (Ca) concentration in dairy cattle. Three groups (A–C) of 10 Danish Jersey cows were each given the following daily supplements from 2 weeks before the expected date of calving until actual calving: group A: zeolite, monoammonium phosphate, standard dry cow mineral and vitamin mix, containing 61 g magnesium phosphate; group B: zeolite, standard mineral and vitamin mix without the magnesium phosphate and group C: standard mineral and vitamin mix, monoammonium phosphate.

All cows in group B had an apparently less variable serum calcium concentration around calving with no cases of milk fever and no subclinical hypocalcaemia or hypomagnesaemia recorded. In contrast, a parturient drop in blood Ca was seen in group A as well as group C. In group A, one cow was hypocalcaemic at calving, and developed milk fever. In group C, 12 blood samples, representing six cows, were hypocalcaemic, and three of these cows were treated for milk fever. All groups remained normomagnesaemic and there were no significant differences in blood Mg across groups. In conclusion, the combined P and Mg supplementation in addition to zeolite supplementation did not increase the serum Mg level (forage Mg 16.9 g/day; 0.21% of DM). Combined P and Mg supplementation reduced the zeolite-induced hypophosphataemia but also reduced the stabilising effect of zeolite on parturient serum Ca.

Keywords: Hypocalcaemia; Milk fever; Zeolite; Hypophosphataemia

Introduction

Prevention of parturient hypocalcaemia (milk fever) by manipulation of the dry cow ration has centred on trying to manage the dietary cation–anion balance in the feed, or on keeping a low calcium (Ca) level in the dry cow ration (e.g. <20 g/day) (Wiggers et al., 1975). However, it is difficult to maintain a sufficiently low Ca intake when using commonly available feeds. To overcome this problem, recent research has shown that supplementing diets with the calcium binder synthetic zeolite A, influenced blood calcium levels in non-pregnant dairy cows in late lactation (Jørgensen et al., 2001) and, when added to the feed during the last weeks of pregnancy, it prevented parturient hypocalcaemia (Thilsing-Hansen et al., 2002a).

Previous in vitro experiments performed with rumen liquor have demonstrated that zeolite is not Ca specific in that it also binds phosphorus (P) and to a lesser extent magnesium (Mg) (Thilsing et al., 2006). In support of in vitro data, zeolite supplemented dry cows fed a 66 g Ca, 33 g P and 19 g Mg ration exhibited a lower but normal serum Mg level at calving compared with unsupplemented cows (Thilsing-Hansen et al., 2002a). Although hypomagnesaemia resulting from zeolite supplementation remains to be demonstrated, its occurrence cannot be excluded in herds with a borderline Mg status and it would be unwanted even at the subclinical level since it is believed

* Corresponding author. Tel.: +45 35282836; fax: +45 35283055.
E-mail address: rjj@kvl.dk (R.J. Jørgensen).

1090-0233/$ - see front matter
doi:10.1016/j.tvjl.2007.01.007

to interfere with the cow's ability to mobilise Ca in response to hypocalcaemia (Sansom et al., 1983). Zeolite supplementation induces hypophosphataemia (Thilsing-Hansen et al., 2002a), but the consequences of this are also unknown.

Although the addition of Mg and P to rumen liquor had no negative influence on the Ca binding capacity of the zeolite in the in vitro studies, this has not been tested in vivo. It is therefore relevant to examine the effect of Mg and P supplementation on pregnant dry cows on a zeolite supplemented ration under commercial conditions.

In Denmark it is common farm practice to give commercial dry cow vitamin and mineral supplements of which magnesium phosphate is currently a major ingredient. The purpose of supplying dry cows with extra Mg is to reduce the risk of milk fever rather than grass tetany, the clinical manifestation of hypomagnesaemia. In the present experiment, such a commonly used dry cow mineral mix was applied together with zeolite to cows in late pregnancy. In order to ensure significant supplementation of P, additional P was given as monoammonium phosphate to study the consequences of high P supplementation on the expected zeolite-induced hypophosphataemia.

Materials and methods

Cows

Experiments took place on a well managed dairy farm with 250 Danish Jersey cows. A total of 30 dry, pregnant cows 2 weeks before expected date of calving and about to enter their fourth or later lactation were divided into three groups (A–C) of 10 cows each. The average body weight of the cows was 400–450 kg. The selection into the three groups was by systematic random sampling based on expected day of calving (ABCABC, etc.) to ensure even distribution of the groups during the trial period.

Stabling and feeding

The cows were kept in a tie-stall barn and fed individually once a day in the morning. Any refusals from the previous day were weighed and recorded for each individual cow.

All cows were given a 20 kg (wet weight) basal mixed ration composed of (DM per day) 5.50 kg corn silage, 1.61 kg commercial concentrate (125 g crude fat and 364 g digestible crude protein per kg DM), 0.60 kg dried beet pulp, 0.061 kg urea and 0.48 kg chopped barley straw, plus additional (2.19 kg) barley straw. The daily feed ration contained 47.1 g Ca, 16.9 g Mg, 26.8 g P, 126.3 g K and 9.7 g Na. These analyses were performed by Steins Laboratory A/S (DK-6650 Brørup) using standard procedures (ICP-method—ISO 11885) with coefficients of variance on Ca, P and Mg analyses of 7%, 6% and 6%, respectively. The daily feed ration contained 10.44 kg DM, 63.12 MJ ME and 713 g digestible crude protein.

Feed supplements

Zeolite. The zeolite supplement consisted of 500 g (450 g anhydrous) synthetic sodium aluminium silicate powder, type 4A, (Zeoline, SA B448, Engis). This commercial product had a water content of 9% and, according to the producer, a Ca exchange capacity (anhydrous basis) of 300 mg $CaCO_3$ per gram zeolite at pH 11.

High Mg and P supplement. This supplement consisted of 100 g of a commercial dry cow mineral and vitamin mix (containing 61% magnesium phosphate; Komix Gold,Vitfoss DK6300 Graasten) plus 100 g of monoammonium phosphate (Superfos Kemi a/s, DK-2950 Vedbæk).

Low Mg and P supplement. The composition and daily amounts of the ingredients of this supplement was identical to the commercial dry cow mineral and vitamin mix mentioned above but without magnesium phosphate. Thus, the daily amount given was 45 g.

The mineral and vitamin content of the two supplements are shown in Table 1.

Experimental treatments

The cows were supplemented daily from 2 weeks before the expected day of calving and until actual calving as follows:

Group A: Zeolite plus the high Mg and P supplement and vitamin mix.
Group B: Zeolite plus the low Mg and P mineral and vitamin mix.
Group C: High Mg and P supplement only.

An overview of the experimental treatments of the three groups is shown in Table 2 which also includes total daily intake of Ca, P and Mg and the dietary cation–anion difference per day (DCAD/day) based on the formula (Na + K + .15Mg) – (Cl + S + .30P).

Blood sampling

Blood samples were taken from the tail vein into Vacutainer tubes without additives. Serum was separated by centrifugation at 1000*g* for 10 min and samples were stored up to 3 days at 4 °C. In total, four blood samples were drawn from each cow: before start of supplementation (1), after 6–10 days of supplementation (2), during the interval 0–2 days post-partum (3) and 13–17 days after calving (4), respectively. Additional blood samples were drawn for later Ca analysis before any therapeutic treatment of any cow during this trial. Limits for subclinical hypocalcaemia were set at 2.00 mmol/L (DesCoteaux et al., 1997) and 0.7 mmol/L for subclinical hypomagnesaemia (Kaneko et al., 1997).

Criteria of exclusion

Cows that calved before they received at least 7 days of supplementation, or cows accidentally not receiving their supplementation for the whole period up to calving, were excluded.

Table 1
Mineral and vitamin content of the high Mg and P supplementation and the low Mg and P supplementation, respectively, calculated per cow per day

	High Mg and P	Low Mg and P
Calcium	1.7 g	1.3 g
Phosphorus, as $MgHPO_4$, $3H_2O$	4.5 g	0.0 g
Phosphorus, as $NH_4H_2PO_4$	24 g	0.0 g
Magnesium (as $MgHPO_4$, $3H_2O$)	18.0 g	0.01 g
Sodium (as NaCl)	10.0 g	12.2 g
Manganese	0.32 g	0.39 g
Copper	0.09 g	0.11 g
Zinc	0.54 g	0.67 g
Iodine	0.02 g	0.02 g
Cobalt	0.003 g	0.0 g
Selenium	0.003 g	0.0 g
Vitamin A	64000 IU	78885 IU
Vitamin D3	10000 IU	12330 IU
Vitamin E	0.64 g	0.79 g
α-Tocoferol	0.58 g	0.71 g