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PREVENTION OF MILK FEVER BY DIETARY MEANS

THE EFFECT OF A CONCENTRATE FORTIFIED WITH MINERAL SALTS

By

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DISHINGTON, INGER W. and J. BJØRNSTAD: *Prevention of milk fever by dietary means — The effect of a concentrate fortified with mineral salts.* Acta vet. scand. 1982, *23*, 336—343. — A concentrate was fortified with mineral salts by adding $CaCl_2$, $Al_2(SO_4)_3$ and $MgSO_4$ to standard concentrate A and pelleting the product. When used as feed supplement from 3 weeks pre partum to 1 week post partum this concentrate mixture produced the intended negative alkali alkalinity in the total feed ration in 20 out of 25 cows. Of these 17 remained healthy in spite of a history of milk fever for the majority of them. Two cows got milk fever and 1 showed weak symptoms.

milk fever; dairy cow; prophylactic diet.

Earlier studies have documented the importance of nutritional factors in the etiology of milk fever. Feeding experiments carried out during the years 1952—61, designed to study the influence of Ca and P on the disposition of the disease, clearly showed that the occurrence of milk fever was related to factors in the feed. The inducing and preventing effects of minerals in the feed did, however, not depend upon the contents of Ca and P per se, but to a greater extent upon the alkaline and acid compounds (*Ender et al.* 1962). Diets made up of beets, with high contents of Na and K and low contents of Cl and S (high alkali alkalinity) induced milk fever, whereas diets consisting of AIV (mineral acid) silage with a low pH and higher contents of Cl and S than of Na and K (negative alkali alkalinity) had pro-

nounced preventive effect. The studies were followed by Ca balance studies (*Ender et al.* 1971). Sixteen cows fed the high alkali alkalinity ration had a pronounced negative Ca balance the first 4 days post partum. Nine got milk fever and 2 had borderline symptoms. Of 13 cows fed the ration containing mineral acids none got milk fever, but 1 case of hypomagnesaemic tetany was observed. The Ca balance level was +1.4 g per day, on average, the first 4 days after parturition. That the opposite effect of the 2 diets really depended upon the contents of Na, K, Cl and S was verified by feeding experiments with ordinary diets supplemented with either Na_2CO_3 + $NaHCO_3$ or $CaCl_2$ + $Al_2(SO_4)_3$ + $MgSO_4$, up to the contents in previous beet and silage diets (*Dishington* 1975). Out of 14 cows given supplements of Na_2CO_3 + $NaHCO_3$ only 1 avoided milk fever symptoms. Of the 13 cows given chloride and sulphates 1 showed borderline symptoms, while 12 remained healthy in spite of histories of milk fever. In a later experiment 6 cows with a history of milk fever received acid salts added to silage, and 5 remained healthy (*Dishington* 1976, unpublished).

Preparation of individual rations containing additions of $CaCl_2$, $Al_2(SO_4)_3$ and $MgSO_4$ separately dissolved in water, is not practicable on the farms. The salts must be incorporated in a palatable and stable feed that is easy to store and handle. The present paper reports how this has been achieved using concentrates fortified with mineral salts.

MATERIAL AND METHODS

Animals

The cows were of the Norwegian Red and White breed, 5 or more years of age. Those used in the preliminary trials were stalled in the research farm at Heggedal. The others belonged mainly to private stocks. They were all under clinical supervision by veterinarians.

Concentrates used in preliminary trials

Concentrate 1. 1.5 kg $CaCl_2 \cdot 2H_2O$, 2.8 kg $Al_2(SO_4)_3 \cdot 16H_2O$ and 2.0 kg $MgSO_4 \cdot 7H_2O$ were separately dissolved in water and mixed with 54 kg of ground barley. A final pH of 4.6 was obtained by adding about 2 kg of $CaCO_3$.

The alkali alkalinity is defined as

$$\left(\frac{\text{mg K}}{39.1} + \frac{\text{mg Na}}{23}\right) - \left(\frac{\text{mg Cl}}{35.5} + \frac{\text{mg S}}{16}\right) = \text{mEq AA}$$

One kg of the concentrate: —940 mEq AA, 1.0 FFU[1], 85 g protein. Daily ration 3 kg.

Concentrate 2. 15.25 kg conc. HCl and 2.06 kg conc. H_2SO_4 in diluted form were mixed with 250 kg fish scraps from the fillet fabrication, neutralized with 4.55 kg $CaCO_3$ and 1.0 kg MgO to a pH of 4.1 and dried. Production took place at the Norwegian Herring Oil and Meal Industry Research Institute, Bergen, in 1978.

One kg concentrate: —4828 mEq AA, 1.15 FFU, 457 g protein. Daily ration 0.6 kg.

Concentrate 3. 50 kg $CaCl_2 \cdot 2H_2O$, 100 kg $Al_2(SO_4)_3 \cdot 16H_2O$ and 70 kg $MgSO_4 \cdot 7H_2O$ were mixed with 1300 kg fish viscera, 500 kg fish scraps and 1200 kg ground barley, neutralized with about 50 kg $CaCO_3$ to a pH of 4.8 and dried. Production took place at the Institute of Fishery Technology Research, Tromsø, in 1979.

One kg concentrate: —675 mEq AA, 0.58 FFU, 94 g protein. Daily ration 4 kg.

Composition of recommended salt enriched concentrate

The salts were mixed with standard cow concentrate A (12.5 kg protein, 95 FFU per 100 kg). Composition of the mixture:

Cow concentrate A	1000	kg	87 %
$CaCl_2 \cdot 2H_2O$	25.5	„	2.3 %
$MgSO_4 \cdot 7H_2O$	33.5	„	2.9 %
$Al_2(SO_4)_3 \cdot 16H_2O$	47	„	4.1 %
$CaHPO_4 \cdot 2H_2O$	33.5	„	2.9 %
NaCl	6.7	„	0.6 %
Trace elements	1.5	„	0.13 %

The salts were first mixed with one third of the concentrate A, and the remainder of the concentrate was added before pelleting. Production took place at the Agricultural Supply Cooperative, Trondheim, in 1980.

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[1] One FFU (fattening feed unit) = net energy of 1 kg barley, 1650 Kcal for fattening.

Analysis of 1 kg pelleted concentrate gave these values: 21.02 g Cl, 10.0 g S, 7.57 g K, 1.85 g Na, 20.02 g Ca, 3.06 g Mg, 7.56 g P, 0.81 FFU, pH 4.6, dry matter 87 %. The alkali alkalinity of the concentrate was —943 mEq/kg.

Feeding regime

Each allotment of fortified concentrate was followed by 2 slips to the user, one with information about analytical values and instructions on the use of the feed, and the other with questions about the behaviour of each cow. It was proposed to substitute 2.5 kg of standard concentrate A with 3 kg fortified concentrate per day from 3 weeks before to 1 week after parturition. Since hay and silage have shown higher contents of potassium in recent years, it was recommended to limit the amount of silage to 25 kg (or equivalent amounts of hay), and to cover the remaining feed requirement with carbohydrate and protein concentrates low in sodium and potassium. Samples of the rations at start and end of the experiments were collected.

Laboratory tests

The contents of Ca and Mg were determined after dry ashing, using atomic absorption spectrometry (Perkin Elmer 103). K, Na and P (inorganic) were determined after wet ashing, phosphate colorimetrically in a centrifugal analyzer, Gemsaec, and Na and K using atomic absorption spectrometry. Cl^- was extracted with alcohol-water and analyzed titrimetrically in Buchler Digital Chloridometer. SO_4^{--} was extracted with a buffer (pH 7.0) and determined by weight as $BaSO_4$. The daily consumption of Na, K, Cl and S was estimated on the basis of information about the amounts of feed consumed, and the alkali alkalinity determined.

RESULTS

Preliminary trials with salt carriers

The results are given in Table 1. Ground barley gave good results but an even adsorption of the salt solutions was difficult to achieve. Theoretically, concentrates made of fish appeared promising. Their gelatinous consistency would keep the salts dispersed and protected. Scraps from the fillet fabrication like-

Table 1. Preliminary feeding experiments on 18 cows with a history of milk-fever, using salt-enriched, ground barley, fish scraps and fish viscera.

Experimental year	Salt carrier substance	Number of cows	Dietary AA mEq/day	Clinical observations at parturition
1977	Ground barley	5	—445	4H, 1B
1978	Fish scraps	6	—240 — —570	4H, 1B, 1M
1979	Fish viscera	7	—370	7H

Result: 15 cows remained healthy at parturition, 2 showed borderline symptoms and 1 got milk fever.

AA = Alkali alkalinity
M = Milk fever
B = Borderline symptoms, but no treatment necessary
H = Healthy

wise gave good results and would, in addition, be a cheap carrier. However, difficulties were encountered in the drying process.

Using fortified fish viscera all animals remained healthy. But also in this case there were difficulties with the drying process. Dry matter could not be increased above 45 per cent. The product had the consistency of a fish silage, making transport and storage impossible.

Experiments with salt enriched concentrate A

Experience from the preliminary trials pointed to a flour mixture as the carrier of choice, and the standard cow concentrate A was chosen. The first product was of meal consistency and somewhat hygroscopic. The salts became lumpy and the cows refused to take it unless it was mixed with more concentrate. These difficulties, however, were avoided by pelleting the product. The pellets could be stored in paper bags at room temperature and were easily transported. The taste did not differ much from usual concentrates and most cows ate it with good appetite.

In Table 2 clinical observations at parturition, and the prehistories of milk fever and dietary AA are set out separately for each cow given the fortified concentrate. Out of 20 cows receiving the salt-containing concentrate in amounts sufficient to obtain a negative AA in the daily ration, 17 (85 %) remained healthy at parturition, 1 showed slight symptoms of disease and 2 (10 %)

Table 2. Feeding experiments on 25 cows, using the recommended concentrate fortified with mineral salts (alkali alkalinity —943 mEq/kg).

A: 20 cows whose daily dietary intake showed negative alkali alkalinity.

Exp. year	Age of cow yrs	Milk fever preceding yrs	Dietary AA mEq/day	Clinical observations at parturition
1980	9	1977	—470*	H
1980	10	1976, 78	—470*	H
1980	9	1977	—470*	H
1980	8	1975	—470*	H
1980	12	—	—258	H
1980	8	1978	—730	H
1980	6	—	—258	H
1980	4	—	—1109	H
1980	9	1979	—1385	M
1980	7	1979	—124	H
1980	6	1979	—167	H
1981	10	1976, 77, 79, 80	—543	H
1981	7	1978, 80	—1166	S
1981	8	1978, 79	—450	H
1981	8	1980	—873	H
1981	11	1979	—124	H
1981	13	1978, 80	—396	M
1981	8	1978, 79, 80	—277	H
1981	8	1980	—396	H
1981	10	1980	—396	H

Result: 17 cows remained healthy at parturition, 1 showed slight symptoms of milk fever and 2 got milk fever.

B: 5 cows whose dietary intake showed positive alkali alkalinity.

Exp. year	Age of cow yrs	Milk fever preceding yrs	Dietary AA mEq/day	Clinical observations at parturation
1980	7	1978, 80	+1599	M
1980	5	1980	+720	M
1980	5	1980	+3698	H
1981		—	+1064	M
1981	7	1980	+724	M

Result: One cow remained healthy at parturition and 4 got milk fever.

H = Healthy
M = Milk fever
S = Slight symptoms (no treatment)

*) unpelleted concentrate

got milk fever. One of 5 cows whose rations did not reach negative AA remained healthy during parturition, the other 4 ended up with milk fever.

DISCUSSION

The overall results of the preliminary experiments confirm the earlier report on the effect of salt addition (*Dishington* 1975). Out of 18 cows tested, 15 remained healthy at parturition in spite of histories of milk fever at earlier parturitions.

Due to practical difficulties the concentrates used were not applicable under practical conditions. Using fortified standard cow concentrate A in pellet form we have succeeded in producing a palatable, dry and stable preparation which will increase the Ca absorption in cows at parturition, and thereby prevent milk fever.

We believe decisive factors in this concentrate to be sufficiency of Ca and sufficient acid salts to give the ration a negative alkali alkalinity. In some cases this last condition was not fulfilled (Table 2B). Some cows may have been unwilling to take the new concentrate, or may have had too easy access to hay, silage, beets etc. with high contents of potassium. Generally, however, the results were convincing: Used continuously from 3 weeks before to 1 week after parturition the fortified concentrate appears to be effective and applicable under practical conditions in preventing milk fever.

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SAMMENDRAG

Forebyggelse av melkefeber ved fôring. — En ny kraftfôrblanding med salter.

Med utgangspunkt i erfaringer fra tidligere forsøk er det fremstilt en ny melkefeber-forebyggende kraftfôrblanding med 87 % tørrstoff, hvor det spesielt er lagt an på en nøyaktig regulering av pH (4—5) og alkali-alkaliniteten, AA (—943 mEq/kg).

Fôringsforsøk i perioden 3 uker før til 1 uke etter kalving har vært utført ved forsøksgårder og i felten. Tre kg av dette kraftfôr pr dag erstattet ekvivalente mengder kufôr A, samtidig som fôrbehov utover 25 kg silo (eller tilsvarende mengde høy) som er særlig rik på K ble erstattet med karbohydrat- eller proteinkraftfôr med lavt K-innhold. Av 20 forsøksdyr som fikk fôr med negativ AA, hvorav 17 hadde hatt melkefeber de siste årene, forble 17 friske, 1 viste svake symptomer, og 2 fikk melkefeber. Ett av 5 dyr som fikk fôr med positiv AA holdt seg friskt, mens 4 fikk melkefeber.

Konklusjon: En forskriftsmessig utskiftning av vanlig kraftfôr med den nye kraftfôrblandingen fra 3 uker før til 1 uke etter partus synes å være et effektivt middel til å redusere den høye melkefeberfrekvensen vi idag har blant høytytende melkekuer.

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