Testing of a zeolite product for the reduction of the risk of milk fever in 22 private herds

By:

Trine Thilsing and **Rolf Jess Jørgensen,** Department of large Animal Sciences, The Royal Veterinary and Agricultural University (presently: Faculty of Life Science, University of Copenhagen), Denmark

and

Finn Eiland and **Torben Hansen,** Stormøllen A/S, DK 4682 Tureby, Denmark.

INTRODUCTION

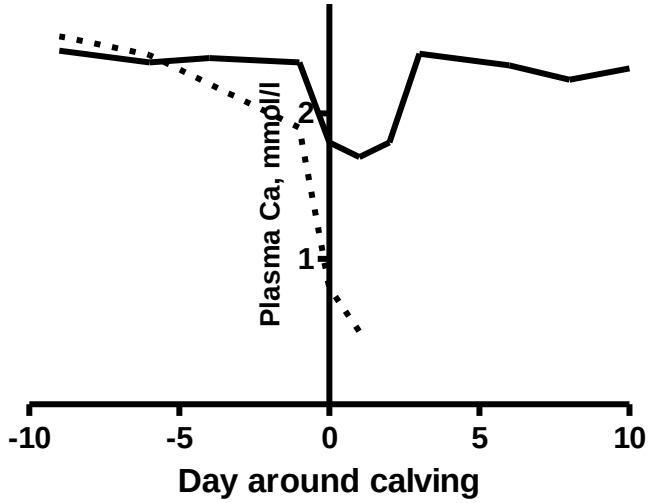
Milk fever is a desease which primarily occurs among older high yielding cows during the period around calving. Biochemically it is characterised by a sudden fall in the concentration of calcium in the blood.

Milk fever results from the massive draw on the calcium of the blood due to the initiation of the new lactation. During the dry period the demand for calcium for maintenance and foetus growth is very limited, and the calcium content of a typical dry cow ration contains substantially more calcium than this demand. As a result the requirement for calcium is almost exclusively covered by passive diffusion across the rumen and gut wall. The excretion of hormones responsible for active calcium transport from gut and mobilisation of calcium from bone is therefore at a minimum during this period and calcium metabolism thus goes into a stand-by state. The onset of lactation around calving demands large amounts of calcium from the blood to the udder. The level of calcium in the blood therefore decreases and the mechanisms which normally control blood calcium level are in a stand-by position, resulting in a drastic fall in calcium level in some, particularly older cows (to around 0,5-1,5 mmol/l). Such cows may express symptoms of milk fever (increasing incoordination, reduced feed intake, reduced body temperature, progressive muscle weakness and paresis and gradual coma and death unless treatment is initiated). Other cows develop a subnormal blood calcium, but at a moderate level without showing overt clinical signs. These cows are termed

subclinically hypocalcaemic. Hypocalcaemia is most often defined as a blood calcium level below 2.0 mmol/l.

Figure 1 shows an example of the fluctuations in the blood calcium level around calving in a cow which develop milk fever (dashed line) and a hypocalcaemic cow which.did not show clinical disease (full line).

Figur 1. Plasma Ca level around calving in a cow developing milk fever (dashed line) and a cow developing subclinical hypocalcaemia only (full line). X-axis shows days in relation to calving.



Prevention of milk fever

The following three principles are most often used in Denmark: Administration of easily available calcium via the oral route during the period close to calving (oral Ca); the feeding of acidifying dry cow rations ("anion supplementation") or feeding dry cow rations low in calcium. The administration of oral Ca is most often in the form of commercial products intended for that use (paste or liquid solutions) containing dissolved salts such as calcium cloride or calcium propionate. Thus the principle is based on passive diffusion of Ca across the rumen or gut wall during the critical period just around calving.

The feeding of acidifying dry cow rations is achieved by an excess of metabolic anions. In practical terms this is achieved by adding products or salts containing anionic salts such as $MgSO_4$, $MgCl_2$, NH_4Cl, $(NH_4)2SO_4$, $CaCl_2$, $CaSO_4$, HCl og H_2SO_4 during the last 2-4 weeks of pregnancy. The mechanism behind the preventive effect is only partially known but may involve calcium regulating hormones which, among other things, result in increased mobilisation of calcium from the skeleton before calving.

The feeding of dry cow rations low in calcium during the last part of pregnancy tend to bring the cow into negative calcium balance, forcing the calcium metabolism to remain active, including the absorption from the gut as well as the bone mobilisation, leaving the cow ready for mobilising large amounts of calcium into the blood in connection with the initiation of the new lactation.

This last mentioned principle is highly effcient, provided the daily intake of calcium can be kept around 20g Ca/cow.

Prevention of milk fever by zeolite supplementation

Difficulties connected with the practical application of the low calcium principle inspired a series of experiments with the supplementation of the dry cow ration with a calcium binder, synthetic zeolite A. The teory was, that the zeolite should bind calcium in the ration, this leaving it unavailable to the cow, thereby mimicking the low calcium principle. The zeolite used is synthetic zeolite A, which is sodium aluminiumsilicate. Zeolit A is used as a water softener in the industry producing laundry products for household use (cloth and dish washing), but it is also part of many feeding stuff as an additive, registered in the EU as a filler and anti caging component in animal feeds (Council Directive 70/524/EEC). In principle, the binding of calcium is in fact an ion exchange process in which Ca is adsorbed in exchange with Na which is released from the crystal structure.

The first intensive experiments with pregnant dry cows with calving number ≥3 involved the supplementation of 0.5-1.0 kg zeolit A/cow per day during the last 2-4 weeks of the dry period. The supplementation was stopped at the first signs of calving. In the first place the purpose was to observe if the expected effect on blood calcium around calving would occur at all. The results were promising since zeolite supplementation led to a significant increase in the parturient serum calcium level and thereby to a reduction in the risk of milk fever.

MATERIALS AND METHODS

The present report deals with results obtained during extensive field conditions in Danish private dairy farms.

The purpose with the experiments was:

1. Confirmation of the effect found on milk fever in intensive studies, including an evaluation of the usefullness of a 250g/d dose (”low dose”).
2. Registration of owner / user satisfaction regarding feeding / use, and general satisfaction with the new concept and the pilot product.

Participants

The experiment was performed as a collaborative one between selected farms, a producing company and the university department (The Cattle Production medicine Research Group of the Department of Large Animal Sciences, The Royal Veterinary and Agricultural University, Copenhagen).

The company had the legal responsibility whereas the university group was responsible for data processing and reporting.

The herds

Twentyone of the 22 dairy herds which participated in the study were placed in northern og in mid-Jutland while the last one was placed on Sealand, 30 km north of the university. The herds were selected by the participating company in collaboration with local bovine practitioners. Desired criteria for selection were farms with a milk fever problem recognised by the veterinary practitioner or the owner. During the second round of the experiment (the low dose herds), it became difficult to find sufficient suitable farms to maintain this criterion among potential clients of the veterinary practitioners involved.

Table 1 shows data on the participating herds:

Tabel 1. Characteristics of the participating herds

Total number participating	22
Herd size	
0-100 cows	3
100-150 cows	9
150-200 cows	8
>200 cows	2
Total	22
Stable type	
Cows tied up	2
Free stall	20
Dry cow stabling	
Tied up	6
Free stall	16
Dry cow management	
Close-up group	7
Pregnant heifers included in dry cow group	12
Ration formulated particularly for dry cows	7
Dry cow ration similar to lactation ration	15
Dry cows fed once/d	12
Dry cows fed twice/d	10
Management around calving	
Calving pen? Yes / No	18 / 4
Previously used attempts to prevent milk fever	
Oral Ca^{++} products	19
Low Ca dry cow ration	2
Dry cow acidification (anionic salt suppl.)	0
No prevention attempted	1

Design

Twenty cows in late pregnancy were selected on each farm. The first ten cows (expected date of calving), heifers excepted, were allocated as untreated controls.

The following 10 cows excluding the heifers formed the treatment group. These were exposed to experimental treatment during the period 14 days before expected calving and until actual calving date. Supplementation was thus abrupted at calving.

Experimental treatments

In a first row of 13 herds the treatment groups were given a daily dose of 625 g/d of a feed supplement containing 80% zeolite, corresponding to a content of 500 g synthetic microcrystalline

zeolite A. In the second row of experiments, comprising 9 herds, the treatment group received 313 g/d corresponding to 250 g/d.
No other milk fever preventive treatments, such as oral calcium preparations or rumen pumping with solutions containing calcium or other electrolytes, were accepted during the experiment.

Blood sampling
During the period from 2 weeks before expected calving and until one week after calving, the manager was obliged to call for veterinary assistance to participating cows, controls as well as treated cows, exhibiting symptoms of milk fever or judged by the herd manager to be developing milk fever. The manager should then ask the veterinarian to draw a blood sample before any therapeutic treatment was given, and submit it to the university laboratory for serum separation, frozen storage and later analyses for Ca, Mg and inorganic P. Information on tentative diagnosis, cow number and date should follow the sample. The envelope should be labelled as follows:

”Mælkefeber”
Laboratoriet, Medicin og Kirurgi,
Dyrlægevej 45,
1870 Frederiksberg C.

Recordings during the experiment:
All veterinary treatments of clinically diagnosed disease during the period 2 weeks before expected calving and until one week after calving should be recorded.

Other recordings during the experiment
Owner / user satisfaction with the new principle and the pilot product should be recorded on a tick mark questionnaire (feeding, cow acceptance, ease of use etc.).

RESULTS

1. Confirmation of the effect found on milk fever in intensive studies, including an evaluation of the usefullness of a 250g/d dose (”low dose”)

Table 2 and 3 show the number of cows registered by the managers as milk fever cases or recorded to be about to develop milk fever. The results are furthermore grouped with regard to the level of Ca.

Table 2. Cases of herd manager registered milk fever (MF) during the first round of the experiment and grouping of the serum Ca results on the same cows according to severity (serum Ca level) of hypocalcaemia.

	Untreated controls	Cows treated with 550g zeolite
MF cases/total	36/129 = 27.9 %	9/130 = 6.9 %
Serum Ca < 2.0 mmol/l	36/36 = 100 %	6/9 = 66.7 %
Serum Ca < 1.8 mmol/l	34/36 = 94.4 %	5/9 = 55.6 %
Serum Ca < 1.5 mmol/l	31/36 = 86.1 %	5/9 = 55.6 %
Serum Ca < 1.0 mmol/l	16/36 = 44.4 %	3/9 = 33.3 %

Table 3. Cases of herd manager registered milk fever (MF) during the second round of experiments and grouping of the serum Ca results on the same cows according to severity (serum Ca level) of hypocalcaemia.

	Untreated controls	Cows treated with 250g zeolite
MF cases/total	12/90 = 13.3 %	7/90 = 7.8 %
Serum Ca < 2.0 mmol/l	10/12 = 83.3 %	7/7 = 100 %
Serum Ca < 1.8 mmol/l	9/12 = 75.0 %	5/7 = 71.4 %
Serum Ca < 1.5 mmol/l	8/12 = 66.7 %	5/7 = 71.4 %
Serum Ca < 1.0 mmol/l	2/12 = 16.7 %	2/7 = 28.6 %

In the case of milk fever, a cow diagnosed as having milk fever on clinical grounds may be confirmed by laboratory analysis disclosing hypocalcaemia of a severity expected to result in the classical symptoms of milk fever. If the laboratory test fails to confirm the clinical diagnose, the case is categorised as a false positive one.

This grouping is complicated by the occurrence of subclinical cases. Most authors define subclinical hypocalcaemia as cows having serum or plasma Ca levels below 2.0 mmol/l. There is no agreement on the limit between subclinical and clinical cases but within studies as the present one, a strong correlation is expected between the blood level and the risk of clinical symptoms. In the present

investigation, between farm / manager factor is likely to have a pronounced effect on the number of cases registered as clinical ones. Marginally hypocalcaemic cases may for instance be overrepresented on farms with a very observant manager. This may bias the summarised results of manager diagnosed cases in Table 2 and 3.
For these reasons it may be appropriate to define an upper limit for true cases of milk fever. True cases may therefore for instance conform to the following criteria:

> *True cases of milk fever are cases exhibiting clinical symptoms of milk fever and having a serum Ca level < 1.8 mmol/l.*

This definition reveals the following results of the present study.

Table 4. True cases of milk fever (MF) during the first round of experiments.

	Untreated controls	Cows treated with 500g zeolite
True cases of MF/total cases	34/129 = 26.4%	5/130 = 3.8%

The difference between the groups is statistically significant (P<0.001).

Table 5. True cases of milk fever (MF) during the second round of experiments

	Untreated controls	Cows treated with 250g zeolite
True cases of MF/total cases	9/90 = 10%	5/90 = 5.6%

In this case the difference between the groups did not reach a statistically significant level (P>0.05).

The development of milk fever is known to be strongly and positively correlated to parity / age. In the present experiment this factor was not considered when cows were allocated into treatment groups. Table 6 shows calculated age in the groups

Table 6. Average calving number (±SEM) in the control – and experimental groups.

	Control groups	Zeolite groups
1st phase of experiment (500 g zeolit)		

Average calving number	3.8 (±0.19)	3.0 (±0.12)
Range	2-12	2-7
2nd phase of experiment (250 g zeolit)		
Average calving number	3.2 (±0.15)	3.1 (±0.16)
Range	2-9	2-10

As can be seen from Table 6 the average calving number was higher among control cows as compared to the experimental group during the first phase of the experiment (P=0.004), while there were no such difference in the second phase of the experiment (P=0.581).
When considering the participating high risk cows only, defined as cows with calving number ≥ 3, the following distribution appears (Tabel 7):

Table 7. Number of high risk cows (three or more calvings) in the various groups.

	Controls	Zeolite exposed
1 st phase (500 g zeolit)		
	78	61
2nd phase (250 g zeolit)		
	54	45

Calculation of the incidence rate of milk fever among participating high risk cows reveils the following results:

Table 8. Result of 1st phase (500 g zeolit/ko/dag), where the milk fever frequency is corrected according to the number of high risk cows in each group

	Controls	Zeolite exposed
No of cows with true milk fever (or developing milk fever) / No. of cows	34/78 (= 43.6 %)	5/61 (= 8.2 %)

Tabel 8a. Data from Table 8 presented in a 2 x 2 table

	+ zeolit	- zeolit	SUM
+ Milk fever	5	34	39
- Milk fever	56	44	100
SUM	61	78	139

The observed difference in milk fever incidence between the groups is statistically significant (P<0.01).

Tabel 9. Results of 2nd phase (250 g zeolit/ko/dag), where the milk fever incidence is corrected according to the number of high risk cows in each group

	Controls	Zeolite exposed
No of cows with true milk fever (or developing milk fever) / No. of cows	9/54 (= 16.7 %)	5/45 (= 11.1 %)

The observed difference in milk fever incidence between the groups is not statistically significant (P<0.01).

2. User / owner satisfaction

Registration of owner / user satisfaction with regard to feeding the new concept / product type, and general satisfaction

Results from the questionnaire were the following:

FIRST PHASE (500 g zeolite/cow per day):

Feeding method:

As top dressing: 92%

Mixed into whole ration: 8%

Mixed into roughage: 0%

No. of daily feedings with zeolite: 1x: 85% 2x: 15%

Palatability / uptake of zeolite product:

How was the palatability / uptake among the cows in general

	OK	Slightly reduced	Poor
At first presentation	38%	31%	31%
Remaining period except last week before calving	31%	54%	15%
Last week before calving	31%	38%	31%

Was there a large individual variation? Yes: 23% No: 77%

Satisfaction with the principle and product

Time spent as compared to previously spent time on milk fever prevention:

Much better: 23% Better: 46% Less attractive: 31% Much less attractive: 0%

Was time spent acceptable? Yes: 85% No: 15%

Impression of efficiency:

Effect on milk fever: No: 0% Yes, positive: 69% Yes, negative: 0% Do not know: 31%

General satisfaction with the new product and principle compared to hitherto practiced milk fever prevention principle or product:

Very satisfied: 31% Satisfied: 38% Not satisfied: 23%* Not decided: 8%

* The following reasons were given by farmers for not being satisfied:

- ”The cows do not eat it too well”
- ”We generally do not have major problems with milk fever”

- ”Palatability and appetite to the product is too poor, which leads to uncertainty regarding its uptake”.

SECOND PHASE (250 g zeolite/cow per day)

Feeding method:

As top dressing: 89 %

Mixed into whole ration: 0 %

Mixed into roughage: 11 %

No. of daily feedings with zeolite: 1x: 100 % 2x: 0 %

Palatability / uptake of zeolite product:

How was the palatability / uptake among the cows in general

	OK	Slightly reduced	Poor
At first presentation	33 %	56 %	11 %
Remaining period except last week before calving	67 %	22 %	11 %
Last week before calving	67 %	22 %	11 %

Was there a large individual variation? Yes: 11 % No: 89 %

Satisfaction with the principle and product

Time spent as compared to previously spent time on milk fever prevention:

Much better: 33 % Better: 45 % Less attractive: 22 % Much less attractive: 0 %

Was time spent acceptable? Yes: 89 % No: 11 %

Impression of efficiency:

Effect on milk fever: No: 22 % Yes, positive: 33 % Yes, negative: 0% Do not know: 45 %

General satisfaction with the new product and principle compared to hitherto practiced milk fever prevention principle or product:
Very satisfied: 22 % Satisfied: 45 % Not satisfied: 11 %* Not decided: 22 %

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* The following reasons were given by farmers for not being satisfied:
"Poor palatability even when the zeolite product was mixed into the concentrate. No obvious effect".

DISCUSSION AND CONCLUSION

As it appears from Table 8, the number of milk fever cases was significantly lower among cows exposed to 500 g zeolite daily as compared to unexposed control cows of the same herds. A similar convincing effect was not seen in herds where cows were exposed to 250 g/cow per day. The results of this trial therefore indicate that the daily dose should be higher than 250 g, and possibly as high as 500 g/day.
The results of the questionnaire showed that the time spent on feeding the zeolite product was found acceptable by far the majority of the herd owners in both parts of the trial. Futhermore there was a general satisfaction with the zeolite product and the principle among 2/3 of the herd owners. The remaining 1/3 were either not satisfied or replied "do not know" (had not made up their mind). Poor palatability / poor uptake during the zeolite supplementation was the most frequent explanation among the herd owners which were not satisfied with the product. The product appeared to have been given as a top dressing in nearly all herds (or it was fed mixed into the concentrate), and most frequently the whole dose was given in one meal.
Regarding its efficiency, it is concluded that under commercial farming conditions zeolite treatment at the level of 500g net/d reduced the incidence rate of milk fever among high risk cows from

26.4% to 3.8%, corresponding to an efficiency of 85 per cent. At a dose level of 250g the reduction was non-significant.

The results of the palatability / uptake recordings show a varied picture, with great differences between herds. In general the results point at better results in herds giving 250 g/cow as compared to herds giving 500 g/cow. Part of the palatability problems which may occur in connection with the zeolite supplementation may therefore probalbly be eliminated by simply dividing the daily dose into two feedings.

Post scriptum

This report was not intended for publication in its present form.

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Finally we, from Stormøllen and from the veterinary university, would like to express our sincere thanks to the participating herd owners and veterinary practitioners for the good cooperation.

Should you have questions related to the experiment, or in case you would like further details on the blood analysis results on single cows, please feel free to contact us.