TECHNICAL SERVICE BULLETIN

Dawe's

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NEW RESEARCH SHOWS DIETARY SULFUR REDUCES MILK FEVER WITHOUT AFFECTING URINE pH

CLOSE-UP PELLET® has been fed to several hundred thousand dairy cows across the United States and overseas during the "close-up" period just prior to calving. It is successful in reducing milk fever (hypocalcemia) and related fresh cow diseases, and in improving milk production and reproductive performance.

Many nutritionists and veterinarians use urine pH to monitor the effectiveness of pre-fresh feeding programs containing anionic salts. However pre-fresh urine pH is poorly correlated with post-partum serum Ca in cows fed **CLOSE-UP PELLET** (See Technical Service Bulletins #292 and #307).

Field trial results indicate that with **CLOSE-UP PELLET**, the incidence of milk fever is reduced and serum Ca levels are maintained above hypocalcemic thresholds, despite inconsistent reductions in urine pH:

- ✓ At 5 farms using **CLOSE-UP PELLET**, urine pH from 166 cows was examined within one week prior to calving. Urine pH averaged 7.70, considerably higher than is often recommended. However, there were only 2 cases of milk fever on these farms; an incidence rate of just 1.2%, well below the national herd average of 6%.

- ✓ On 2 of these farms, serum Ca was measured as well as urine pH (Technical Service Bulletins #292 and #307). Despite a pre-fresh urine pH mean of 7.71, the average serum Ca concentration at calving for these 49 cows was 8.40 mg/dl, well in excess of the subclinical hypocalcemic level (8.00 mg/dl).

- ✓ Urine pH was monitored on a large Midwest dairy, where 161 multiparous cows received **CLOSE-UP PELLET** as part of their pre-fresh ration (Technical Service Bulletin #308). Pre-calving urine pH among the 8 mature cows treated for milk fever averaged 7.51, while mean urine pH among the 153 other cows was 7.61. At 5.0%, the incidence rate of milk fever was low for multiparous cows. A typical milk fever incidence rate among mature cows is 8.5% or higher.

- ✓ On a large Western dairy, approximately 200 cows were fed **CLOSE-UP PELLET**, while another 200 cows were fed a commercial supplement supplying chlorides as the sole source of anions. Urine pH averaged 7.40 for cows fed **CLOSE-UP PELLET** and 6.40 for cows fed chlorides. However, milk fever incidence was just 2.3% in cows fed **CLOSE-UP PELLET** and 3.3% among cows fed chlorides. Retained placenta incidence also was lower in the **CLOSE-UP PELLET** group compared with those fed chlorides: 2.7% and 7.5%, respectively.

How can **CLOSE-UP PELLET** be effective at maintaining blood Ca concentrations if it is not always associated with reduced urine pH? Consider that the "urine-pH marker" was developed to measure the effectiveness of anionic-salt products that rely primarily on the anion chlorine. **CLOSE-UP PELLET** is relatively richer in the anion sulfur.

Research does indeed suggest that Cl is more effective than S at reducing urine pH. It is not surprising then, that competitive products with greater Cl concentration are often more effective at reducing urine pH. But they are never more successful than (or often even as successful as) **CLOSE-UP PELLET** at maintaining proper blood Ca concentrations, and maintaining cow health and performance.

In fact, research has shown supplements supplying only Cl anions reduced urine pH, but cows still had high rates of milk fever. In one study, urine pH was lowered to 6.1 by HCl-treated soybean meal, yet the clinical milk fever rate was 9%-36%, and the rate of subclinical hypocalcemia was 18%-64% **(Rodriguez, 1999).** In another study, low DCAD rations including high dietary Cl lowered urine pH, but incidence of milk fever and retained placenta exceeded those of control cows **(Gutierrez-Ornelas et al, 2003).**

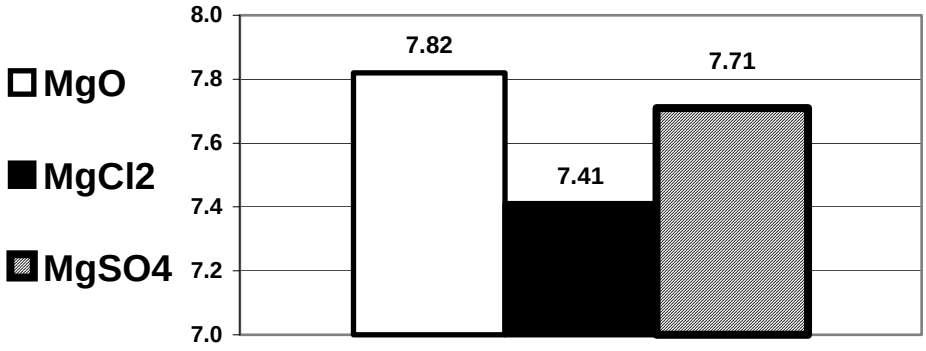
RESEARCH SHOWS SULFUR ELEVATES BLOOD CALCIUM

Recent research from New Zealand **(J. R. Roche et al., 2002)** shows dietary S sources in the close-up ration improve Ca status of fresh cows, despite minimal effects upon acid-base status.

Cows were rotationally grazed on four experimental farms, with daily access to fresh pasture. Average DCAD of the pastures was 37.5 mEq/100 g DM. Cows received 150 g $MgCl_2$ (19 animals), 200 g $MgSO_4$ (19 animals), or 35 g MgO (21 animals) for 25 $\pm$ 10 d prior to calving. These supplements provided equal amounts of Mg. Treatments were distributed evenly across the four farms. Supplements were mixed with 1 liter of warm water and administered orally each day. $MgCl_2$ treatment lowered DCAD by 1400 mEq/cow/d, while $MgSO_4$ lowered DCAD by 1600 mEq/cow/d.

Blood and urine were sampled at approximately 0700 h on d –1, d 0, d 1, d 2, d 3, and d 4 around calving. Urine samples were also collected twice per week prior to calving, with these results:

Figure 1: Pre-Fresh Urine pH



Pre-fresh urine pH was lower (P<.001) in cows fed $MgCl_2$ than in cows fed $MgSO_4$ or MgO, which were not significantly different from each other (Figure 1). Note that $MgCl_2$ was more effective in reducing urine pH than $MgSO_4$, despite supplying fewer anions in this test.

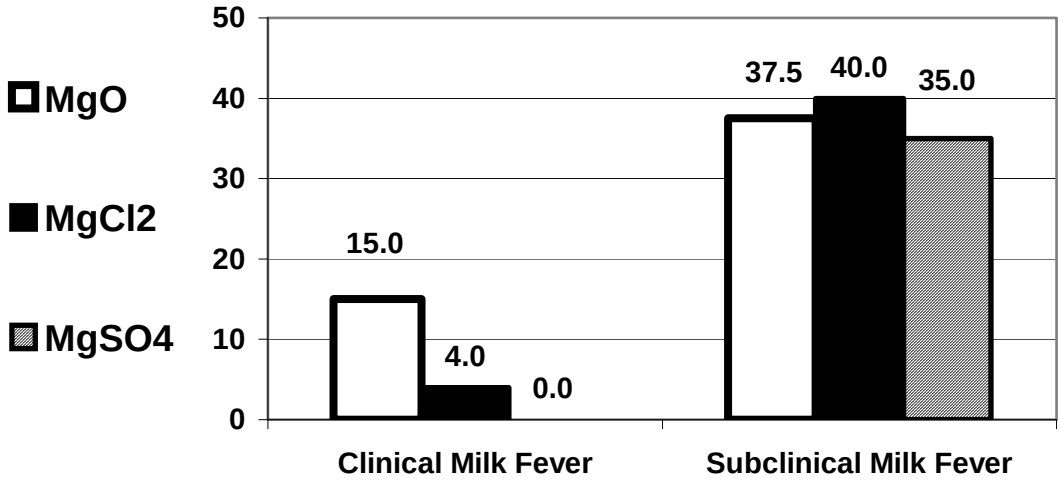
Overall plasma Ca tended to be higher (P=.08) with $MgSO_4$ compared with $MgCl_2$ (Table 1). On d 1, plasma Ca was greater (P<.001) with $MgSO_4$ and $MgCl_2$. On d 2 and d 4, cows fed $MgSO_4$ had greater (P<.05) plasma Ca compared with MgO. Also on d 2, cows fed $MgSO_4$ tended to have higher (P=.06) plasma Ca than cows fed $MgCl_2$:

Table 1. Plasma Calcium Concentration

Item	MgO	$MgCl_2$	$MgSO_4$
Plasma Ca, d 0 (mmol/L)	1.98	2.03	2.04
Plasma Ca, d 1 (mmol/L)	1.98	2.21	2.27
Plasma Ca, d 2 (mmol/L)	2.09	2.12	2.27
Plasma Ca, d 3 (mmol/L)	2.16	2.20	2.25
Plasma Ca, d 4 (mmol/L)	2.22	2.32	2.37

The incidence of clinical hypocalcemia (plasma Ca < 1.4 mmol/L) on the day of calving was lower in cows supplemented with $MgSO_4$ and $MgCl_2$ than in cows receiving MgO (Figure 2). The incidence of subclinical hypocalcemia (plasma Ca < 2.0 mmol/L) was not different among treatments:

Figure 2. Incidence of Milk Fever



Estimated DCAD of the $MgCl_2$ and $MgSO_4$ diets was 14 to 20 mEq/100 g DM, presumably not enough to alter acid-base balance in pre-fresh cows. Previously **Oetzel (2002)** suggested a DCAD of –5 mEq/100 g DM is needed to reduce urine pH consistently.

This study shows that increased dietary S in the pre-fresh diet can be more effective than dietary Cl at improving Ca status of fresh cows, despite a minimal effect upon acid-base status. The authors state:

"These results question the currently accepted understanding of the processes involving DCAD and hypocalcemia. Although the effects of a systemic acidosis on Ca absorption are now largely beyond dispute, the effect of dietary S on periparturient Ca homeostasis when absorption of S is low in comparison to Cl, Na, or K suggest that there are mechanisms involved that are not related to acid-base balance."

By what other mechanisms of action might dietary S improve Ca status of periparturient cows, independent of this nutrient's role in acid-base balance? Such a mechanism of action might (1) increase Ca absorption from the digestive tract; (2) increase bone Ca resorption; (3) reduce urinary Ca excretion; and/or (4) increase Ca retention by other tissues.

DIETARY SULFUR MAY INCREASE CALCIUM ABSORPTION

Previous research does suggest increased dietary S can improve Ca absorption and retention. **Buttrey et al (1986)** reported a tendency for increased Ca apparent absorption (P=.17) and retention (P=.06) in lambs fed S-supplemented or S-fertilized corn silage (Table 2).

Table 2. Effects of Increased Dietary Sulfur Upon Calcium Metabolism

Item	Control	S-Supplemented	S-Fertilized
S Intake, g/d	.21	1.08	0.31
Ca apparent absorption, g/d	.25	.40	.45
Ca apparent absorption, % of intake	16.0	25.3	28.6
Ca retention, g/d	-.29	-.06	-.03
Ca retention, % of intake	-18.4	-3.6	-1.9

The effects of dietary S supplementation upon Ca metabolism in this study were not due to lower DCAD, since Na_2SO_4 was fed, which has a slightly positive DCAD. Ammonium sulfate was used as the S fertilizer, which may have lowered DCAD. Unfortunately, DCAD could not be calculated from the data presented in this report.

Ahmad et al. (1995) also found sheep fed S-fertilized sorghum silage (resulting in 30% higher dietary S content) had 17% greater (P<.05) apparent absorption of Ca than sheep fed non-fertilized sorghum silage.

Greater absorption of Ca from the digestive tract with increased dietary S has also been found in other species. **Whiting and Draper (1981)** reported that rats fed supplemental $CaSO_4$ and $MgSO_4$ had increased Ca absorption from the digestive tract, as compared with rats fed a 15% soy protein control diet with or without high S-amino acids. Feeding rats high sulfate diets also increased bone Ca resorption compared with rats fed control and high S-amino acid diets.

The important role of dietary S in improving Ca status of fresh cows has been recognized before. **Oetzel (1991)** examined data from 75 published trials using meta-analysis (pooling of data from many trials into one analysis) and found dietary S was the factor most highly correlated with reduced milk fever incidence rate, with r = -.425 (P<.0001). This was greater than the relationship of milk fever with dietary Cl (r = -.026, P=.8245). **Enevoldson (1993)** later analyzed this same dataset using a more discriminating statistical technique. He also found dietary S was the "strongest and most consistent risk factor" associated with reduced milk fever incidence.

Therefore research indicates that greater dietary S intake may be even more effective than Cl at improving Ca status of fresh cows, perhaps by increasing digestive tract absorption of Ca. Improvements in Ca metabolism due to higher dietary S appear to be independent of S effects upon acid-base balance.

This partly explains why **CLOSE-UP PELLET**, with a relatively higher S content than competitive products, is so effective in reducing milk fever and related fresh cow diseases, as well as improving milk production and reproduction across a wide range of urine pH. Dawe's Laboratories combines the benefits of both S and Cl anions from a variety of sources in our patented formula for **CLOSE-UP PELLET,** for exceptional palatability and effectiveness.

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