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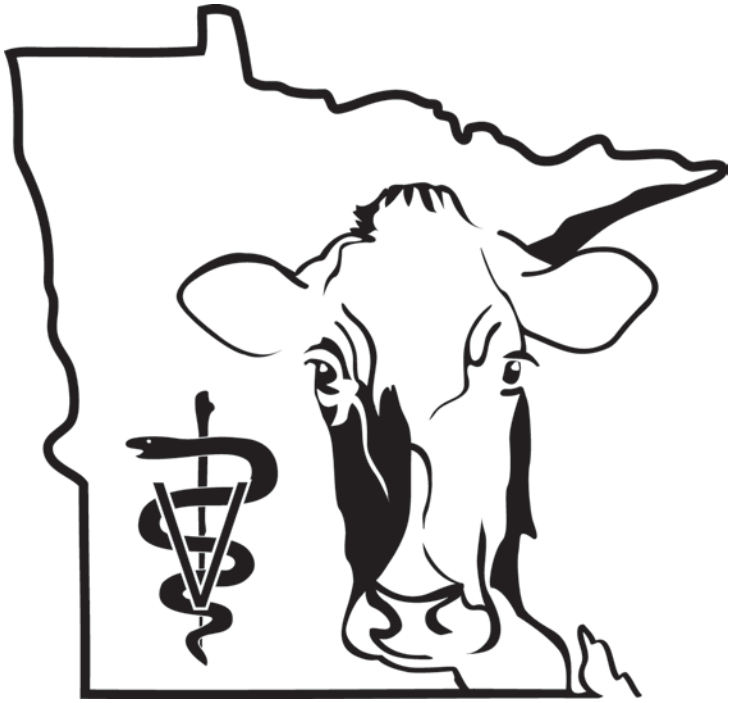

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Management Considerations for the

Successful Use of Anionic Salts in Dry Cow Diets

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Introduction

Dry cow feeding is the most neglected area of dairy cattle nutrition. This is is a serious oversight because this period sets the stage for the subsequent lactation. Dr. Dave Beede, University of Florida, correctly proclaims, "It is an investment in the next lactation."[1,2]

In recent years, a new concept in dry cow nutrition, called dietary cation-anion difference (DCAD), has become popular. Synonymous names are dietary cation-anion balance (DCAB), dietary electrolyte balance (DEB), cation-anion balance (CAB), cation-anion difference (CAD), strong ion balance (SIB) and fixed ion difference (FID). In this system, anionic salts are added to produce a diet that is negatively charged (i.e., a diet that contains more ions of Cl and S than Na and K). The most commonly used anionic salts are calcium sulfate, magnesium sulfate, ammonium sulfate, ammonium chloride, and calcium chloride. This relationship is quantified as follows:

DCAD= [(%Na/.023) + (%K/.039)] - [(%Cl/.0355) + (%S/.016)] mEq/100 g DM

For example, if the dry matter content of a ration is .10%, 1.2%, 1.0% and .45% of Na, K, Cl, and S respectively, then the DCAD is calculated as follows:

DCAD= [(.10/.023) + (1.5/.039)] - [(1.0/.0355) + (.45/.016)] mEq/100 g DM
= [(4.35) + (38.46)] - [(28.17) + (28.13)] mEq/100 g DM
= -13.49 mEq/100 g DM

DCAD has a direct impact on blood acid-base balance. As DCAD decreases the following physiological parameters may change: (1) increase of blood $[H^+]$, (2) decrease of blood $[HCO_3^-]$, and (3) decrease in blood pH, (4) reduction of urinary $[HCO_3^-]$, and (5) decrease in urinary pH.[1-3] These changes allow us to manipulate the cow's physiology through dietary means.

Interest in feeding anionic salts followed the studies of Block and Beede. Block[4] fed diets of +33 and -13 mEq(Na+ K) - (Cl+ S)/100 g DM in a two-year switchback design. The results of this study show two positive benefits: reduced milk fever and increased milk yield. None of the cows consuming the anionic diet for five weeks prepartum had milk fever; Whereas, 47.4% (9 of 19) developed milk fever on the cationic diet. Cows fed the anionic diet prepartum gave an additional 7% 305-day milk yield. Cows that did not have milk fever

in the cationic group had 16% higher milk yields than those that had milk fever.

Beede et al.[5] conducted a large field study in 1990 to compare the effects of feeding an anionic diet. An anionic diet of -25 and a cationic diet of +5 mEq(Na+ K) - (Cl+ S)/100 g DM was fed for three to five weeks before calving. This study showed three positive benefits to feeding anionic salts prepartum: improved calcium metabolism, increased lactation yield, and greater reproductive efficiency. Total serum calcium and ionized calcium were higher for cows fed the anionic diet. Cows that had serum Ca below eight mg/dl were 7.35 times more likely to have abomasal displacement than cows with levels greater than eight mg/dl ($P < .004$). In addition, milk yield was 3.61% greater ($P < .01$) for cows fed the anionic diet during the prepartum period. The anionic diet improved reproductive performance. Number of services per conception ($P < .16$) and average days from calving to confirmed pregnancy ($P < .10$) was reduced for cows fed the anionic compared to the cationic diet.

It is not the purpose of this paper to discuss ration formulation. The principles of formulating anionic dry cow rations are described in the literature.[6-11]

The aim of this presentation is to discuss the application of these rations at the farm level. Key feeding principles are clarified. Basic truths are applied to the real dairy world. The ideal goal is that the modern dairy cow is the ultimate beneficiary.

Key Management Principles

Feeding anionic diets to prepartum cows is a challenge. Anionic rations are easy to formulate, but they can be quite difficult to manage. Remember, DCAD is a method to fine tune rations. Not surprisingly, it requires top nutritional management. The type of management that gives attention to detail.

Consequently, some herds have had problems when feeding anionic prepartum rations. Simply feeding 100 grams of this and 100 grams of that will not work. Certain feeding principles must be followed for success. Feeding management, then, becomes more important than ration formulation.[8] This paper will discuss in detail the following key feeding principles: (1) minimize forage preference, (2) optimize dry matter intake, and (3) acclimatize to anionic salts.

***Minimize Forage Preference.** Feeding programs that allow preferential selection of feedstuffs invite problems. Three rations may exist on a farm: the ration that is formulated, the ration that is fed, and the ration that is consumed. The goal of ration delivery is for the cow to consume the ration that is formulated. Problems are common if cows are not fed a total mixed ration (TMR) and, consequently, when they can express forage preference. This practitioner has had success hand feeding anionic salts in well managed herds. The anionic salts are incorporated into 6 to 8 lb. of grain. This grain mix is topdressed onto approximately 10 lb. corn silage. Feedbunk space should be 2 to 2.5 ft per head to be sure all animals consume their portion of the feed. Hay is fed free choice. Ideally, anionic rations are fed as a TMR. TMRs offer many advantages.

***Optimize Dry Matter Intake (DMI).** Maintain DMI at 22 lb. or greater. Field experience has taught this practitioner that if DMI falls below this key level, then beware. Serious

metabolic and disease problems will follow.[12] Generally, there will be an increased incidence of retained placenta, fatty liver, ketosis, and abomasal displacement.

These ingredients are not palatable. This can lead to problems with consumption.[13,14] Incorporate anionic salts into a TMR, which has some moist, highly palatable feeds (i.e., wet brewers grains, brewers condensed solubles, wet distillers grains, etc.). If this is not possible, then they should be combined in a grain mix with such appetizing ingredients as distillers grains and molasses. Pelleting may improve consumption, and it helps prevent the separating out of the anionic minerals.[14] The pellet should be formulated to be fed at 6 to 8 lb. per cow per day.

Anionic salts will negatively affect DMI when 3 or more equivalents are required for a negative DCAD of -10 to -15 mEq/100 g DM.[10] In such cases, forage substitutions should be made to reduce the amount of anionic salts.[14,15]

Mycotoxins can also cause problems with feed intake. Vomitoxin, also known Deoxynivalenol (DON), is especially troublesome. Screen suspect feeds for myctoxins and avoid feeding moldy feeds.

Other basic factors affecting DMI should be emphasized. They include the following.

Water. A clean, adequate supply of water should be available. Remember, DMI follows water intake. Therefore, the adequacy of water is essential to a successful dry cow feeding program.

Feed Bunk Space. If hand feeding grain, 2 to 2.5 ft per cow of trough space is necessary. With a TMR, 1 to 2 ft is adequate for good DMI.

Cow Comfort. Overcrowding, dirty conditions, poor footing, poor ventilation, extreme heat, etc. adversely affects DMI. In recent years, my clients have greatly helped themselves by improving cow comfort in the springer group. Ideally, this group of cows should be the most comfortable, most pampered animals on the farm.

Forage Quality. High DMI is only achieved with top quality forage. It is this dairy practitioner's belief that the best forages should be allocated to this group of cows and to the cows recently fresh. This also allows getting the cow's rumen adjusted to these forages before calving.

***Acclimatize to Anionic Salts.** How long should anionic salts be fed? They are expensive, costing 30 cents per cow per day. So the length of time is an important consideration.

Also, these minerals need to be fed long enough to exert a positive effect on the cow (i.e., the "anionic effect"). The underlying principle is that all animals need to be electrically neutral.[1-3,6-8,10] That is the sum of the positive charges in a solution must equal the sum of the negative charges. This is the principle of electrical neutrality, and it is the underlying principle of DCAD.

For example, if a cow is fed a diet high Cl and S anions, there will be a decrease in blood pH. This increase in acidity will yield a basic response to buffer the anions. Calcium is mobilized from bone, and blood Ca is elevated.

It was formerly thought that Ca absorption was increased in the gut, but this is not the case.[1]

Research trials have ranged from 21 to 45 days.[14] Based on these studies, anionic salts need to be fed 10 to 14 days to produce the desired physiological response. The inaccuracy of freshening dates makes this too restrictive and impractical in the field. Therefore, it is

best to feed these minerals for 3 to 5 weeks. Also, herd size can be a factor. Smaller herds, for example, may need a longer period that will allow adequate group size for proper mixing and delivery of the ration.

Case Study

The following case study shows the above feeding management principles. The management of a 250-cow herd with a rolling herd average (RHA) of 18,000 lb. milk wants to try feeding anionic salts. They are not open to splitting their dry cows into two groups. Instead they insist on feeding the following ration (Tables 1 and 2) to all their dry cows.

Anionic salts were added to the ration in a step-up fashion (i.e., 0.25, 0.50, 0.75, 1.00, 1.50 lb. per cow per day). This process took four weeks and is best described in four stages.

Stage I: On July 27, 0.25 lb. per cow of anionic mineral was fed in the ration (Table 1). On August 1, this was raised to 0.50 lb. per cow per day. During the period of July 27 to August 8 (12 days), 18 cows calved, 1 cow had an atypical retained placenta (Owner description: "It was like it was glued in there, even after 10 days.") This cow also developed nervous ketosis, and she was milking considerably below her production potential.

Stage II: On August 9, 0.75 lb. per cow of anionic mineral was fed in the ration. On August 16, this was raised to 1.00 lb. per cow per day. During the period of August 9 to 23 (15 days), 19 cows calved, 8 had retained placentas--all atypical--5 developed nervous ketosis, 4 were milking poorly and 1 died.

Stage III: On August 24, 1.50 lb. per cow per day of anionic mineral was fed in the ration. On August 25, they quit feeding the anionic salts.

Stage IV: During the period of August 25 to September 14 (20 days), 18 cows calved, 1 had a typical retained placenta, and there was 1 case of mastitis.

What happened? It is difficult to explain this crisis. Remember, problems began at a low level of anionic salts, problems began the first 2-3 weeks after anionic salts were introduced, and problems subsided almost immediately with removal of anionic salts.

The following conclusions deserve mention. First, was it a problem of feedstuff preference? The herd was receiving hay free choice, and they were on pasture. With the addition of the anionic salts, the "TMR portion" of their ration became less palatable. Perhaps this resulted in widely varied rations among the herd.

Second, was DMI a problem? The anionic salts are unpalatable, Also, barley and feather meal are not appetizing ingredients. This combination of ingredients could have created a ration that the cows did not like. In addition, mycotoxins, especially DON, can cause dry matter intake depression and poor fresh cow performance. A mycotoxin screen of the barley grain detected 1800 ppm of DON.

Third, was single dry cow grouping a problem? Cows need to receive anionic salts for 2 to 3 weeks, but what are the effects of longer supplementation (i.e., 6 to 8 weeks)? Periods longer than 3 to 4 weeks would seem unnecessary and undesirable. In the present case this was not a factor, because the cows were only feed the anionic diet for approximately 4 weeks.

Table 1. Ration Composition of Case Herd

INGREDIENT	AS FED (LB)	DM (LB)
Grass Hay/Pasrure	10.00	9.00
Corn Silage	25.00	7.50
Ground Barley	5.25	4.67
DC Mineral	1.50	1.50
Feather Meal	0.25	0.25
TOTAL	42.00	22.90

Table 2. Mineral Composition of Case Herd

INGREDIENT	AS FED (LB)
Limestone	0.45
Ammonium Chloride	0.25
Magnesium Sulfate	0.25
Calcium Sulfate	0.20
Mono-Dicalcium Phosphate	0.10
Vit-TM Premix	0.10
Salt	0.05
TOTAL	1.50

Table 3. Ration Analysis of Case Herd

NUTRIENT	DM (%)
Crude Protein	13.95
Soluble Protein	6.31
Acid Detergent Fiber	27.42
Neutral Detergent Fiber	51.19
NElact (Mcal)	65.00

Table 4. Mineral Analysis of Case Herd

NUTRIENT	DM (%)
Ca	1.41
P	0.43
Mg	0.37
K	1.49
Na	0.11
Cl	0.85
S	0.45
Dietary Cation Anion Difference	
mEq(Na+ K) - (Cl+ S)/100 g DM	-9.08

The Acid Test

Urinary pH is an indicator of DCAD efficacy.[15,16] As DCAD declines (i.e., an acidotic diet) blood pH is lowered. Accordingly, urinary pH is reduced to offset the mild acidosis.[1-3,10,15,16]

Urinary pH lends itself to cow-side testing. Digital pH meters and quantitative pH strips work well in the field.
ould yield urinary pH levels below 6.5. If urinary pH is above 8, milk fever is likely to result.[15,16] Well designed diets should produce urinary pHs of 5.50 to 6.50. Table 5 is a summary of this clinician's experience.

Table 5. Urinary pHs and Interpretations of DCAD

URINARY pH	INTERPRETATION
8.0 >	High incidence of milk fever possible, approaching upper limit of the kidneys to regulate pH
7.0 - 7.99	High incidence of hypocalcemia, milk fever a potential problem
6.51 - 6.99	Borderline range, hypocalcemia still a potential problem
6.00 - 6.50	Optimun level for holsteins, may not be adequate for jerseys
5.50 - 5.99	Optimum level for jerseys
<5.50	Excessive acidification, approaching lower limit of the kidneys to regulate pH

Summary and Recommendations

DCAD allows us to manipulate the physiology of the cow. Dry cows are fed anionic salts, which are acidifying agents. DCAD has a direct impact on blood acid-base balance. As DCAD decreases the following physiological parameters may change: (1) decrease in blood pH, (2) decrease in urinary pH and (3) increase in serum calcium. The chief principle is that all animals need to be electrically neutral.

Urinary pH is a useful indicator of DCAD proficiency. Properly formulated and implemented anionic rations should produce acidic pHs. Ideally, urinary pH should be between 6.0 - 6.5 for Holsteins and 5.5 to 6.0 for Jerseys.

Use of DCAD in the field requires top management. Attention to detail is necessary for successful feeding of anionic salts. Feeding management may be more critical than ration formulation. The following key principles are decisive: (1) minimize forage preference, (2) optimize DMI at 22 lb., and (3) acclimatize to anionic salts for 3 to 5 weeks.

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