Alberta Dairy Management

PREPARED FOR AND DISTRIBUTED BY THE DAIRY EXTENSION ADVISORY GROUP

Dietary Cation-Anion Balance

The day she calves, a cow will commonly produce 10 litres of colostrum, containing about 23 grams of calcium (Ca). She will need another 23 grams for maintenance resulting in a total requirement which is about 12 times the amount of Ca circulating in her blood at any point in time.

Where does she get the extra Ca she needs for lactation? Most cows adapt to the demand by increasing the absorption of Ca from the ration, mobilizing Ca from bone and reducing urinary Ca excretion. Cows that don't adapt effectively will end up with low blood calcium levels (hypocalcemia).

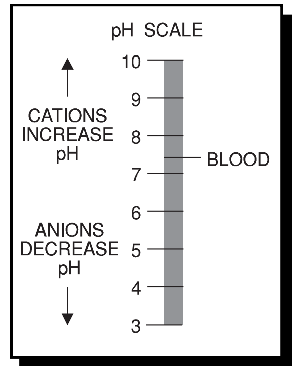
Because Ca is essential for muscle tone and contraction, low blood levels can result in cows going down with milk fever. Poor muscle tone also contributes to displaced abomasum. And weak uterine muscle contractions are involved in retained placenta. Strategies to prevent these problems are aimed at feeding the dry cow to prepare her systems for the increased Ca demand at calving.

Dry Cow Feeding Strategies

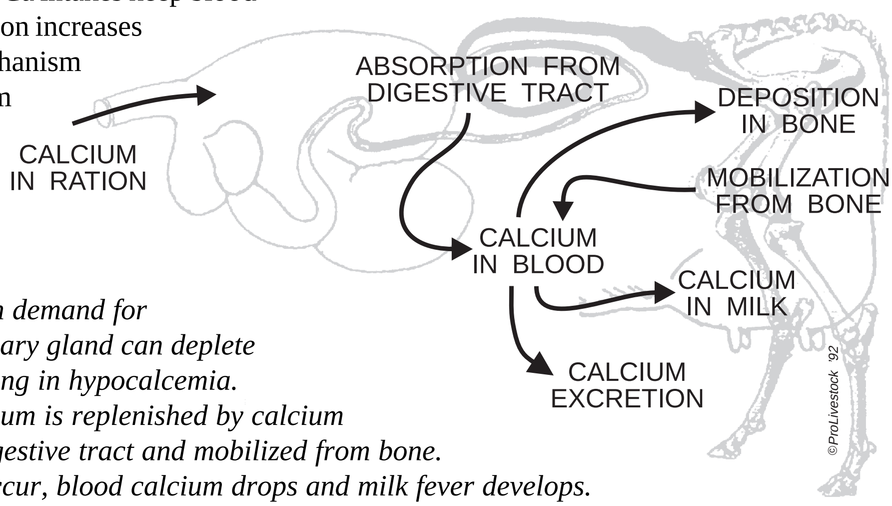
Limiting Ca intake to less than 80-100 grams/day in the close-up dry period has been the most commonly recommended strategy to help reduce the incidence of milk fever. High ration calcium levels result in decreased absorption rates. In addition, when higher Ca intakes keep blood Ca levels high, excretion increases and the hormonal mechanism for mobilizing Ca from bone is effectively shut down.

A second strategy which has been developed over the last few years uses the concept of dietary cation-anion balance (DCAB). Here's how it works :

- cations, including sodium (Na^+) and potasium (K^+), carry positive charges and increase pH in the blood;
- anions, including chlorine (Cl^-) and sulphur (S^{2-}), carry negative charges and have an acidifying (pH lowering) effect in the blood;
- when the balance between cations and anions results in a net negative charge (negative DCAB), blood pH is lowered;
- to neutralize the lower blood pH caused by negative DCAB, the cow mobilizes buffers, including Ca phosphate and bicarbonate from bone.



These two strategies are both aimed at activating mechanisms which allow the cow to quickly draw from bone Ca reserves when her demand for Ca increases abruptly at calving. However, the two should not be used together. When DCAB is negative, ration Ca intake must be maintained above 130 grams/day.



At calving, the sudden demand for calcium by the mammary gland can deplete blood calcium, resulting in hypocalcemia. Normally, blood calcium is replenished by calcium absorbed from the digestive tract and mobilized from bone. When this does not occur, blood calcium drops and milk fever develops.

This table demonstrates the method used to calculate dietary cation-anion balance (DCAB). The feed used in this example is alfalfa hay.

Mineral	Atomic weight	chg	Equivalent weight	mEq weight	% in feed dry matter	mEq/kg feed DM§
Sodium	23	1+	23	.023	.04	+ 17
Potassium	39	1+	39	.039	1.74	+ 446
Chlorine	35	1-	35	.036	.45	- 126
Sulfur	32	2-	16	.016	.23	- 144
				DCAB		+ 193

§ mEq/kg feed DM = charge x (% in feed dry matter / mEq weight) x 10

Calculating DCAB

Cation-anion balance is calculated by adding the milliequivalents (mEq) of positive charged cations to the mEq of negative charged anions in the feed. An equivalent is the weight of the element that carries a single charge. So, in the case of Na^+, K^+ and Cl^-, the equivalent weight is the same as the atomic weight. But, for S^{2-} the equivalent weight is one-half the atomic weight because of the double negative charge. The weight of a milliequivalent is simply the equivalent weight divided by 1000. The method of calculating DCAB is demonstrated in the table above.

Feed	Na^+	K^+	Cl^-	S^{2-}	DCAB
	------ % in feed DM ------				mEq/kg
Alfalfa Hay	.04	1.74	.45	.23	+ 193
Grass Hay	.02	1.20	.32	.18	+ 114
Barley Silage	.23	1.50	.27	.20	+ 284
Barley Grain	.02	.48	.15	.14	+ 2
Canola Meal	.27	.10	.21	.46	- 279
Soya Meal	.01	2.25	.04	.44	+ 295
Meat Meal	.60	.39	.52	.47	- 79
Corn Dist	.04	1.24	.20	.43	+ 10
Beet Pulp	.17	.19	.04	.18	- 1
Ammonium Chloride					- 18670
Ammonium Sulphate					- 15169
Calcium Chloride					- 13586
Calcium Sulphate					- 11638
Magnesium Chloride					- 9825
Magnesium Sulphate					- 8131
Salt (Sodium Chloride)					+ 17

Typical cation, anion and DCAB levels for Alberta dairy feeds, anionic minerals and salt.

Formulating rations for DCAB

Several recent research trials have suggested that the ideal DCAB for the late dry cow is in the range of -75 to -200 mEq/kg of feed dry matter. As shown in the table to the left, many of the feeds we use in Alberta dairy rations have a positive DCAB. In particular, their high potassium (K^+) levels result in very positive DCABs for most of our forages. Since the dry cow ration should be mainly forage, formulating a ration with a negative DCAB requires the use of minerals with high negative DCABs.

Because of the extreme variability of mineral levels in our feeds, dry cow forages should be analysed for Na, K, Cl and S. Depending on the results, target levels for the total ration can usually be achieved by feeding a few hundred grams of negative DCAB minerals per day to close-up dry cows.

Although all of the anionic salts are quite unpalatable, magnesium sulphate appears to be more readily consumed than the others, probably as a result of its higher (less negative) DCAB (see table on left). However, to achieve reasonable anion intakes it is essential to feed these minerals with other, more palatable ingredients. In addition, negative DCAB minerals are very potent in lowering blood pH and it is, therefore, important to maintain good control over intake to avoid potential toxicity.

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