Prevention of Parturient Paresis in a Jersey Herd by Feeding Anionic Salts During the Prepartum Period

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The Food Animal Production Medicine Section received a request in November, 1989, to investigate a 30-cow Jersey dairy herd in northeastern Wisconsin having a high incidence of parturient paresis (milk fever). The herd owner estimated that greater than 75% of all cows in their fourth or greater lactation required treatment with intravenous calcium salts for parturient paresis. The incidence rate of parturient paresis had been at this high level for approximately three years.

The herd was evaluated for nutritional and management factors that could be associated with the observed problem of parturient paresis. Both lactating and non-lactating cows in the herd were housed in a stanchion barn. Partitions were located in the manger between each stall to prevent cows from having access to feed other than their own. The non-lactating, prepartum diet consisted of approximately 8.2 kg corn silage, 4.4 kg alfalfa hay, and 1.8 kg of a grain mixture per cow per day. The grain mixture was 94.4% ground ear corn, 3.5% liquid molasses, 1.2% commercial mineral supplement (17% calcium and 17% phosphorus), 0.4% salt, and 0.5% limestone. The corn silage and alfalfa hay were analyzed by a commercial feed laboratory for dry matter, crude protein, acid detergent fiber, net energy for lactation, calcium, phosphorus, potassium, and magnesium content. The sodium, chlorine, and sulfur content of these feeds was estimated using standard reference values.[1] Nutrient content of the ingredients in the grain mixture was also estimated using the same reference source.[1] The nutrient analysis and anion-cation balance of the diet is presented in Table 1. The non-lactating cow diet met the NRC nutrient requirements for pregnant, non-lactating animals[1] for the major nutrients: energy, protein, fiber, calcium, and phosphorus. The diet provided 65 g of calcium and 26 g of phosphorus per cow per day.

Because the prepartum diet was considered to already be properly formulated with regard to the major nutrients, an alternative approach to reformulation with conventional feed ingredients was considered. Because of reported success in the prevention of parturient paresis by the feeding of various mixtures of anionic salts (salts high in chlorine and sulfur relative to sodium and potassium),[2,3,4] it was decided to supplement the diet of the non-lactating cows with an anionic salts mixture that could be custom prepared by the local feed mill. The mixture was formulated to provide 53 g ammonium chloride, 66 g ammonium sulfate, 123 g magnesium sulfate (heptahydrate), and 212 g dried distillers grains (as a carrier) per cow per day. The dried distillers grains were added so that the owner could conveniently feed 454 g (1.00 lb) of anionic salt mixture per cow per day. Each daily dose of the salt mixture provided one equivalent of anions (whether chlorine or sulfur) from each of the three salts. Addition of the anionic salts mixture lowered the anion-cation balance of the diet from +258 meq/kg to -103 meq/kg of diet dry matter.

TABLE 1. Nutrient compostion and anion-cation balance of diets fed to non-lactating Jersey cows.

Nutrient	Diet:	
	Without Anionic Salts	With Anionic Salts
Dry Matter, %	56.9	58.1
Dry Matter Intake, kg/day	8.2	8.6
	--- 100% Dry Matter Basis ---	
Net Energy for Lactation, Mcal/kg	1.53	1.49
Crude Protein, %	12.7	14.8[1]
Acid Detergent Fiber, %	26.9	26.0
Calcium, %	.79	.75
Phosphorus, %	.32	.32
Magnesium, %	.24	.37
Sodium, meq/kg	39	39
Potassium, meq/kg	440	420
Chlorine, meq/kg	90	200
Sulfur, meq/kg	131	362
Anion-Cation Balance,[2] meq/kg	258	-103

[1]Addition of ammonium salts adds non-protein nitrogen and crude protein to the diet; addition of the carrier (dried distillers grains) also adds crude protein to the diet.

[2]Calculated as meq/kg (Na + K) - (Cl + S).

A mixture of salts, rather than three equivalents of anions from a single salt, was chosen to lower the potential for interference in mineral metabolism due to feeding large amounts of any single anion or cation.[2] The potential of the three different anionic salts to prevent parturient paresis has been shown to be similar.[5] Cost of the salts and their availability in the area were also considered when the mixture was formulated. The doses and costs of the salts are summarized in Table 2. The approximate cost of feed-

ing the anionic salts mixture was $0.27/cow/day.

The anionic salts mixture was fed to cows in their fourth or greater lactation. Feeding the mixture started three weeks before each cow's expected calving date. Cows were gradually adjusted to the salts to help prevent feed refusal because of their poor palatability. Each cow was fed ¼ of the total dose of the mixture for two days, then ½ of the total dose for 2 days, ¾ of the total dose for 2 days, and finally the full dose (1 lb/cow/day) until parturition. The daily dose of the anionic salts mixture was divided evenly between morning and evening feedings and was mixed by hand with the corn silage offered to each cow.

Nine non-lactating cows were fed the salts from November, 1989, to March 1990 (see Table 3). Four of these cows had previous episodes of parturient paresis. Of the nine that received the salts, only one cow developed severe clinical signs of parturient paresis. This cow was one of two cows who did not eat the anionic salt mixture well. One other cow developed slight signs of hypocalcemia but did not become recumbent.

Based on the experience of recent years in this herd, five or six of those nine cows would have succumbed to parturient paresis if the diet had not been altered. However, with the addition of anionic salts to the diet, only one cow developed severe paresis and one other cow was slightly affected. Because of the apparent clinical success of the anionic salts mixture, the owner of the herd elected to continue to feed the salts to all mature, non-lactating cows.

TABLE 2. Compostion and approximate cost of the anionic salt mixture.

	Salt Properties:		Mixture Properties:	
Feed Ingredient	g/eq	$/kg	g/day	$/day
Anionic salts:				
NH_4Cl	53.5	$1.32	53	$0.071
$(NH_4)_2SO_4$	66	$0.68	66	$0.045
$MgSO_4 \cdot 7H_2O$	123	$0.87	123	$0.107
Carrier:				
Dried Distillers Grains	---	$0.21	212	$0.044
Total:				
Complete Mixture	---	$0.59	454	$0.267

TABLE 3. Summary of clinical response of cows receiving the anionic salt mixture for a three week period prior to parturition.

Cow	Parity	Previous Episodes of Parturient Paresis	Appetite for Salt Mixture	Parturient Paresis with Salts?
1	4	0	good	no
2	5	1	good	no
3	4	0	good	no
4	4	0	good	no
5	8	3	poor	no
6	6	2	poor	yes
7	7	2	good	slight[1]
8	4	0	good	no
9	8	0	good	no

[1]This cow had slight signs of paresis at calving but did not become recumbent.

Discussion

Experimental evidence in controlled trials supports the conclusion that anionic salts fed during the prepartum period can reduce the incidence of parturient paresis in highly susceptible dairy cows.[2,3,4,6] The exact mechanism by which the salts protect against hypocalcemia is unclear. It has been suggested that anionic salts improve calcium metabolism by increasing intestinal absorption of dietary calcium[7,8] and/or by increasing mobilization of calcium from bone.[3] Consumption of anionic salts evokes an acidic response in the cow, which results in a slight, compensated metabolic acidosis.[4,8] Bone then responds as a systemic buffer and mobilizes calcium in exchange for hydrogen ion. Increased release of calcium from skeletal stores is reflected in elevated plasma hydroxyproline concentrations[3] and hypercalcuria.[8] Under these conditions of increased dietary calcium absorption and increased calcium mobilization from bone, dairy cows can apparently respond more effectively to the sudden outflow of calcium that occurs around parturition.

Neither the exact dose of anionic salts nor the minimum duration of anionic salt feeding required to prevent parturient paresis have been established. It appears that a dose between 1.5 to 3 eq of supplemental anions/cow/day is necessary. The precise dose of anionic salts required depends on the existing anion-cation balance of the base diet (before the addition of salts). Balancing prepartum diets to a final anion-cation balance of approximately 0 to -100 meq/kg [(Na + K) - (Cl + S)] may be the most practical method of dosing the salts. However, the optimal final anion-cation balance of a prepartum ration has not yet been determined.

Restricting dietary calcium during the prepartum period is the traditional method of preventing parturient paresis.[9] However, recent studies have disputed this method. In one study,[2] prepartum dietary calcium intake was not a significant factor in determining calcium concentrations at calving, while dietary anion-cation balance was significant. In fact, the highest serum calcium concentrations at parturition were achieved by feeding diets high in both calcium and anionic salts. The use of anionic salts in prepartum diets already low in calcium has not given consistent results in preventing parturient paresis and is not recommended.[10]

Because anionic salts are generally unpalatable, extra effort may be necessary to get cows to consume them. Adding the salts to a total mixed ration most effectively hides their unpleasant taste. Palatability of various mixtures of anionic salts has been acceptable in feeding trials where the salts were included in a total mixed ration,[2,3] although

one study[4] reported a decrease in voluntary dry matter intake. If a suitable feed mixer is not available, then mixing the salts with silage is probably the next best option. If silage and/or haylage is not part of the prepartum diet, then the salts may be mixed into a grain mixture; however, the unpalatability of the salts may decrease consumption of the grain mixture in some situations. Adding a carrier such as dried distillers grains, molasses, and/or flavoring agents to the salts before mixing them helps dilute and mask their flavor. Pelleting the salts with a carrier may also increase their palatability in a grain mixture. Accidental feeding of anionic salts in quantities large enough to result in toxicity due to excess ammonia and/or systemic acidity[2] is theoretically possible but unlikely under practical conditions because poor palatability of the salts limits their consumption.

When properly utilized, anionic salts may be added to prepartum diets in order to effectively reduce the incidence of parturient paresis in dairy cattle. Anionic salts should be considered when the prepartum diet is properly balanced for the major nutrients, yet a problem with parturient paresis persists. The cost of the salts and the extra effort of delivering them in a palatable fashion to dairy cows is usually more than offset by the decreased incidence of parturient paresis and related disorders.

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