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PREVENTING HYPOCALCEMIA BY OFFERING AN ANIONIC DIET TO CALVING COWS

Emily Ramos Machado
Veterinary Medicine student - UNA
University Center - Contagem/MG - Brazil

Brym Johnys Bruno Vilaça
Veterinary Medicine student - UNA
University Center - Contagem/MG - Brazil

Breno Mourão de Sousa
Professor of Veterinary Medicine - UNA
University Center - Contagem/MG - Brazil

INTRODUCTION

Hypocalcemia in calving cows is a growing concern in the dairy industry due to its significant impact on animal health and productivity. This metabolic condition, triggered by the intense mobilization of calcium during calving and the postpartum period, can result in serious complications, including tetany, paresis and even the death of the animal if not treated properly[12] . Understanding the mechanisms underlying hypocalcemia, as well as developing effective prevention and management strategies, is crucial to ensuring the well-being of herds and the sustainability of dairy operations.

This review explored the main factors involved in the pathogenesis of hypocalcemia in multiparous dairy cows, highlighting the importance of nutrition and management during the transition period. In addition to addressing the physiological aspects that contribute to the occurrence of hypocalcemia, the effectiveness of anionic diets in modulating calcium homeostasis and reducing the risk of this condition was examined, while the possible adverse effects associated with these nutritional strategies were balanced.

MATERIAL

The sources used for this summary were scientific articles, literature reviews, term papers and books published between 1988 and 2021 in the Scopus, Web of Science, SciELO and Google Scholar databases. The criteria for selecting the materials were relevance and quality, as well as suitability for the objective and approach of this study. Based on the analysis of the selected materials, a synthesis of the main theoretical and practical aspects related to the topic was drawn up.

THEME SUMMARY

Hypocalcemia in parturient cows is a metabolic condition that manifests itself during the transition period, resulting from imbalances in the regulation of free calcium in multiparous dairy cows[12] . This imbalance is caused by the significant mobilization of calcium from the bloodstream for the production and concentration of colostrum, which contains approximately twice as much calcium (2.3g/litre) as regular milk, and at the time of calving. This mobilization results in a decrease in ionized calcium levels in tissue fluids, representing a biochemical defect[5] . Symptoms begin with tetany, progressing to paresis and paralysis and, if left untreated, can lead to the animal's death[12] . Maintaining the concentration of calcium, especially in the ionized form, within the range of reference values is crucial, which vary from 4.4 to 5.6 mg/dL.

Although commonly referred to as "milk fever", this designation can be considered inappropriate, since the affected animals have hypothermia[12] . Also popularly known as "fallen cow syndrome", this clinical condition arises in the postpartum period, following episodes of hypocalcemia, often associated with dystocia and possible retained placenta. Subclinical hypocalcemia affects approximately 50% of dairy herds. However, the incidence of hypocalcemia varies between studies, depending on the geographical location and profile of the animals evaluated.[10]

Calcium homeostasis is primarily maintained through intestinal absorption and bone reabsorption of this mineral. These processes are regulated by a complex cascade of reactions, initiated by the release of parathormone by the parathyroid gland. This hormone regulates the conversion of 25-hydroxyvitamin D (25-OHD3) into its active form, 1,25-dihydroxyvitamin D [1,25(OH)2D3], in the kidneys. 1,25(OH)2D3, in turn, increases the production of a calcium transport protein in

the intestinal enterocytes, promoting its absorption. In addition, in bones, 1,25(OH)2D3 can increase the activity of osteoclasts for bone resorption, while also stimulating endochondral or osteoblastic bone calcification in young animals .[7,8]

Oetzel et al. (1988) conducted an experiment to evaluate the impact of calcium levels and dietary cation-anion balance on the occurrence of hypocalcemia in cows. They concluded that a positive cation-anion balance was more significant in inducing hypocalcemia than high levels of calcium in the diet. In a later analysis, using meta-analysis, Oetzel (1991) observed that dietary calcium levels play a significant role in determining hypocalcemia, with low levels (less than 0.6% of dry matter) or high levels (greater than 1.6% of dry matter) being less determinant than intermediate levels (between 0.6% and 1.6% of dry matter).

The adoption of an anionic diet, i.e. where there is a predominance of anions (negatively charged ions) over cations (positively charged ions), is a strategy often used in dairy cows during the transition period to prevent metabolic disorders such as hypocalcemia. The mild metabolic acidosis resulting from this diet can help improve acid-base balance and optimize the animal's performance during this critical period .[4]

The cation-anion balance refers to the difference between the cations and anions present in the diet, with a cationic diet having a positive balance and an anionic diet a negative balance. The macronutrients in the digested food determine the electrical charges in the diet, and the body seeks to maintain a state of electroneutrality. Diets rich in anions tend to cause mild acidosis in the body, while diets rich in cations can lead to a state of alkalosis. Cows fed an anionic diet for 30 days before calving have a slightly more acidic blood pH due to the increase in the intestinal concentration of chloride (Cl-) and sulphate (SO42-) ions, resulting in an increased excretion of bicarbonate (HCO3-) and consequent acidification of the blood pH[3] (Fig.1).

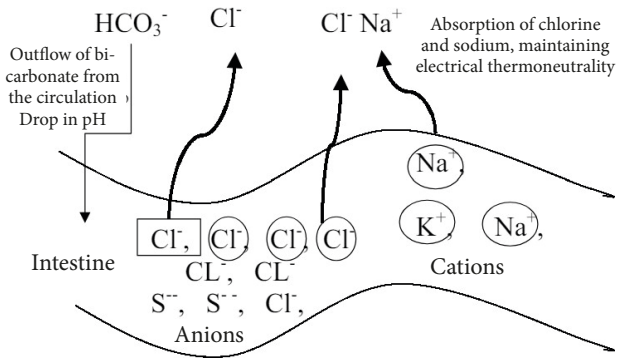

Figure 1: Mechanism of action of anionic diets. With the increase of anions in the diet and their subsequent intestinal absorption, bicarbonate is directed to the intestine to maintain thermoneutrality, with the result that pH tends to decrease (Source: Block, 1994).

Goff and Horst (1997) observed that the addition of cations to the pre-partum diet increased blood and urine pH and reduced the plasma concentration of hydroxyproline, indicating inhibition of bone calcium reabsorption. They also pointed out that the concentration of calcium in the diet is not the most important factor in preventing hypocalcemia, and that strong cations can induce metabolic alkalosis, impairing calcium homeostasis.

The recommended diet for multiparous cows is anionic, fed during the 30 days prior to calving, followed by a transition to a cationic diet 48 hours after calving. This nutritional change helps to modulate calcium homeostasis, reducing the risk of puerperal hypocalcemia .[3]

It is essential to calculate the sodium, potassium, chlorine and sulphur content of each food to determine the appropriate amount of anionic salts to add. Potassium is the most variable macronutrient in food, especially in fodder and its derivatives. The

anionic diet induces an increase in hydrogen absorption, leading to acidification of the intracellular and blood pH, stimulating the expression of parathyroid hormone (PTH) receptors in osteoclasts, which increases bone resorption and the availability of serum calcium .[1]

In addition to preventing hypocalcemia, the anionic diet provides other benefits, such as improving udder health, reducing fertility disorders and increasing milk production[13] . However, the implementation of the anionic diet must be carefully monitored, as metabolic acidosis can result in other health problems in dairy cows.

A remarkably effective method for monitoring the effectiveness of an anionic diet is to measure the urinary pH, which should be in the range of 6.0 to 7.3, indicating adequate acidification. It is recommended to avoid sodium bicarbonate and calcium carbonate in the pre-partum diet, as these components raise the blood pH and decrease the effectiveness of anionic diets. The supply of anionic diets should be limited to the last 30 days before calving, with the transition to a cationic diet after calving to avoid negative impacts on milk production and feed intake .[8]

Some problems need to be addressed and solved, such as the low palatability of anionic salts. This can be circumvented by mixing with palatability enhancers and pelleting in order to avoid selection. There are several options of anionic salts available to correct the diet, such as ammonium chloride, calcium chloride, calcium sulphate (agricultural gypsum), magnesium sulphate and ammonium sulphate. The choice between these salts depends on factors such as palatability, availability, cost and safety .[9]

Calcium sulphate has many advantages, being cheap, palatable, easy to obtain and safe for health. It is recommended to use it in a proportion of 1% of the dry matter of the feed, which increases the level of sulphur in the diet to 0.455%. As well as supplying sulphur, calcium sulphate is also a source of calcium. In general, salts containing sulphates are more palatable than those containing chlorides, and should therefore be preferred for supplementing the diet .[9]

Although adopting an anionic diet can represent a significant investment for dairy farmers, many consider this cost to be justifiable due to the potential benefits in terms of animal health, reproductive performance and milk production. However, it is crucial to thoroughly evaluate the costs and benefits before implementing this nutritional strategy, regardless of the size of the farm, whether large or small. In addition to the costs of the ingredients, it is also essential to consider the costs of formulating the feed, transportation and distribution to the farm, as well as the costs associated with labor and storage.

FINAL CONSIDERATIONS

Hypocalcemia is a common metabolic condition in dairy cows, especially during the transition period. In this sense, an anionic diet appears to be an effective preventative measure, since during this phase calcium is the mineral most mobilized for colostrum production and at the time of calving. Therefore, implementing an appropriate nutritional management system, including an anionic diet and mineral supplementation, is essential for maintaining the animals' metabolic homeostasis, preventing disease and improving herd productivity.

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