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A brief review of milk fever prevention in dairy animals by nutritional alteration management strategies

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Abstract
The most difficult condition to treat in the dairy animal production cycle is milk fever, which occurs during the transition phase due to an imbalance in blood calcium (Ca) levels. In order to maintain a plasma Ca concentration, parathyroid hormone, calcitriol, and calcitonin are closely regulated to keep blood calcium levels within a restricted range. Dairy cows during the end of gestation need an adequate amount of calcium for maintenance, late-stage foetal growth, anticipated endogenous loss, and colostrum development. Ca is therefore also crucial for milk production in high-yield dairy cows at the beginning of lactation. Postpartum production and health can suffer from a delay in endocrine signalling or a failure to respond to restoring the circulating Ca. Milk fever can be controlled by a variety of principles and factors, such as feeding low-calcium rations just two weeks before calving, supplementing with vitamin D products during the transition period, feeding postpartum animals acidifying rations with negative dietary cation anoin difference (DCAD), and supplementing with ionic salt. Numerous studies have demonstrated the value of changing an animal's diet to reduce milk fever in dairy animals. The two most beneficial techniques among them are giving a diet that has a negative DCAD value in the same and reducing the amount of dietary calcium in transitory animal feed.

Keywords: Milk fever, nutrition, metabolic disorders, transition period, dietary calcium

Introduction
Milk fever, also known as hypocalcemia or parturient paresis, is a metabolic disorder that commonly affects cows after calving (Giving birth). It occurs due to a sudden drop in blood calcium levels, leading to muscle weakness and other related symptoms. Although it primarily affects dairy cows, it can also occur in other animals that produce milk, such as goats and sheep. (Akalu, 2017) [2]. The onset of milk fever usually occurs within the first few days after calving when the demand for calcium-rich milk production exceeds the cow's ability to mobilize calcium from its body reserves or absorb enough calcium from its diet. It is more common in high-producing dairy cows that have a higher calcium demand (Ibrahim and Kirmani, 2021) [18]. Symptoms of milk fever can vary in severity but typically include general weakness and lethargy, Loss of appetite, Muscle tremors or twitching, Difficulty in rising or standing, Unsteady gait or staggering, Cold ears and limbs, Decreased body temperature, Dry muzzle and constipation, Decreased or absent milk production (Baj *et al.*, 2020) [5]. The primary treatment for milk fever involves intravenous administration of calcium solutions to rapidly increase blood calcium levels. This can provide immediate relief from the symptoms. Additionally, oral calcium supplements or drenches may be prescribed to maintain calcium levels in the long term. It is also important to address any underlying dietary imbalances or management factors that contributed to the development of milk fever (Martín and Martens, 2014) [24]. Prevention of milk fever focuses on providing proper nutrition and management to cows during late pregnancy and early lactation. Strategies include feeding a balanced diet with sufficient calcium, avoiding excessive calcium supplementation during the dry period, managing energy intake, and ensuring adequate vitamin D levels. Monitoring calcium levels and adjusting the diet accordingly can help prevent milk fever (Lean *et al.*, 2006) [23].

The transition period, also known as the periparturient period or the "fresh cow" period, refers to the period of time surrounding calving in dairy cows. It typically includes the three weeks before and the three weeks after calving. This period is critical for the cow's health and productivity as it involves significant physiological and metabolic changes (Drackley and Cardoso, 2014) [10]. During the transition period, cows undergo various hormonal and metabolic adjustments to transition from late pregnancy to early lactation. The demand for nutrients, especially energy, protein, and minerals like calcium, increases dramatically as milk production ramps up. The transition period poses several challenges to the cow's body, including maintaining a balance between nutrient intake, metabolism, and milk production (Calderon and Cook, 2011) [7]. Milk fever is one of the metabolic disorders that can occur during the transition period. It is characterized by low blood calcium levels, which can lead to muscle weakness and other related symptoms, as I explained in the previous response. Milk fever typically occurs within a few days after calving when the demand for calcium for milk production exceeds the cow's ability to mobilize or absorb enough calcium (Tesfaye, 2019) [31]. Besides milk fever, other common health issues that can arise during the transition period include ketosis, displaced abomasum, retained placenta, metritis (Uterine infection), and reduced feed intake. These conditions can impact the cow's health, milk production, reproductive performance, and overall profitability (Deniz *et al.*, 2020) [9]. To manage the transition period effectively and minimize the risk of metabolic disorders like milk fever, dairy farmers employ several managemental practices such as Nutrition, Dry Cow Management, Housing and Environment and Veterinary Care (Reddy *et al.*, 2016) [28]. By implementing these management practices, dairy farmers aim to optimize the health and productivity of cows during the transition period, reducing the risk of metabolic disorders like milk fever and ensuring a successful start to the lactation cycle. The objective of this review paper is to outline potential control strategies that can be used to reduce milk fever losses by minimally altering dietary patterns.

Feeding of acidifying rations having negative DCAD

Feeding acidifying rations with a negative dietary cation-anion difference (DCAD) is a nutritional strategy commonly used in dairy cow management. This approach aims to manipulate the cow's acid-base balance and calcium metabolism to improve calcium availability around calving and reduce the risk of milk fever (Glosson *et al.*, 2020) [12]. The DCAD concept focuses on adjusting the dietary levels of cations (Positively charged ions like potassium and sodium) and anions (Negatively charged ions like chloride and sulfur). By formulating rations with a negative DCAD, the diet becomes more acidic, which can help enhance calcium mobilization from the cow's body reserves and increase blood calcium levels during the transition period (DeGaris and Lean, 2008) [8]. Anionic salts are commonly used in acidifying rations to create a negative DCAD. Common anionic salts used include calcium chloride, magnesium chloride, ammonium chloride, and magnesium sulfate (Epsom salts). These salts are typically added to the ration in the close-up dry cow period, usually starting around three weeks before calving (Goff *et al.*, 2004) [13]. Minerals' balancing is major practice while formulating an acidifying ration, it's important to ensure that other mineral requirements are met. This includes providing adequate levels of other essential minerals like potassium, sodium, magnesium, and phosphorus. The overall diet still needs to be balanced and meet the cow's nutritional requirements (Azapagic, 2004) [4]. Regular monitoring of urine pH and/or using commercially available pH test strips can help assess the effectiveness of the acidifying ration. Targeting a urine pH of around 6.0-6.5 is often recommended. If the pH is too high, adjustments to the ration can be made by increasing the anionic salts, and if it's too low, the anionic salt levels may need to be reduced (Serrenho *et al.*, 2021) [29] Feeding acidifying rations is just one component of overall transition period management. It should be integrated with other practices such as proper nutrition, cow comfort, and health monitoring to optimize cow health and productivity during this critical period (Humer *et al.*, 2018) [17]. It's important to recognize that individual cows may respond differently to acidifying rations. Some cows may require a higher level of anionic salts to achieve the desired urinary pH, while others may need less. Regular monitoring of individual cow responses and adjustments to the ration based on observations can help fine-tune the approach (Min *et al.*, 2020) [26].

Feeding low calcium rations just 2 weeks prior to calving

Dietary supplements the primary cause of subclinical hypocalcaemia and milk fever is not high pre-calving calcium intake, despite the fact that calcium feeding is one of the topics of current discussion as a risk factor for milk fever (Beede *et al*. 1992) [6]. Studies have reported that a low dietary Ca before parturition leads to higher Ca levels postpartum and a lower incidence of milk fever. Prepartum Ca and P levels in the blood were lower in the group fed a low Ca diet, according to research by Green *et al.* (1981) [14] that investigated the effects of a low (8 g/day) and a high (80 g/day) Ca diet on farm animals. The group fed a low Ca diet had greater peripartum blood levels of Ca than the group fed a high Ca diet, and there were trends towards higher levels of hydroxyproline and 1, 25 (OH) 2 vitamin D in the low Ca diet group. These findings are explained by the hypothesis that a reduced pre-parturient Ca diet stimulates Ca metabolism prior to calving, preventing the lag phase of Ca metabolism in the early postpartum period when Ca requirements are greatest. On the day of delivery, when calcium export in colostrums increases abruptly, feeding a low calcium diet in late pregnancy ensures that PTH and the active form of vitamin D3 are in circulation in larger amounts (Kovacs, 2016) [22].

Supplementation of Vitamin - D in transition period

Supplementation of vitamin D in dairy animals during the transition period is important for their overall health and productivity. The transition period is a critical time for dairy cows, starting three weeks before calving and continuing three weeks after calving (Abuelo *et al.*, 2019) [1]. During this time, cows experience significant physiological and metabolic changes that can impact their immune function, calcium metabolism, and reproductive performance (Keshri *et al.*, 2021) [20]. Vitamin D plays a crucial role in calcium homeostasis and bone metabolism. It helps in the absorption and utilization of calcium and phosphorus, which are essential for proper skeletal development and milk production (Stein *et al.*, 2014) [30]. Adequate vitamin D levels also support a healthy immune system and reduce the risk of various metabolic disorders such as hypocalcemia (milk fever) and mastitis (Khazai *et al.*, 2008) [21]. In dairy cows, vitamin D can be synthesized through exposure to sunlight. However, factors such as limited sunlight availability, housing conditions, and low dietary vitamin D content may lead to suboptimal levels. Therefore, supplementation of vitamin D is commonly recommended to ensure adequate levels during the transition period (Wilkens *et al.*, 2020) [32]. Vitamin D can be provided as an oral supplement in the form of capsules, tablets, or boluses. These can be administered individually or mixed into the animal's feed. The dosage and frequency of supplementation should be determined based on the specific requirements of the animal and the recommendations of a veterinarian or animal nutritionist. Injectable vitamin D formulations are also available, which can be administered subcutaneously or intramuscularly (Hassanabadi *et al.*, 2020) [15]. This method provides a direct and quick absorption of vitamin D into the bloodstream, ensuring a rapid increase in circulating levels. Another approach is to include vitamin D-fortified feed or mineral mixes in the animal's diet. This can help provide a consistent and controlled dosage of vitamin D throughout the transition period. It is important to note that the specific vitamin D requirements for dairy animals can vary based on factors such as age, breed, body weight, and environmental conditions (McCourt and O'Sullivan, 2022) [25]. Regular monitoring of blood calcium and vitamin D levels, along with observation of cow behavior and health, can help assess the effectiveness of the vitamin D supplementation program (Hossein and Holick, 2013) [16].

Oral supplementation of calcium at the time of parturition or postpartuirent period

Typically, it was understood that one method of preventing milk fever during pregnancy was to provide patients low calcium diets. The dairy animals were fed less than 50 g of calcium per day to achieve this. Therefore, animal diets should not contain high calcium forages like berseem. To lower the calcium content in forages, dry animals must regularly consume corn silage and grass hay (Zhang *et al.*, 2022) [33]. A 1400-pound cow's daily calcium needs are as little as 41 grammes, and calcium is only necessary for maintenance and foetal bone growth. Therefore, the metabolic pathways that cause calcium mobilization from bone will be inactivated when calcium requirements are satisfied through dietary intake. However, there is an urgent need for significant amounts of calcium for the creation of colostrum following parturition and the start of nursing (Pascottini *et al.*, 2022) [27]. Since dry matter consumption often declines a few weeks prior to parturition, the acute requirement for calcium at this period could not be satisfied by dietary calcium. Therefore, to supply this sudden calcium requirement, calcium must be released from bone. However, because the diet during the dry period provides all of the calcium needed, relatively little calcium is mobilized from the bones, which causes milk fever in the cows (Fadlalla *et al.*, 2020) [11]. One of the approaches to prevent milk fever, according to Jesse P.G. *et al.* (2018) [19], is to feed the cows diets low in calcium during the dry season. To minimize calcium levels during the dry season, frequent feedings of corn silage and grass hay are recommended. Amanlou H. *et al*. (2016) [3], indicated that Two subcutaneous calcium infusions within the first 18 hours after delivery are associated with a decreased risk of postpartum diseases (Metritis, clinical and subclinical endometritis, and hypocalcemia) in cows from the experimental group as compared to animals from the control group. So, dietary calcium of dry dairy animals should be low to prevent milk fever.

Conclusion

Milk fever and subclinical hypocalcemia are the most important macro mineral disorders of the transitioning dairy animals. Prevention of hypocalcemia, not just milk fever, should be a major goal of dairy farms. The addition of a calcium binder to the feed might be a potential answer to this issue. It is determined that the absolute amount of calcium in the diet appears to be more significant when considering the impact of the Ca/P ratio. A few management related issues were discussed briefly, and the following conclusions were made: It is important to supply the periparturient cow with sufficient Ca to fulfil its needs that's helps in milk fever prevention.

Conflicts of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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