TRENDS IN AGRICULTURE SCIENCE
ISSN:2583-7850

Popular Article
Domain: Veterinary Science
Vol 4 Issue 5, May 2025, 3500-3504

Role of Minerals in Transition Period of Ruminants

S. L. Kolhe, K. Sethy*, A. K. Das, H. P. Chanda, S. N. Jadhav and A. Swain
Department of Animal Nutrition, C.V.Sc and AH, Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha
DOI:10.5281/TrendsinAgri.15398262

Introduction

The complex dynamics of dairy farming are not only animal welfare and productivity but also heavily dependent on nutritional management, especially at key transitions. The transition period is a critical stage in dairy cattle reproductive life and metabolic adjustments when the demand for minerals becomes a priority. Knowledge about the function of these minerals is important, as their deficiency or imbalance can result in harmful health impact and financial losses to the farmers. With the interconnectedness of farming systems across the world, as noted by current research, it is crucial to assess the mineral nutrition of dairy cattle in a larger agricultural perspective. This makes sustainable practices, as required to meet the rising demand for food from animals, in line with food security and nutritional requirements. By emphasizing mineral nutrition at the time of transition period, dairy farmers can improve animal health and farm productivity overall, a requirement in today's competitive market.

Importance of minerals in dairy cattle nutrition

Minerals' Significance in the Nutrition of Dairy cattle undergo major physiological and metabolic changes during the transition period, which increases their need for certain nutrients, especially minerals. Maintaining optimal immune function and metabolic health depends on the balance of vital minerals like calcium, phosphorus and magnesium. The health of cows and their overall milk production can be directly impacted by metabolic stress caused by inadequate mineral intake, which can result in conditions like hypocalcemia and retained placenta. During this time, there is a negative energy balance, meaning that the body needs more minerals to support different physiological processes because the demand for nutrients exceeds the intake. According to studies, taking enough minerals can improve immune responses and reduce stress, which lowers the risk of metabolic diseases and boosts reproductive function.

Calcium

Calcium plays a critical role during the periparturient period (3 weeks before to 3 weeks after calving) in ruminants, particularly dairy cows. This period is marked by dramatic physiological and metabolic changes, and calcium balance is vital for the health and productivity of the animal.

Published: 13 May 2025

Hypocalcemic condition at the threshold level develops sub clinically in most cows following calving. Low blood calcium levels correlate with various calving difficulties as well as retained placenta and uterine prolapse. Metritis, mastitis and ruminal stasis with depressed immune responses lead to lower reproductive success which decreases farm productivity potentially causing fatal outcomes. Prior to calving cellular Ca^{2+} depletion start several days before but serum calcium decreases become noticeable only 12 to 24 hours after the calving period. Low blood calcium level interferes with muscle contraction. The reduced calcium levels across the body result in complete body weakness together with depression which leads to death. Old dairy cows along with high milk producing breeds experience this issue because they have limited capability to extract calcium from bone tissue. The control system for serum Ca^{2+} exists under the influence of essential calcitropic hormones PTH from parathyroid gland and 1,25-$(OH)_2$ D_3 from vitamin D metabolites produced in the kidney alongside calcitonin. Blood calcium levels lower than 7.5 mg/dl classifies cows as hypo calcaemic and along with a decrease in blood phosphorus levels the blood magnesium levels tend to increase.Animals exhibiting stage I hypocalcaemia had serum calcium levels between 5.5 to 7.5 mg/dl. The progression of hypocalcaemia occurs through three stages from 3.5 to 6.5 mg/dl in Stage II and below 3.5 mg/dl in Stage III to as low as 2 mg/dl.The function of calcium include facilitating muscle contraction.The development of milk fever does not start until plasma calcium level drops below 4 mg/dl but studies show 5 mg/dl plasma calcium weakens abomasal motility by 70% along with a 50% reduction in contraction strength.Combined these changes create a deterioration in dry matter consumption from impaired rumen functionality leading to serious negative energy balance (Lean and Westwood, 2016). Increased fat release from tissue leads to both fatty liver syndrome and ketosis as side effects. (Daniel, 1983). Ketone bodies at excessive levels worsen appetite suppression while low calcium level block insulin production which intensify the condition. The lowering of milk yield will occur while fertility struggle as previously explained. Cows that experience long calving period and retain their placenta will develop impaired uterine muscle tone (Goff and Horst, 1997).

The manipulation of prepartum dietary cation-anion difference stands as a common strategy to decrease hypocalcemia risk. Acidogenic diet consumption enhances Ca homeostasis functions and lowers hypocalcemia occurrence while lowering uterine disease risk and enhancing performance outcomes. Synthesizing prepartum diets with negative Ca balance characteristics lowers clinical hypocalcemia risk. Current research indicates adding mineral-binding agents to diets reduces P and Ca absorption before calving thus increasing blood Ca at parturition. However, production and health benefits from this approach need to be demonstrated target DCAD in pre-calving transition rations is −100 to−200 mEq/kg DM (Goff and Horst, 1997) calculated as $(K^+ + Na^+) - (Cl^- + S^{2-})$. In order to prevent milk fever maintaining the sodium levels at 0.1% and potassium levels at 1.0% as close as possible to the animal's natural requirement is beneficial. To reduce subclinical hypocalcemia farmers need to include chloride in the nutrition mix which block the potassium-induced changes in blood alkalinity.

Phosphorus

During the milk production initiation period after calving a cow requires high energy levels but the feed consumption remains minimal. A negative energy balance happens because the individual consumes less energy than needed. The presence of phosphorus enables cattle to convert food into a usable energy form. The cattle will experience fatigue and body functions will decline when there is insufficient phosphorus intake. The body developing fatty liver or experiencing ketosis becomes a possible consequence.After giving birth downer cow syndrome become a serious problem due to insufficient phosphorus intake. The immune system strength of cows remains essential throughout the transition period for successful infection resistance. Phosphorus serves as a vital substance for immune cells since it enables them to perform optimally. Lack of phosphorus availability in cows makes them prone to sickness. Common problems include: Mastitis (inflammation of the udder) and metritis (infection in the uterus). The placenta fails to leave the body following birth which is referred to as retained placenta. The immune system weakened by inadequate phosphorus intake will cause delayed recovery time both during and after the birth period.

Magnesium

The magnesium level of cattle diet has the greatest influence on the chance of developing milk fever. Magnesium may prevent milk fever through its roles in PTH release and the production of 1,25-dihydroxycholecalciferol. The magnesium level of cattle diet has the greatest influence. In hypomagnesemia, the kidney and bone are less sensitive to PTH, reducing renal calcium excretion. According to studies, non-pregnant and non-lactating cows on a high-magnesium diet had lower renal calcium excretion than those fed a low-magnesium diet. Although clinical hypomagnesemia is rare in dairy cattle, very low dietary sodium or high dietary potassium concentration may interfere with magnesium transport across the rumen wall and result in clinical disease (Lean *et al.,* 2013). Hypomagnesemia shows the sign of muscle spasms, convulsions and death from respiratory failure. The condition affects cows that are nursing. The pulse, temperature, and respiration rate are all elevated (Reddy, 2018)

Selenium

Selenium functions as an essential trace element because it contains antioxidant and immunomodulatory properties. Scientific research shows that the selenium level in cow nutrition directly impacts mastitis occurrences because neutrophils phagocytic action remains the principal defense against this disease. Selenium affects such immune components of the mammary gland as both innate and adaptive response mechanisms through cellular functions and humoral activities (Hall *et al.*, 2009) Selenium proves vital in transition period. Animals heavily depend on selenium throughout their entire reproductive cycle. The reproductive system of cattle operates poorly because of selenium deficiency. Selenium deficiency in animals leads to reproductive problems which include retained placenta and poor fertilization along with abortion, mastitis and metritis (Reddy, 2018)). Selenium addition in the form of selenite to colostrum improves IgG absorption in new-born calves. The redox balance of colostrum function as a primary factor for transferring passive immunity between colostrum and calf (Kamada *et al.*, 2007)

Zinc

Zinc plays an essential role by strengthening immune responses in the body. The calving period naturally reduces cow immunity which leaves them exposed to infections such as mastitis, metritis and retained placenta. White blood cells require zinc for their proper development and operational function to fight infections. Cattle have sufficient zinc content demonstrate improved protective abilities to disease threats during stressful periods.The fast healing of uterus and birth canal injuries after calving becomes essential for infection prevention and recovery promotion. Zinc functions in cell division as well as collagen production and tissue repair which are essential components for internal wound healing following the birth process. It plays an antioxidant role during the time of calving. Free radicals emerge from metabolic stress during calving because of biochemical processes. The reproductive cycle of dairy cattle requires zinc to return to normal after calving because deficiency in this mineral leads to reduced fertility and increases the risk for uterine infection. A cow generates colostrum milk following calving which contains numerous antibodies that guard newborn calves against sickness. The quality of colostrum increases when zinc supports both mammary gland health and fortified immune function. Newborn calves that drink excellent colostrum from cows supplemented with zinc develop better growth and remain healthier.

Conclusion

The transition period in dairy cattle represents a physiologically demanding phase, where mineral nutrition assumes a pivotal role in ensuring animal health, reproductive efficiency, and overall farm productivity. Deficiencies or imbalances in key minerals such as calcium, phosphorus, magnesium, selenium, and zinc can precipitate significant metabolic disorders, compromise immune function, and lead to substantial economic losses. Therefore, a thorough understanding and strategic management of mineral supplementation during this critical window are indispensable. In the broader context of sustainable agriculture and rising global food demands, optimizing mineral nutrition not only enhances individual animal performance but also contributes to the resilience and efficiency of dairy production systems. Integrating evidence-based nutritional practices remains essential for meeting the challenges of modern dairy farming while supporting animal welfare and long-term food security objectives.

References

Daniel, R. C. W. 1983. Outbreaks of hypocalcaemia in dairy cows. *Veterinary Record*, 113: 110–112.

Goff, J. P and Horst, R. L. 1997. Physiological changes at parturition and their relationship to metabolic disorders. *Journal of Dairy Science*, 80: 1260–1268.

Hall, J. A., Bobe, G., Vorachek, W. R., Kasper, K. and Orndorff, S. 2009. Effects of feeding selenium-enriched alfalfa hay on selenium status and immune function in weaned beef calves. *Biological Trace Element Research*, 129: 58–70.

Kamada, H., Nonaka, I., Ueda, Y. and Murai, M. 2007. Selenium addition to colostrums increases immunoglobulin G absorption by newborn calves. *Journal of Dairy Science*, *90*(12):5665-5670.

Lean, I. J and Westwood, C. T. 2016. Nutritional Management to prevent hypocalcemia in dairy cows. *Veterinary Clinics: Food Animal Practice*, 32: 315–330.

Lean, I.J., Van Saun, R. and DeGaris, P.J. 2013. Mineral and antioxidant management of transition dairy cows. *Veterinary Clinics: Food Animal Practice*, 29: 367-386.

Reddy, D. V. 2018. Principles of Animal Nutrition and Feed Technology 3rd ed.pp. 120 -135.