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Dhawal Kant Yadav
Lactation and Immuno-Physiology Laboratory, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Surender Singh Lathwal
Lactation and Immuno-Physiology Laboratory, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Aarti Kamboj
Lactation and Immuno-Physiology Laboratory, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Mohanned Naif Alhussien
Lactation and Immuno-Physiology Laboratory, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Ajay Kumar Dang
Lactation and Immuno-Physiology Laboratory, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Corresponding Author:
Dhawal Kant Yadav
Lactation and Immuno-Physiology Laboratory, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Systemic administration of micronutrients in crossbred cows and their health assessment

Dhawal Kant Yadav, Surender Singh Lathwal, Aarti Kamboj, Mohanned Naif Alhussien and Ajay Kumar Dang

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Abstract

Injections of vitamins and minerals can improve nutrient availability at the cellular level, which is crucial for reducing the stress of the transition phase and enhancing the health and output of dairy cows. This study was carried out to evaluate the quality of colostrum and the health of the calf following intramuscular injection of multi-minerals and multi-vitamins to peripartum cows in the winter. Twenty-four pregnant crossbred Karan Fries cows were divided into four groups, each with six cows, for each season. Group 1 received only basal diet and no other intervention; it served as the control group. Group 2 received multivitamin injections; group 3 received multimineral injections and group 4 received combination of multivitamin and multimineral injections. Blood samples were collected on 1, 3, 7 and 15 days before parturition and same number of days after parturition. Cortisol levels were found lower in the group which were injected multimineral injections followed by the group which was injected multivitamin injections and they were highest in group which was fed only basal diet ($p<0.05$). IGF1 levels were highest in the group that was injected combination of multivitamin and multimineral injections while it was lowest in the group fed only basal diet followed by multivitamin and multimineral.

Keywords: Systemic administration, micronutrients, crossbred cows

Introduction

Nutrient injections, such as vitamins, minerals, and other supplements, can have various effects on the health profile of cows depending on the specific nutrients administered and the cow's individual needs. Here are some common effects of nutrient injections on cow health such as improved immune function: Certain nutrient injections, such as vitamin A, vitamin D, vitamin E, and selenium, can help support the immune system. Adequate levels of these nutrients are essential for the proper functioning of the immune system, helping cows fight off infections and diseases. Risk of diseases are reduced, Nutrient injections can help reduce the risk of specific diseases and health conditions. For example, selenium injections can prevent white muscle disease, while vitamin B12 injections can help prevent deficiency-related conditions such as anemia. Reproductive performance is enhanced, nutrient injections can improve reproductive performance in cows by addressing deficiencies that may affect fertility and reproductive health. For example, injections of vitamin E and selenium can improve reproductive efficiency and reduce the incidence of retained placenta and metritis. Increased Milk Production: Certain nutrient injections, such as vitamin A and vitamin D, can support milk production and quality. Adequate levels of these vitamins are necessary for proper udder health and milk synthesis (Abuelo *et al.*, 2019) [2]. Improved Growth and Development: Nutrient injections can support the growth and development of calves and young stock. For example, injections of vitamins, minerals, and trace elements can promote bone development, muscle growth, and overall health in growing animals.

Reduced Stress Response: Some nutrient injections, such as vitamin C and certain B vitamins, can help reduce the stress response in cows. These nutrients act as antioxidants and support the adrenal glands, helping cows cope with stressors such as transportation, handling, and environmental changes. Enhanced Hoof Health: Nutrient injections containing biotin and other nutrients can promote hoof health and reduce the risk of hoof-related disorders such as lameness.

Management of Specific Conditions: Nutrient injections may be used to manage specific health conditions or deficiencies in individual cows. For example, injections of vitamin B12 may be used to treat cases of pernicious anemia, while injections of calcium and magnesium can help prevent hypocalcemia (milk fever) in dairy cows. It's important to note that nutrient injections should be administered under the guidance of a veterinarian or nutritionist, and the decision to use them should be based on a thorough assessment of the cow's nutritional status and health needs. Overuse or improper administration of nutrient injections can lead to adverse effects or nutrient imbalances, so it's crucial to follow proper dosing and administration protocols. Micronutrients play a crucial role in the regulation of various physiological processes in cows, including the production of hormones such as cortisol and insulin-like growth factor 1 (IGF1). Here's how certain micronutrients may affect cortisol and IGF1 levels in cows:
Magnesium: Magnesium deficiency can lead to increased cortisol levels in cows. Cortisol is a stress hormone, and inadequate magnesium levels can contribute to stress-related conditions such as hypomagnesemia (grass tetany). Supplementing magnesium in the diet can help maintain normal cortisol levels and reduce the risk of stress-related disorders. Zinc: Zinc is involved in the regulation of cortisol levels and the stress response in cows. Adequate zinc levels may help modulate cortisol secretion and reduce the negative effects of stress. Additionally, zinc is essential for the production and function of IGF1, which plays a key role in growth and development. Selenium: Selenium deficiency can lead to increased cortisol levels and impaired stress response in cows. Supplementing selenium in the diet can help maintain normal cortisol levels and improve the cow's ability to cope with stress. Selenium also supports the production of IGF1 and helps regulate its activity. Vitamin D: Vitamin D is involved in the regulation of cortisol and IGF1 levels in cows. Adequate vitamin D levels may help modulate cortisol secretion and promote the synthesis and function of IGF1, which is essential for bone growth and overall health (Brugger *et al*., 2022) [13]. Vitamin E: Vitamin E is an antioxidant that helps protect cells from oxidative damage and may play a role in cortisol regulation. Adequate vitamin E levels in the diet can help reduce cortisol levels and support the cow's stress response. Vitamin E also contributes to the production of IGF1 and may help improve growth and performance. Copper: Copper is involved in the regulation of cortisol metabolism and may help modulate cortisol levels in cows. Adequate copper levels in the diet are important for maintaining normal cortisol function and overall stress response. Copper also plays a role in the synthesis of IGF1 and may influence its activity.
It's important to note that while these micronutrients can influence cortisol and IGF1 levels in cows, the effects may vary depending on factors such as diet, management practices, and individual animal health status. Additionally, excessive or imbalanced supplementation of micronutrients can have adverse effects, so it's essential to work with a veterinarian or nutritionist to develop a balanced diet and supplementation program tailored to the specific needs of the herd.

Materials and Methods

The study was performed on 48 healthy Karan Fries (Holstein Friesian X Tharparkar) cows in their peripartum stage. These cows were located in the tropical climatic zone at the Livestock Research Centre (LRC) of the National Dairy Research Institute (NDRI) in Karnal, Haryana, India. This institution is situated at a latitude of 29º43' N and a longitude of 76º58' E. It stands at an elevation of 245 meters above sea level, positioned within the expanse of the Indo-Gangetic alluvial plain. The study was conducted in both the winter (cold) and summer (hot) seasons. The average Temperature-Humidity-Index (THI) for the study period, calculated using the method outlined by McDowell *et al*. (1976), was 60.29 during the winter (December 2019 to February 2020) and 81.05 during the summer (May 2020 to July 2020).

Estimation of cortisol

1. **Principle:** ELISA relies on the specific binding of cortisol molecules in the blood sample to antibodies that are immobilized on a solid surface (e.g., a microplate). This binding reaction is then detected using an enzyme-linked secondary antibody and a substrate that produces a measurable signal.
2. **Procedure**
   a) **Coating:** The first step involves coating the wells of a microplate with cortisol-specific antibodies. The antibodies are typically attached to the bottom of the wells.
   b) **Sample Addition:** Cow blood samples, which may be serum or plasma, are added to the wells and allowed to incubate. During this step, cortisol in the sample binds to the antibodies on the microplate.
   c) **Washing:** The wells are washed to remove any unbound substances, such as proteins and other components of the blood.
   d) **Secondary Antibody Addition:** A secondary antibody that is specific to cortisol and linked to an enzyme (e.g., horseradish peroxidase) is added to the wells. This secondary antibody binds to the cortisol that is already bound to the primary antibodies.
   e) **Substrate Addition:** A substrate solution is added to the wells. The enzyme linked to the secondary antibody catalyzes a reaction with the substrate, producing a color change.
   f) **Measurement:** The intensity of the color change is proportional to the amount of cortisol present in the sample. This can be measured spectrophotometrically at a specific wavelength.
3. **Calculation:** The concentration of cortisol in the sample is determined by comparing the absorbance or fluorescence of the sample to a standard curve generated using known concentrations of cortisol.
   Same way IGF1 was calculated using ELISA

Results

The results of cortisol content (Means ± SE) in colostrum of administered and control groups cows have been presented in table 4.11, The (Means ± SE) of cortisol levels of E1, E2, E3 and E4 groups on day 1 was found to be 6.3±0.881, 5.7±0.59, 5.5±0.78 and 4.0±0.301 ng/mL respectively. It was observed that on 1st day total cortisol of E4 group was significantly ($p<0.05$) lower as compared to other treatment groups. On 3rd day postpartum cortisol levels (Means ± SE) of E1, E2, E3 and E4 groups were 4.8±0.51, 3.8±0.83, 4.0±0.46 and 2.9±0.40 respectively. Cortisol in E4 group was found significantly ($p<0.05$) lower as compared to other treatment group and control.

On 7th day postpartum cortisol levels (Means ± SE) of E1, E2, E3 and E4 groups were 3.1±0.412, 3.2±0.25, 3.3±0.12 and 2.5[ab]±0.28 respectively. Cortisol level of E4 group was found significantly ($p<0.05$) lower as compared to other treatment group and control.

On 15th day postpartum means ± SE of total immunoglobulins of E1, E2, E3 and E4 groups were 3.0±1.1, 2.8±0.59, 2.8±0.08 and 1.5[a]±0.28 respectively. Only the experimental group T_3 revealed significantly ($p<0.05$) lower as compared to control and T_1 group.

The results of IGF1 content (Means ± SE) in colostrum of administered and control groups cows have been presented in table 4.13. The (Means ± SE) of IGF1 levels of T_0, T_1, T_2 and T_3 groups on day 1 was found to be 317.0±23.86, 420.3±26.93, 400.0±38.25 and 552.0±19.53 ng/mL respectively. It was observed that on 1st day IGF1levels of T_3 group was significantly ($p<0.05$) higher as compared to other treatment groups. On 3rd day postpartum IGF1 levels (Means ± SE) of E1, E2, E3 and E4 groups were 223±6.65, 231±4.72, 252±16.25 and 387±13.05 ng/mL. respectively. IGF1 in E4 group was found significantly ($p<0.05$) higher as compared to other treatment group and control.

On 7th day postpartum IGF1 levels (Means ± SE) of E1, E2, E3 and E4 groups were 98.0±5.84, 72.0±4.34, 114.0[a]±8.76 and 126.5[b]±9.56 ng/mL respectively. IGF1 level of T_2 and T_3 group was found significantly ($p<0.05$) lower as compared to other treatment group and control.

On 15th day postpartum means ± SE of IGF1 levels of E1, E2, E3 and E4 groups were 5.8±1.01, 5.5±0.71, 5.5±0.44 and 5.8±10.17 ng/mL respectively. None of the experimental group revealed significantly ($p<0.05$) difference as compared to control.

Discussion

Nutrient injections are commonly used in the dairy industry to address specific nutritional deficiencies and support the health and productivity of cows. These injections can have a significant impact on various aspects of cow physiology, including growth and stress hormone levels such as cortisol. In this discussion, we will explore the effects of nutrient injections on cow growth and cortisol levels. Effect on Growth: Nutrient injections can play a crucial role in supporting the growth and development of cows, particularly during critical stages such as pregnancy, lactation, and early life. Several nutrients, including vitamins, minerals, and amino acids, are essential for optimal growth and body condition in cows. Vitamin and mineral injections, such as vitamin A, vitamin D, calcium, and selenium, are commonly used to address deficiencies that may hinder growth and development. These nutrients play key roles in bone development, muscle function, and overall metabolism. vitamin D is essential for calcium absorption and bone mineralization, while selenium is important for muscle function and immune system health (Gantner *et al*., 2011; Alhussien and Dang, 2018) [19, 3]. By providing these nutrients through injections, dairy farmers can ensure that cows have the necessary building blocks for growth and development. Additionally, certain amino acids, such as lysine and methionine, are crucial for protein synthesis and muscle growth in cows. Injectable amino acid supplements can help optimize protein utilization and support muscle development, particularly in young or growing animals. Overall, nutrient injections can contribute to improved growth rates, better body condition, and higher productivity in cows by addressing specific nutritional needs and supporting metabolic processes essential for growth.

Effect on Cortisol Levels: Cortisol is a stress hormone produced by the adrenal glands in response to various stressors, including environmental, physiological, and psychological factors. Elevated cortisol levels can negatively impact cow health and productivity by suppressing immune function, reducing feed intake, and impairing reproductive performance (Girard *et al*., 1999) [20]. Nutrient injections may influence cortisol levels in cows through several mechanisms: Improved Nutritional Status: Nutrient injections can help correct deficiencies that may contribute to stress and elevated cortisol levels. For example, adequate levels of certain vitamins and minerals, such as vitamin C, vitamin E, and magnesium, are essential for adrenal gland function and cortisol regulation. Reduced Stress Response: Certain nutrients, such as vitamin C and certain B vitamins, have been shown to attenuate the stress response and reduce cortisol levels in animals. These nutrients act as antioxidants and support adrenal gland function, helping cows cope with stressors more effectively. Enhanced Immune Function: Nutrient injections that support immune function can indirectly influence cortisol levels by reducing the need for cortisol-mediated immune responses to pathogens and stressors. For example, selenium and vitamin E injections can improve immune function and reduce the risk of infections that may trigger cortisol release.

Conclusion

In conclusion, nutrient injections can have beneficial effects on both growth and cortisol levels in cows. By addressing specific nutritional deficiencies and supporting metabolic processes, these injections can promote optimal growth and development while helping to reduce stress and maintain a healthy hormonal balance. However, it's essential to use nutrient injections judiciously and in conjunction with a comprehensive herd health management program to ensure maximum benefits and minimize risks. Further research is needed to better understand the specific effects of different nutrients on cow physiology and the long-term implications for health and productivity.

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