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Antioxidant effects on the yield and somatic cell count of crossbred cattle

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Abstract
Vitamin injections, such as vitamins A and E, and minerals, such as selenium, zinc, and copper, can reduce somatic cell counts (SCC) in dairy animals and help them recover from mastitis. A study found that a continuous injection of 2.5 mg/kg of vitamin B2 for three days significantly decreased SCC in quarter milk at 3, 7, and 14 days after the initial injection. Another study found that subcutaneous injections of melatonin can reduce SCC in the milk of dairy cows with subclinical mastitis for at least 24 days after treatment. Compared to the control group, the milk yield showed a substantial increase in the T_2 and T_3 groups over the course of the study ($p<0.05$). On the other hand, neither season's T_1 group's milk yield significantly differed from the control group's. Although there were significant differences in the milk yield between the T_3 group on the 15th and 30th days of lactation in the winter ($p<0.05$), there were no differences in the milk yield on different days of lactation in the summer. Notably, milk yield was shown to be significantly impacted by the interaction between the two seasons and the groups ($P = 0.022$). Significant effects were seen on the somatic cell count (SCC) in colostrum/milk when days and groups ($P = 0.001$) and days and seasons ($P = 0.001$) interacted. The SCC in colostrum/milk peaked in all groups on the day of calving ($p<0.05$), and then declined significantly in the days that followed during lactation in both seasons ($p<0.05$).

Keywords: Vitamins, SCC, Milk yield, season, crossbred cattle

Introduction

Micronutrients play a crucial role in milk production and overall dairy cow health. Here's how various micronutrients can affect milk yield: Calcium and Phosphorus: Adequate levels of calcium and phosphorus are essential for milk production and the maintenance of cow health Nicola *et al.* (1996) [34]. Calcium is a key component of milk, and cows require a constant supply to support lactation. Deficiency can lead to milk fever and reduced milk yield. Phosphorus is involved in energy metabolism and plays a role in milk synthesis. Insufficient phosphorus can decrease milk production and compromise cow health. Vitamin A: Vitamin A is essential for maintaining healthy epithelial tissues, including those of the mammary gland. A deficiency in vitamin A can lead to reduced milk production due to impaired mammary gland function and increased susceptibility to infections (Kamada *et al*., 2007) [16]. Vitamin D: Vitamin D is crucial for calcium absorption and utilization, which is essential for milk synthesis. Adequate vitamin D levels help ensure proper calcium metabolism, which in turn supports optimal milk yield. Vitamin E and Selenium: Vitamin E and selenium act as antioxidants and protect cell membranes from oxidative damage (Bourne *et al* 2008) [35]. Both nutrients are important for maintaining mammary gland health and function, which can positively impact milk yield. Selenium deficiency has been linked to decreased milk production and increased susceptibility to mastitis. B Vitamins (B12, Riboflavin, Niacin, etc.): B vitamins are involved in energy metabolism and various enzymatic processes necessary for milk synthesis. Deficiencies in B vitamins can lead to reduced milk production and metabolic disorders such as ketosis. Zinc and Copper: Zinc and copper are important for numerous enzymatic reactions involved in milk synthesis and overall cow health.

Deficiencies in these minerals can lead to reduced milk yield, poor reproductive performance, and compromised immune function. Magnesium: Magnesium is essential for muscle function and plays a role in milk let-down (Goff and Horst, 1997) [2]. Inadequate magnesium levels can result in decreased milk yield and increased risk of metabolic disorders such as grass tetany. Iron: Iron is required for hemoglobin synthesis and oxygen transport, which are important for milk synthesis. Iron deficiency can lead to anemia, reduced energy levels, and ultimately decreased milk production. In conclusion, ensuring adequate levels of micronutrients is essential for maximizing milk yield in dairy cows. Micronutrient deficiencies can negatively impact cow health and productivity, leading to decreased milk production and increased susceptibility to diseases. Proper nutrition, including supplementation, when necessary, is key to optimizing milk yield and maintaining a healthy herd.

Materials and Methods

The present study was carried out to study the effect of micronutrient administration on crossbred cows and their calves.
Location – Livestock Research Complex NDRI, Karnal Breed – Karan Fries and Frieswal Twenty four (n=24) pregnant crossbred cows (Karan Fries and Frieswal) in their late gestation (i.e. 30 days before the expected date of calving) were selected from the experimental herd of Livestock Research Centre of NDRI. Animals were injected intramuscularly micronutrients because this route of administration provides better bioavailability of nutrients and reduced incidences of disease. Only animals expected to calve from January, 2021 to March, 2021 were considered for the winter study. Based on their milk yield and parity, the animals will be selected and randomly allocated to one of the three different treatments and one control; each group comprised of six animals. Group 1, without any intervention will act as control. The experimental cows will be injected intramuscularly individually with multivitamins (Group 2), multiminerals (Group 3), and combination of both (Group 4), to study the cumulative effect of all micronutrients. Animals will be administered intramuscularly multivitamins, multiminerals and their combination at -30, -15, -7, 0 before the expected date of calving and 7, 14, 21 days after expected date of calving. The same experiment was again repeated during summer months (May 2021 to July 2021) Somatic cell count (SCC) is an important indicator of milk quality and udder health in dairy cows. Elevated SCC levels can indicate mastitis or other udder infections. Several methods are used to calculate somatic cell count in cow milk:

1. Direct Microscopic Count (DMC)

In this method, a small volume of milk is stained with a specific dye, such as methylene blue, and examined under a microscope.
The somatic cells appear as distinct cells against the background, and they are counted manually using a counting chamber or hemocytometer.
The result is expressed as the number of somatic cells per milliliter (cells/mL) of milk.

2. Electronic Cell Counters

Electronic cell counters automatically count somatic cells in milk samples based on their size, shape, and electrical properties.
These instruments are more efficient and accurate than manual counting methods.
The result is typically reported as cells/mL of milk.

3. Flow Cytometry

Flow cytometry is a technique that measures physical and chemical characteristics of particles suspended in a fluid as they pass through a laser beam.
Somatic cells in milk are labeled with fluorescent dyes and analyzed based on their fluorescence properties.
Flow cytometry provides rapid and accurate measurement of somatic cell count in milk.

4. Fluorescence Microscopy

- In this method, somatic cells in milk are labeled with fluorescent dyes and visualized under a fluorescence microscope.
- The cells are counted manually or using automated image analysis software.
- The result is reported as cells/mL of milk.

5. Automated Milk Analyzers

- Some automated milk analyzers are equipped with modules for somatic cell count measurement.
- These analyzers use various principles such as conductivity or impedance to estimate somatic cell count in milk samples.
- The result is reported as cells/mL of milk.

6. Commercial Test Kits

- There are commercial test kits available for rapid measurement of somatic cell count in milk.
- These kits often use colorimetric or immunological methods to detect somatic cells in milk samples.
- The result is usually provided as a visual color change or measured using a spectrophotometer.

Each method has its advantages and limitations in terms of accuracy, speed, and cost. Dairy farmers and milk processors often choose the method that best suits their needs and resources for routine monitoring of somatic cell count in cow milk.

Results

Individual daily milk yield of the experimental crossbred cows was recorded upto 30th days postpartum. The results are the mean values of individual milk yield recorded on the dates of weekly milk sampling and graphically represented for winter and summer seasons. The results of milk yield (Means ± SE) in administered and the control groups on 1st week of T_0, T_1, T_2 and T_3 were 14.12±0.82, 12.99±1.27, 13.63±0.7 and 17±0.65 kg respectively in winter season and 7.22±0.82, 6.19±1.27, 7.61±0.63 and 8.18±0.65 for T_0, T_1, T_2 and T_3 respectively during summer season. Means of milk yield of T_3 group were found to be significantly (p<0.01) higher than T_0 group. Furthermore, mean of T_3 group was significantly higher as compared with T_1 and T_2 groups. The means ± SE on 2nd week of T_0, T_1, T_2 and T_3 were 11.17±0.45, 12.98±1.5, 16.21±0.66, and 18±0.69 kg respectively in winter season and 9.27±0.45, 9.48±1.5, 12.21±0.66 and 11.36±0.69 in summer season for T_0, T_1, T_2 and T_3 groups respectively. Means ± SE on 3rd week of T_0, T_1, T_2 and T_3 were 12.91±0.73, 14.38±1.4, 16.57±0.61 and 19.08±0.71 kg in winter season respectively and 9.52±0.73, 12.36±1.4, 14.57±0.65 and 13.26±0.71 for T_0, T_1, T_2 and T_3 respectively for summer season respectively. Means of milk yield of T_3 group were found to be significantly (p<0.01) higher than T_0 group. Furthermore, mean of T_3 group was significantly higher as compared with T_1 and T_2 groups.
Means ± SE on 4th week of T_0, T_1, T_2 and T_3 were 12.91±0.59,

15.21±1.5, 16.77±0.61 and 20.62±0.71 kg respectively in winter season and 10.76±0.59, 13.21±1.5, 13.17±0.61 and 15.26±0.71 for T_0, T_1, T_2 and T_3 groups respectively in summer season. Means of milk yield of T_1, T_2 and T_3 group were found to be significantly (p<0.01) higher than T_0 group. Furthermore, mean of T_3 group was significantly higher when compared with T_1 and T_2 groups.

Discussion

Micronutrients play a crucial role in supporting milk yield in dairy cows. These essential nutrients are involved in various metabolic processes that directly or indirectly affect milk production. Here's a discussion on the effect of micronutrients on milk yield of cows: Calcium and Phosphorus: Calcium and phosphorus are essential for milk synthesis and maintaining milk yield. Calcium is a major component of milk, and cows require sufficient calcium intake to support lactation. Phosphorus is involved in energy metabolism and the formation of phospholipids, which are important for milk fat synthesis. Deficiencies in calcium and phosphorus can lead to reduced milk yield and impaired milk composition (Duplessis *et al.*, 2014). Vitamin A: Vitamin A plays a role in maintaining the health of the mammary gland and promoting milk production. Adequate vitamin A levels are necessary for proper epithelial cell function in the udder, which affects milk synthesis. Vitamin A deficiency can lead to reduced milk yield and increased susceptibility to mastitis. Vitamin D: Vitamin D is crucial for calcium absorption and utilization, which is essential for milk synthesis. Adequate vitamin D levels ensure proper calcium metabolism, supporting optimal milk yield. Vitamin D deficiency may result in decreased milk production due to impaired calcium homeostasis. Vitamin E and Selenium: Vitamin E and selenium act as antioxidants and protect cell membranes from oxidative damage (Muehlenbein *et al.*, 2001) [37]. Both nutrients are important for maintaining mammary gland health and function, which can positively impact milk yield. Selenium deficiency has been associated with decreased milk production and increased risk of mastitis. B Vitamins (B12, Riboflavin, Niacin, etc.): B vitamins are involved in energy metabolism and various enzymatic processes necessary for milk synthesis. Deficiencies in B vitamins can lead to reduced milk yield and metabolic disorders such as ketosis. Riboflavin, in particular, is important for energy metabolism in the mammary gland and milk synthesis (Alhussien and Dang, 2021) [1].

Conclusion

In conclusion, micronutrients are essential for supporting milk yield in dairy cows by promoting proper mammary gland function, energy metabolism, and overall cow health. Ensuring adequate levels of micronutrients through proper nutrition and supplementation is crucial for maximizing milk production and maintaining the profitability of dairy operations. Dairy farmers should pay close attention to the micronutrient needs of their cows to optimize milk yield and ensure the health and well-being of their herd.

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