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Effect of anion-cation supplementation during transition period on Pluriparous cow

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Abstract

This study evaluated the efficacy of dietary cation-anion balance (DCAB) supplementation during the transition period on postpartum health and productivity in pluriparous cows. Twelve cows were allocated into treatment (TANUVAS PAM 21 from 250 days of gestation) and control groups in a 60-day prepartum protocol. Parameters including placental expulsion time, metritis incidence, calf weights, and lactation yield were recorded and analyzed. The treatment group exhibited a significantly faster placental expulsion (4.63 ± 0.33 vs. 6.93 ± 0.22 hours; $p < 0.001$) and a higher daily milk yield (9.64 ± 0.16 vs. 8.64 ± 0.11 L/day; $p < 0.001$). No significant differences were observed in metritis/pyometra incidence or calf weights. The results demonstrate that strategic DCAB supplementation significantly improves critical postpartum health and production outcomes, supporting its use as a vital nutritional management strategy to enhance transition success and dairy farm profitability.

Keywords: Transition cow, Dietary Cation-Anion Difference (DCAD), postpartum health, placental expulsion, milk yield, metabolic disease

Introduction

India is first among all the countries in both production and consumption of milk. During 2023-24, dairy cooperatives procured an average of 660 lakh kilograms per day, compared to 589 lakh kilograms per day milk procured in 2022-23. Dairy is the most important agricultural commodity in India, accounting for 5% of agricultural GDP and app 24-25% of India's gross domestic product in 2024. In dairy animals, a period called transition period is the period between three weeks before and three weeks after parturition. It is the most critical stage during which animal owners have to keep attention on their animal. Transition period Fig 1 (A) and (B) decides the milk production after parturition, the occurrence of metabolic diseases and reproductive efficiency. Every animal needs a quality transition time otherwise negative energy balance will be there and the animal will not perform very well in the subsequent lactation. Sufficient milk production is the key to dairy profitability, hence a healthy transition period is necessary to maintain the profits and reduce economic loss.

Mechanism behind negative energy balance during the transition period

When the animal approaches parturition energy requirements of the animal increase due to the huge changes taking place inside an animal's body. In the last period of parturition, the foetus grows at a high rate and mammary glands are being prepared by the body for the next lactation. Animal tries to maintain its body energy balance and immune system. If animals are not fed properly during this period, then the animal faces negative energy balance (NEB). This makes the animal, particularly the high yielding dairy cows, susceptible to various metabolic and infectious diseases like clinical ketosis, milk fever, mastitis, metritis etc. This leads to a great economic loss to the dairy industry. As the animal approach pregnancy, the level of progesterone decreases and estrogen increases, leading to a decrease in the dry matter intake (DMI) of the animal up to 30%. Requirement of high energy, minerals and nutrients for the growth of the foetus, production of colostrum and milk, and less intake of food can cause NEB. Various metabolic and endocrine changes occur in dairy animals near the time of

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parturition. Growth hormone activity increases during the time of lactation leading to high glucose supply by stimulating hepatic gluconeogenesis and causes insulin resistance. Insulin inhibits glucose utilization by the liver, muscles and adipose tissue, enhancing the availability of glucose for milk production and causes lipolysis, which makes the fatty acids (Non-esterified fatty acids-NEFA) available for lactogenesis. This is a normal adaptive process for all dairy animals, but in high yielding animals, a hypoglycaemic condition can be faced. This inadequate glucose concentration leads to partial or complete oxidation of NEFA, leading to the formation of ketone bodies like acetic acid, acetone and mainly beta hydroxy butyric acid (BHBA). This NEFA and BHBA may lead to decreased milk production, suppression of dry matter intake, decreased immunity, some clinical diseases like ketosis, milk fever, mastitis and infertility problems (Wankhade *et al.*, 2017) [13]. NEFA and BHBA are essential biomarkers of negative energy balance in the animal. Pre partum NEFA and postpartum BHBA were both significantly associated with the developing clinical disease. In contrast, postpartum serum NEFA concentration was most associated with the risk of developing displaced abomasum, clinical ketosis, metritis, or retained placenta. Cows developing postpartum diseases had higher average serum NEFA and lower plasma IGF-I value pre partum period.

Management of transition period

Monitor dry matter intake: As animal eats very less near the time of parturition, we should take care of our animal's energy and nutrient intake. We should manage the feed energy intake according to the change in feed intake. Feed rich in energy and nutrients should be provided to the animal because inadequate energy sources may lead to ketosis condition in cows. These complications due to NEB can affect the fertility of animal and increase in culling rate also.

Three weeks close-up period: Dry cows should be moved to the close-up pen three weeks before the due date because she needs to be able to mobilize calcium from her bones and absorb calcium in her intestines to use this calcium for successful lactogenesis. The animal needs time to adapt to the forages and high energy diets that we will give after lactation. During the dry period, calcium is being mobilized in a very less quantity compared to that during lactation so she needs time to adapt her body to these tremendous changes in her body. This event may take 10 to 15 days and a close up period is very essential to prevent problems after calving. During the dry period mainly forages (70-80% of the ration) are given to the animal to provide rumen fill. However, this feed is

deficient in energy, so grains are introduced in the close-up period. Grains can be given 3-8 pounds depending on the quality and type of forage. Anionic salts, vitamin E and selenium (Se) can also boost the immune system and minimize postpartum diseases.

Balanced diet during the transition period: A balanced diet is very necessary during the peri parturient period to reduce the chances of metabolic diseases. A balanced diet contains the proper amount of energy, proteins, carbohydrates, minerals, trace elements and dietary cation-anion difference (DCAD) level (Praveen and Dhaarani, 2018) [9]. It is the difference between the cations (Na^+ and K^+) and anions (Cl^- and S^{2-}) in the diet. Animal during calving may face some problems like dystocia, retention of placenta, uterine prolapsed, cervical tear etc. To overcome this metabolic diseases and post-partum complication, Cation Anion supplement was used. This research work was undertaken to study the Effect of Anion-Cation supplementation during Transition period on Pluriparous cow. The supplement used was TANUVAS PAM 21 from Tamil Nadu Veterinary and Animal Science University.

Materials and Methods

Cows were randomly and equally distributed to Treatment group and Control group. Animals in treatment group A were given TANUVAS PAM 21 daily orally; 250 days onwards for 21 days. During the Experiment the cows were fed roughage to concentrate ration of 60:40 with 40% silages and 60% fodder along with compound cattle feed as concentrates. The cows belonging to the Group B were not provided these supplements and acted as untreated control. The animals were kept in separate calving boxes one week prior to the expected calving date. After parturition, the birth weight of all the calves was recorded. The cows were subsequently shifted to milking shed and their daily milk yield recorded for a period of three months. Efficient estrous detection was attempted to inseminate (AI) the dams around 60 days postpartum. All the animals were clinically examined daily for four months postpartum for timely diagnosis of any illness particularly clinical mastitis, metritis or pyometra. Parameters such as occurrence of metabolic diseases, reproductive performance, post-partum, lactation yield and body weight of calf at birth and weaning, statistical analyses (unpaired t-test for continuous data and Fisher's Exact Test for categorical data) to study the effect of anion-cation supplementation during the transition period. All the statistical analysis was performed using SPSS package software.

Results and Discussion

Parameter (Unit)	Treatment group (Mean SEM)	Control group	P-value	Significance
Placental expulsion time (hrs.)	4.63±0.33	6.93± 0.22	< 0.001	P<0.001
Calf birth weight (kg)	24.48 ±0.32	24.67 ±0.38	0.705	Ns
Calf weaning weight (Kg)	56.08 ±0.78	56.82± 0.58	0.474	Ns
Lactation yield (L/day)	9.64 ±0.16	8.64± 0.11	< 0.001	P<0.001
Metritis/Pyometra incidence (%)	0.0% (0/6)	33.3% (2/6)	0.211*	Ns
Downer cow/Milk fever incidence%	0.0% (0/6)	33.3% (2/6)	0.211*	Ns

*SEM: Standard Error of the Mean. Analyzed by Fisher's Exact Test (two-tailed).

Cows in treatment group has shown no metabolic disease (0%) when compared to control group, where it has nearly 33.33% occurrence of milk fever after parturition. Clinical signs of milk fever include weakness, recumbency, shock and mortality. Diseases commonly occur in 5-10 years age group and most marked in third to seventh parity (Singh and Singh,

2017) [11]. Cow's calcium requirements increase due to colostrum production during periparturient period which exposes multiparous lactating cows to milk fever unless they adapt to compensatory mechanisms. Similarly, although the prevalence of hypocalcaemia is usually low in primiparous cows, study conducted in primiparous cows in 115 German

herds reported a relatively higher prevalence (5.7%). Similarly, although the prevalence of hypocalcaemia is usually low in primiparous cows, study conducted in primiparous cows in 115 German herds reported a relatively higher prevalence (5.7%) least 48 h to start functioning, milk fever is very likely to occur during the first 48 h of parturition (Alshehhi *et al.*, 2024) ^[12].

The dietary supplementation had a statistically significant and positive impact on two critical parameters. Cows in the treatment group expelled the placenta significantly faster (4.63 ± 0.33 hours) than cows in the control group (6.93 ± 0.22 hours), a highly significant reduction ($p < 0.001$) that serves as a primary indicator of improved postpartum uterine health and a smoother transition. Concurrently, supplemented cows produced significantly more milk (9.64 ± 0.16 L/day) compared to control cows (8.64 ± 0.11 L/day), demonstrating a clear benefit of the anion-cation balance on subsequent milk production performance ($p < 0.001$).

In contrast, other observed effects were not statistically significant. While no cases of metritis/pyometra (0%) were observed in the treatment group versus two cases (33.3%) in the control group, this difference was not significant ($p = 0.211$) with the current sample size. However, this trend suggests a potential protective effect of the supplementation against uterine infections, warranting investigation with a larger cohort. Within 6-9 h of delivery, the fetal membranes which remain in the uterus begin to deteriorate and become a suitable culture medium for various bacteria. These bacteria initially cause an acute puerperal metritis and later a clinical or subclinical endometritis, which results in the late involution of the uterus and the late regression of the ovarian corpus luteum after calving (Mordak and Antony 2015) ^[8]. Furthermore, the supplementation showed no significant effect on calf birth weight or weaning weight ($p > 0.05$), indicating that the intervention's benefits were primarily maternal. These benefits influenced calving ease and the cow's own metabolic and productive state without directly altering fetal growth or the calf's postnatal growth under the given management conditions. Overall, the statistical analysis confirms that anion-cation supplementation during the transition period in pluriparous cows had a highly significant beneficial effect by reducing the time to placental expulsion and increasing daily milk yield. A strong, though statistically non-significant, trend towards reduced uterine infection rates was also observed. The supplementation did not significantly influence calf birth or weaning weights. These results validate the strategic use of transition period nutrition to improve critical postpartum and production outcomes in dairy cows.

This study demonstrates that strategic dietary cation-anion balance (DCAB) manipulation during the close-up transition period exerts significant positive effects on critical postpartum and production outcomes in pluriparous cows. The findings confirm the hypothesis that optimizing prepartum nutrition mitigates the detrimental effects of negative energy balance (NEB) and hypocalcaemia, which are hallmark challenges of the periparturient period (Wankhade *et al.*, 2017) ^[13]. The most practical and proven method for monitoring hypocalcemia is by feeding cows an acidogenic diet for 3 weeks before calving (Tufarelli *et al.*, 2024) ^[12]. The most pronounced effect was the highly significant reduction in the time to placental expulsion. Retained placenta is a well-documented sequel to impaired uterine involution and immune function, often linked to hypocalcaemia and excessive inflammation around calving. A properly balanced

DCAD diet, by inducing a mild metabolic acidosis, enhances calcium mobilization from bone reserves and improves intestinal absorption, thereby reducing the risk of subclinical hypocalcemia (Praveen and Dhaarani, 2018) ^[9]. The faster expulsion observed in the supplemented group (4.63 vs. 6.93 hours) is a direct clinical indicator of improved calcium homeostasis and smoother parturition, which aligns with the fundamental goal of transition cow management. This result is consistent with previous research showing that anionic salt supplementation reduces the incidence of retained fetal membranes (Goff, 2008) ^[4]. Although the incidence of metritis/pyometra was not statistically different, the absence of cases in the treatment group versus a 33.3% incidence in controls suggests a biologically meaningful trend towards improved uterine health. This is consistent with the established link between metabolic stress, immune suppression, and postpartum infections (LeBlanc, 2010) ^[6]. A larger cohort study is warranted to confirm this protective effect.

Concurrently, the supplemented cows achieved a significantly higher daily milk yield (9.64 vs. 8.64 L/day; $p < 0.001$). This 11.6% increase in production is a critical economic outcome. It can be attributed to the improved metabolic status at calving. By mitigating NEB and hypocalcaemia, DCAB supplementation likely allowed cows to have a more robust appetite postpartum, smoother lactation onset, and more efficient nutrient partitioning towards milk synthesis. This finding validates the concept that investments in transition cow nutrition directly translate to enhanced lactation performance, as improved calcium status is a key determinant of dry matter intake in fresh cows (Horst *et al.*, 2024; McArt, 2020) ^[5, 7]. Study results from Ghasemi *et al.*, (2024) ^[3] showed similar result, Cows in the control group were 6.43 times more at risk of developing metritis than normocalcemic cows ($p = 0.002$; 95% CI = 1.51-21.56); while the incidence of metritis in treatment cows was not significantly different from normocalcemic cows ($p = 0.22$; 95% CI = 0.56-6.52).

Importantly, the benefits of supplementation were confined to the dam. The lack of significant difference in calf birth and weaning weights indicates that the intervention did not alter fetal growth or the calf's postnatal performance under the given management conditions. This suggests that the primary mechanism of action is the modulation of the dam's periparturient metabolism and calcium dynamics, rather than a direct nutritional effect on the fetus or the quality of milk produced for the calf. This aligns with the understanding that DCAB manipulation primarily targets maternal physiology to prevent disorders like milk fever (Goff, 2008, Rodríguez, 2017) ^[4, 10]. Similarly Tereso *et al.*, 2011 reported that intake of 40 to 50 g of magnesium (approximately 0.30-0.45% dry matter in the diet) will reduce the incidence of hypocalcaemia and hypomagnesaemia in Pluriparous cow.

In conclusion, the strategic use of the anion-cation supplement TANUVAS PAM 21 during the three-week prepartum period in pluriparous cows resulted in a faster placental expulsion and increased milk yield, confirming its efficacy in promoting a healthier transition and improved productivity. These results strongly support the integration of DCAB management as a standard practice to reduce postpartum complications and enhance the economic sustainability of dairy operations. Future research should focus on profiling metabolic biomarkers (e.g., NEFA, BHBA, calcium) to elucidate the precise physiological pathways involved.

Conflict of Interest

Not available

Financial Support

Not available

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