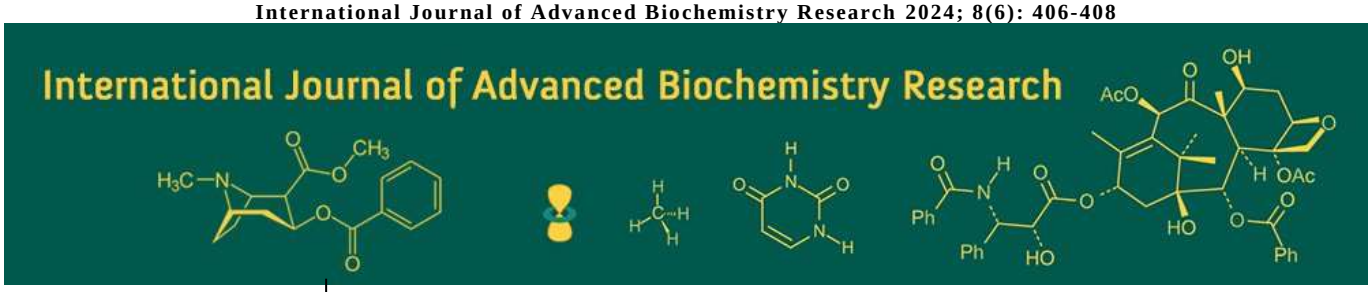

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(6): 406-408
www.biochemjournal.com
Received: 20-03-2024
Accepted: 24-04-2024

Komal
Department of Livestock Production Management, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, India

Pooja
Department of Veterinary Gynaecology and Obstetrics, International Institute of Veterinary Education and Research, Rohtak, Haryana, India

Pardeep Kumar
Department of Animal Nutrition, International Institute of Veterinary Education and Research, Rohtak, Haryana, India

Shubhnish
Department of Animal Nutrition, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, India

Corresponding Author:
Pardeep Kumar
Department of Animal Nutrition, International Institute of Veterinary Education and Research, Rohtak, Haryana, India

Impact of supplementation of sodium bicarbonate in the diet of lactating animals suffering from sub-acute rumen acidosis

Komal, Pooja, Pardeep Kumar and Shubhnish

DOI: https://doi.org/10.33545/26174693.2024.v8.i6e.1358

Abstract
The inclusion of sodium bicarbonate in the diet of lactating animals has been a topic of research due to its potential benefits in improving milk production and overall health because maximum. milch animals are in sub acute rumen acidosis in their early lactation due to the feeding pattern of high level of concentrate feeding. This study was done to observe the impact of sodium bicarbonate supplementation in buffalo and cattle feed, emphasizing its effects on milk yield, feed intake, rumen pH, and general health parameters. The findings suggest that sodium bicarbonate can enhance productivity in buffaloes by optimizing rumen function and nutrient absorption.

Keywords: Milch animals, subacute rumen acidosis, SARA, sodium bicarbonate, buffer

Introduction
Buffaloes are vital to the dairy industry, particularly in India. Enhancing their productivity and health through dietary interventions is a key area of research. Ruminal pH is a critical ecological factor in the rumen that influences the end products of microbial fermentation, directly impacting ruminant productivity and health. Optimal ruminal pH ranges from 6.3 to 7.0, facilitating the most efficient fermentation processes. Cellulolytic bacteria in the rumen cannot thrive at pH levels below 6.0, and a moderate increase in pH can enhance their activity (Santra *et al*., 2003) [12]. Mild acidosis occurs when ruminal pH falls below 6.0, while subacute acidosis is defined by pH levels dropping below 5.5. Subacute ruminal acidosis (SARA) involves episodes of moderately low ruminal pH, situated between acute and chronic durations (Cooper and Klopfenstein, 1996) [3]. SARA is mainly induced by high-concentrate diets, with the most consistent and early clinical sign being reduced feed intake, likely due to excessive organic acids impairing rumen function [Cooper *et al*., 1995] [4]. Sodium bicarbonate (NaHCO3) is commonly used as an effective rumen buffer to maintain optimal ruminal pH levels (Hu and Murphy, 2005; Raucha *et al*., 2012) [6, 11]. Sodium bicarbonate ($NaHCO_3$), also known as baking soda, has been widely used in ruminant nutrition, particularly for dairy cattle, due to its buffering capabilities that help stabilize rumen pH. By buffering the rumen, sodium bicarbonate mitigates this risk, ensuring better feed efficiency and nutrient absorption (Scientific Feeding of Transition Buffalo, 2023) [14]. Maintaining optimal rumen pH is essential for the health and productivity of cattle as it affects microbial activity, digestion, and nutrient absorption. In high-yielding dairy cows, diets rich in fermentable carbohydrates can cause subacute ruminal acidosis (SARA), leading to reduced feed intake, milk production, and overall animal health. For instance, a study reported an increase in milk production when sodium bicarbonate was included in the diet of early lactating buffaloes (Animal Bioscience, 2019) [1]. This is attributed to improved rumen function and enhanced nutrient uptake. This study examines the effects of sodium bicarbonate supplementation on milk production, focusing on feed intake, milk yield, growth performance, and metabolic health.

Material and Methods

1. Experimental Design

This study was conducted in the field near about Rohtak district with 55 buffaloes and 25 cattles. All of them are in early lactation and suffers from Sub-Acute-Rumen Acidosis. With the concerned of animal owner their diet was supplemented with sodium bicarbonate at the rate 150 gm each without any other supplementation. The trial duration was 12 weeks. All study was conducted for a year, supplementation was done randomly according to the occurrence of cases.

2. Diet Composition

All animals were fed a total mixed ration according to their production which include wheat straw, seasonal green fodder (Berseem, Sorghum, Maize) and concentrate which include cotton seeds and their cakes, mustard cakes, cereal grains and meals. Sodium bicarbonate was included in the ration at a level of 150 gm each for about 12 weeks.

3. Data Collection

a. Feed Intake: Feed intake was recorded weekly by the farmers and recorded effectively.
b. Milk Production: Milk yield was measured at each milking session, and milk composition (fat and protein percentages) was analyzed weekly.
c. Growth Performance: Body weight and body condition score (BCS) were recorded at the start and end of the trial to assess growth performance.
d. Rumen Fermentation and Metabolic Profile: Rumen fluid samples were taken monthly to measure pH, volatile fatty acids (VFA), and ammonia levels. Blood samples were collected biweekly to analyze metabolic parameters including glucose and blood urea nitrogen.

4. Statistical Analysis

Data were analyzed using a mixed-effects model with treatment, time, and their interaction as fixed effects. Significance was determined at $p<0.05$.

Results

1. **Feed Intake and Digestibility:** Animals fed on supplemented diet showed a significant increase in DMI compared to the control group ($p<0.05$). The average DMI for the treatment group was 26 kg/day in buffaloes and 24.5 kg/day in cattles, while in the starting it was the control group averaged 24 kg/day and 22 kg/day. Nutrient digestibility, particularly fiber digestibility (NDF), was also improved in the treatment group ($p<0.05$).
2. **Milk Production and Composition:** Milk yield was significantly higher in the supplemented animals throughout the study period ($P < 0.05$). The average daily milk production for animals receiving sodium bicarbonate was 13.8 kg, compared to 8.95 kg in the same animals before the supplementation. Additionally, milk fat and protein percentages were marginally higher in the treatment group, although these differences were not statistically significant ($P > 0.05$).
3. **Growth Performance:** Body weight gain and BCS improved significantly in the treatment group ($P < 0.05$). Animals supplemented with sodium bicarbonate gained an average of 0.383 kg/day. The BCS increased from an average of 2.8 to 3.4 in the supplemented group.
4. **Rumen Fermentation and Metabolic Profile:** Rumen pH in the supplemented group was consistently higher, averaging 6.5, compared to 5.9 in same animals before supplementation group ($P < 0.05$). After supplementation animals exhibit higher concentrations of total VFA and a more favorable acetate-to-propionate ratio. Blood metabolites, including glucose and beta-hydroxybutyrate, were within normal ranges for both groups, but after supplementation animals had lower levels of blood urea nitrogen.

Discussion

Sodium bicarbonate effectively maintained a more stable rumen pH, crucial for optimizing microbial activity and preventing acidosis. Enhanced fiber digestibility observed in the treatment group can be attributed to the improved rumen environment, facilitating the growth and activity of cellulolytic bacteria (Zhao *et al*., 2021; Lee *et al.,* 2020) [15, 10]. The stabilization of rumen pH is particularly important in high-producing dairy animals fed energy-dense diets, which can lead to SARA. SARA is associated with decreased feed intake, milk production, and animal health. By maintaining rumen pH within an optimal range, sodium bicarbonate supplementation helps mitigate the risks associated with SARA (McArt *et al*., 2018). The supplemented group also showed increased levels of total volatile fatty acids (VFA) and a more favorable acetate-to-propionate ratio (Smith *et al*., 2020; Garcia *et al*., 2019) [13, 5]. Blood metabolites, including glucose and beta-hydroxybutyrate, within normal ranges in all animals before and after supplementation; however, after supplementation animals exhibited lower blood urea nitrogen levels (Jones *et al*., 2019) [7]. The increase in milk yield among animals receiving sodium bicarbonate supplementation is likely due to improved feed intake and nutrient utilization. The slight increase in milk fat content suggests enhanced acetate production, a key precursor for milk fat synthesis (Kim *et al*., 2020) [8]. While protein percentages were not significantly affected, the overall higher milk yield contributes to increased total protein output. Sodium bicarbonate's role in improving milk yield aligns with findings from other studies. Zhao *et al*. (2021) [15] reported that cows supplemented with sodium bicarbonate had higher milk yields and better milk composition compared to unsupplemented cows. The increased feed intake observed in the treatment group likely provided the additional nutrients necessary for higher milk production.

The positive effects on body weight and BCS indicate that sodium bicarbonate supplementation supports better energy balance and metabolic health. Lower blood urea nitrogen levels in the treatment group suggest more efficient protein metabolism, reducing the metabolic burden on the liver and enhancing overall health (Chen *et al*., 2018) [2]. Efficient protein metabolism is crucial for maintaining the health and productivity of dairy cows. High levels of blood urea nitrogen are often associated with inefficient nitrogen utilization, leading to increased ammonia production and liver stress. By improving protein metabolism, sodium bicarbonate supplementation helps reduce these negative effects, promoting better overall health (Garcia *et al*., 2019) [5].

Incorporating sodium bicarbonate into the diet of dairy cattle can be a cost-effective strategy to enhance productivity and health. The improved feed efficiency and milk production observed in this study highlight the potential economic benefits for dairy farmers. However, it is important to tailor supplementation strategies to specific herd needs and management practices to maximize benefits. Further research is needed to determine the optimal dosage and administration methods of sodium bicarbonate supplementation. While the results of this study are promising, variations in diet composition, cow breed, and management practices can influence the effectiveness of sodium bicarbonate. Therefore, farmers should work with nutritionists to develop tailored supplementation plans that meet the specific needs of their herds.

Conclusion

Sodium bicarbonate supplementation in dairy cattle diets positively impacts feed intake, milk production, growth performance, and metabolic health. By maintaining optimal rumen pH and enhancing fiber digestibility, sodium bicarbonate supports the overall productivity and well-being of dairy cows. These findings underscore the importance of nutritional management in intensive cattle production systems and suggest that sodium bicarbonate can be a valuable tool in achieving sustainable and profitable dairy farming.

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