

Effect of Sodium Bicarbonate Supplementation On Subacute Ruminal Acidosis (Sara) of Milch Cattle



Veterinary Medicine

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ABSTRACT

Subacute ruminal acidosis (SARA) is one of the serious digestive disorders resulting from defective feeding management and causing heavy losses to the dairy farmers. Major reasons attributed for production losses are altered rumen fermentation with derangement of rumen fatty acid profile, dry matter intake depression, inflammatory reactions and allied health problems. Management of SARA in high yielding cows considered to be difficult, as to meet the increased energy requirements needs high carbohydrate diets. Rumen buffering with sodium bicarbonate is one cheaper and effective alternative option. Present study examined the efficacy of supplementation of sodium bicarbonate in SARA positive cattle at the rate of 100 grams daily orally on various haematological and production parameters as well rumen volatile fatty acid profile and serum acute phase proteins viz. serum Haptoglobin (Hp) and serum Amyloid A (SAA). Sodium bicarbonate supplementation to SARA affected animals showed considerable improvement in all parameters, when compared same with untreated controls. Significant improvements in rumen liquor pH, SAT, total protozoal count and significant reduction in SAA and Hp concentrations were observed in 72 hours of supplementation ($p \leq 0.05$).

Introduction

Subacute ruminal acidosis (SARA) is a common condition observed in high yielding exotic and cross bred cattle, characterized by periodic episodes of moderately depressed ruminal pH (about 5.2-5.6) that are between acute and chronic in duration (1, 2). Dietary requirements of energy and fiber are not easily met for the high yielding dairy cow. This is especially true for early lactation cows because their energy expenditure exceeds the energy consumed. Diets high in starch and low in fiber are fed to increase intake of energy, but these diets increase the risk of subacute ruminal acidosis (SARA). Subacute ruminal acidosis occurs when the production of fermentation acids exceeds the ability of the animal to remove or neutralize the acids produced (3). Sodium bicarbonate is an important endogenous buffer of ruminal pH (4) and it is also the most common buffer used in the dairy industry. Although addition of buffers to diets for lactating dairy cows has been extensively investigated the responses often varies, making it hard to determine if an optimal level of buffer addition exists for lactating dairy cows.

Materials and Methods

Apparently healthy milch cows with ruminal pH 5.2 to 5.6 and remains in the same range for minimum three hours were considered as SARA positive (5). Six animals positive for SARA were selected randomly and were administered 100 grams of sodium bicarbonate (50 grams twice daily) orally for three days as per the recommendations of Hu and Murphy (6), to study the effect of ruminal buffering on various physiological parameters. An equal number SARA positive animals were kept as untreated controls. Clinical materials viz. rumen liquor, whole blood in EDTA, serum and milk were collected from all the animals. Average daily milk yield was collected from farm records.

Rumen liquor was subjected to assessment of sedimentation activity time (SAT) (7), methylene blue reduction time (MBRT) (8) and protozoal count (9). Volatile fatty acid profile of rumen liquor was assessed by gas chromatography (10).

Various haematological parameters viz. total RBC count, total WBC count, total platelet count, haematocrit value, haemoglobin concentration and differential leukocyte count were estimated employing standard techniques. Milk fat percentage was

estimated using Electronic Milk Fat Tester (Rajasthan Electronic and Instruments Ltd, Jaipur, India).

Serum amyloid A estimation was done using Bovine serum Amyloid A (SAA) ELISA kit (Catalogue no. CSB-E08592b) from CUSA-BIO® and serum Haptoglobin (Hp) estimation was done using bovine Haptoglobin ELISA test kit from Immunology consultants laboratory, Inc, USA. Blood glucose estimation was done using Liquixx Glucose estimation kit by M/s Erba Manheim, Germany by Trinder's method (End point assay), in semi automatic chemistry analyzer LABMATE 10 PLUS.

The data obtained were analyzed using the statistical software viz. Microsoft excel 2007, SPSS version 20 and GraphPad Prism version 5.01 for windows. The data were analyzed by Student's t-test (Paired and independent) and Pearson's bivariate correlation and linear regression methods.

Results

Results of the treatment trials conducted in SARA positive cattle showed considerable improvement in all parameters compared to the untreated controls and the details are given in Table 1. Ruminal pH reduced significantly from 5.48 ± 0.14 to 6.67 ± 0.11 in treatment group after three days of supplementation of sodium bicarbonate.

Statistically significant improvement in rumen liquor pH, sedimentation activity time, total protozoal count, total erythrocyte count and haemoglobin concentration were noted while significant reduction in serum amyloid A and haptoglobin concentration occurred following intervention ($p \leq 0.05$). Considerable improvement in milk production and milk fat content were observed following supplementation.

There was increase in acetic acid and decrease in propionic acid concentration in rumen within 72 hours of sodium bicarbonate supplementation.

Discussion

SARA is mainly a chronic management issue and continuous management intervention in feeding practices and inclusion of rumen buffering agents are needed for long term solutions. Pe-

rusal of literatures fetched little information on post treatment improvements.

There is documentation showing that the addition of 150 g of sodium bicarbonate to the lactation feed per day had a positive effect on the milk yield (11). A positive effect of bicarbonate supplementation on feed intake and milk fat percentage has also been demonstrated (4).

Buffers, especially bicarbonate, may prevent an overgrowth of acid tolerant lactobacilli where feeding a high proportion of concentrate may cause a pH depression (12). Supplementation of sodium bicarbonate improved ruminal pH significantly ($p \leq 0.05$) from 5.67 ± 0.08 to 5.91 ± 0.08 (13). Bicarbonate supplementation has improved the dry matter intake along with milk yield and milk fat percentage. Ruminal pH increased 0.13 units, and the acetate to propionate ratio increased by 0.26 (6).

Combinations of several buffers are possible with a documented positive influence on milk yield, fat percentage and dry matter intake. In this trial, average daily milk production (corrected on 3.9 per cent milk fat) was 11.19 per cent higher in the experimental compared to control group of cows (14, 15).

Results of the present trials recommend supplementation of sodium bicarbonate in the diet of milch cattle as buffer to maintain ruminal pH in farms practicing feeding more of non fibre carbohydrates, which ensures optimum health and production.

Conclusions

Results of sodium bicarbonate supplementation to SARA affected animals showed considerable improvement in all parameters, when compared same with untreated controls. Significant improvements in rumen liquor pH, SAT, total protozoal count and significant reduction in SAA and Hp concentrations were observed in 72 hours of supplementation ($p \leq 0.05$). Though not statistically significant, increase in average daily milk yield as well as milk fat content were also recorded following supplementation. Total leukocyte count and differential granulocyte counts also reduced in treatment group after 72 hours. It can be concluded that sodium bicarbonate supplementation in feeds of high yielding exotic and cross bred cattle will be helpful in buffering the rumen and reversal of deleterious effects caused by SARA.

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Table 1: Effect of supplementing sodium bicarbonate on SARA in cattle

Parameter	Treatment group (n=6)		Untreated control group (n=6)	
	0 day	3rd day	0 day	3rd day
Milk yield (Litres/day)	9.42±0.30	10.25±1.04	12.58±1.19	11.00±1.13
Milk fat percentage	3.45±0.16	3.78±0.25	3.18±0.12	3.77±0.18
Rumen liquor pH	5.48±0.14 ^a	6.67±0.11 ^b	5.42±0.03	5.48±0.01
SAT (Min)	2.67±0.11 ^a	3.50±0.13 ^b	2.33±0.11	2.28±0.10
MBRT (Min)	3.83±0.33	2.92±0.20	3.33±0.21	3.75±0.17

Proto-zoal count ($\times 10^5$ /ml)	1.17±0.18 ^a	2.28±0.30 ^b	0.85±0.11	1.17±0.15
Total VFA (mmol/ml)	127.65±12.72	135.79±11.11	164.00±16.23	127.58±10.64
Acetic acid (mmol/ml)	77.59±3.21	90.49±7.05	102.71±8.85	85.84±6.46
Propionic acid (mmol/ml)	33.90±10.10	28.68±2.45	40.75±5.91	25.66±2.86
Bu-tyric acid (mmol/ml)	13.10±3.52	13.76±1.60	16.98±1.98	12.88±1.57
Total erythrocyte count ($\times 10^6$ /cmm)	5.22±0.24 ^a	6.17±0.50 ^b	5.62±0.34	6.00±0.64
Total leucocyte count ($\times 10^3$ /cmm)	12.75±1.76	12.30±1.46	12.70±0.64	13.92±1.66
Lymphocytes (%)	42.02±4.56	50.05±2.49	38.43±3.29	40.27±5.50
Mono-cytes (%)	7.03±0.58	6.90±1.01	6.43±0.74	7.53±1.08
Granulo-cytes (%)	50.95±4.34	43.05±2.97	55.13±3.76	52.20±5.13
Haemoglobin (g/dL)	7.80±0.70 ^a	8.58±0.69 ^b	8.20±0.39	8.53±0.7
PCV (%)	28.30±2.49	29.38±2.20	29.07±1.37	29.58±1.15
Platelets ($\times 10^3$ /cmm)	367.83±69.64	530.00±133.62	128.83±69.99	418.83±50.74
Serum amyloid A (mg/L)	25.03±4.27 ^a	14.82±1.57 ^b	17.25±4.75	21.23±2.94
Serum Haptoglobin (mg/L)	69.44±10.94 ^a	38.55±3.26 ^b	76.41±14.96	75.80±10.94
Blood glucose (mg/dL)	45.17±1.49 ^a	53.50±2.26 ^b	56.33±6.41	49.33±2.29
Means bearing different superscripts in a row differ significantly ($p \leq 0.05$)				

References

- GARRETT, E. F., PERREIRA, M. N., NORDLUND, K. V., ARMENTANO, L. E., GOODGER, W. J. and OETZEL, G. R., 1999. Diagnostic methods for the detection of subacute ruminal acidosis in dairy cows. *J. Dairy Sci.*, 82: 1170-1178
- NORDLUND, K. V., GARRETT, E.F. and OETZEL, G. R., 1995. Herd-based rumen-entesis: A clinical approach to the diagnosis of Sub acute rumen acidosis. *Compend. Contin.Educat.Pract. Vet. Food. Animal*, 17: 48-56
- ALLEN, M. S., 1997. Relationship between fermentation acid production in the rumen and the requirement for physically effective fibre. *J. Dairy. Sci.*, 80: 1447-1462
- ERDMAN, R. A., 1988. Dietary buffering requirements of the lactating cow: a review. *J. Dairy Sci.*, 71: 3246-3266
- GOZHO, G. N., PLAIZIER, J. C., KRAUSE, D.O., KENNEDY, A. D. and WITTENBERG, K.M., 2005. Subacute ruminal acidosis induces ruminal lipopolysaccharide endotoxin release and triggers an inflammatory response. *J. Dairy Sci.*, 88: 1399-1403
- HU, W., and MURPHY, M. R., 2005. Statistical evaluation of early- and mid-lactation dairy cow responses to dietary sodium bicarbonate addition. *Anim. Feed Sci. Technol.*, 119: 43-54
- NICHOLAS, R. E. and PENN, K. E., 1958. Simple methods for the detection of unfavorable changes in ruminal ingesta. *J. Am. Vet. Med. Assoc.*, 133: 275-277
- DIRKSEN, G., 1969. Methylene blue test for rumen function. Quoted in *Modern Vet. Practice. International Veterinary Reference Service*. A3 -443
- SANKARANARAYANAN, G. and NAMBIAR, K. T. K., 1972. Physico-chemical stud-

ies on rumen liquor. *Cherion*, 92-101

10. FILIPEK, J. and DVORAK, R., 2009. Determination of the Volatile Fatty Acid Content in the Rumen Liquid: Comparison of Gas Chromatography and Capillary Isotachopheresis. *Acta Vet. Brno.*, 78: 627-633
11. DOWNER, J. V. and CUMMINGS, K. R., 1985. A ten year review of lactation study. *J. Dairy Sci.*, 68 (Suppl. 1): 191-201
12. GARRY, F. B., 2002. Indigestion in ruminants. In: *Large Animal Internal Medicine*, ed. SMITH, B. P., 3rd edn. Mosby, St Louis and Baltimore pp 722-747
13. COTTEE, G., KYRIAZAKIS, I., WIDOWSKI, M., LINDINGER, M. I., CANT, J. P., DUFFIED, T. F., OSBORNE, V. R. and MCBRIDE, W., 2004. The effects of subacute ruminal acidosis on sodium-bicarbonate supplemented water intake for lactating dairy cows. *J. Dairy Sci.*, 87: 2248-2253
14. HUTJENS, M. F., 1991. Feed additives. *Vet. Clin. N. Am. - Food A.*, 7: 525-540. Cited by Enemark (2009)
15. PETRUJKIĆ, B., SAMANC, H., ADAMOVIĆ, M., STOJIĆ, V., PETRUJKIĆ, T., GRDOVIĆ, S., SEFER, D. and MARKOVIĆ, R., 2010. Effects of feeding buffering mineral mixture on subacute rumen acidosis and some production traits in dairy cows. *Jpn. J. Vet. Res.*, 58 (3-4): 171-7