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Clinical and hematological changes during therapeutic trial on ruminal acidosis in goats

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Abstract
The present study was conducted to estimate various hematological parameters in acidotic goats in Jaipur, Rajasthan during June, 2020 to December, 2020. A total of 50 clinical cases of ruminal acidosis of different age group, sex and irrespective of breed having the history of ingestion of large quantity of highly fermentable carbohydrate rich diet and showing acidic pH (5.5 or less) of rumen liquor were selected for present investigation. They were randomly divided into five groups of ten animals in each group. Ten healthy goats were also included as healthy control group in the study. Goats were treated with intravenous 7.5% sodium bicarbonate @ 0.9 ml/kg b.wt., oral rumen buffer with live yeast culture (Bufkind®) @ 1 gm/kg b.wt., oral dry ginger powder @ 500 mg/kg b.wt as electuary alone and combination of intravenous sodium bicarbonate with Bufkind and combination of intravenous sodium bicarbonate with dry ginger powder. Blood samples were collected at 0 hour before and at 24, 48 and 72 hours after initiation of treatment for hematological studies. Clinical examination revealed subnormal rectal temperature, increased pulse and respiration rate. Hematological profile of the acidotic goats revealed significant increase in haemoglobin (Hb), packed cell volume (PCV), total leucocyte count (TLC), total erythrocyte count (TEC), and significant increase in leucogram like neutrophilia, eosinophilia and monocytosis and significant decrease in lymphocytes. In all the groups clinical and haematological values were returned to normal physiological range after treatment. All the goats recovered well without any complications. Depending on changes in blood and rumen constituents the present study suggest a recommendation for using dry ginger powder supplementation as 500 mg/kg bwt orally along with intravenous 7.5% sodium bicarbonate @ 0.9 ml/kg b.wt. for treating ruminal acidosis in goats.

Keywords: Ruminal acidosis, clinical, hematological, sodium bicarbonate, oral rumen buffer with live yeast culture (Bufkind®), ginger

Introduction
Acidosis results in acidic pH of rumen liquor (normal rang 6.2-6.8) which is caused by feeding of readily fermentable carbohydrates, feeding of low fiber diet, poor management practices or a combination of these. Degree of acidosis varies from seriousness, a slight drop in feed intake (mild) to death (severe). Clinically it is manifested by indigestion, rumen stasis, toxemia, in-coordination, collapse and frequent death [32].The systemic effects of acidosis include changes in haemato-biochemical and rumen ecosystem (at pH of 5.5 or less), hyperkeratosis, liver abscesses, rumenitis and laminitis. It is very important to know the changes in haemato-biochemical parameters as it gives the actual physiological status of the body [3]. Rapid fermentation of carbohydrates alters the ruminal function through proliferation of acid resistant bacteria and an increase in the production of volatile fatty acids and D and L lactate, which cause a marked drop in ruminal pH to < 5.00 in most cases [14, 13]. Treatment is aimed to correcting the dehydration, acidic pH, toxemia and removing or neutralizing the offending feed stuffs. Intravenous fluid containing sodium bicarbonate or oral rumen buffers or oral natural herbs like ginger should be administered. Intra ruminal antibiotics have been recommended to kill gram positive bacteria (lactic acid producing bacteria) [15]. Current scientific research highlights the potential significance of using plant-based medicine to enhance rumen function in ruminants. These methods have the advantage of utilizing locally available plants with high medicinal properties.

Materials and Methods

The work was conducted at the Veterinary Clinical Complex (VCC), Department of Veterinary Medicine Post Graduate Institute Veterinary Education and Research (PGIVER) Jaipur Rajasthan during June, 2020 to December, 2020. In the present investigation, goats of different age, sex, irrespective of breed having the history of ingestion of excess of highly fermentable carbohydrate rich diet were screened. Total 50 goats having rumen liquor pH below 5.5 were selected for the study and were randomly divided in to five groups of 10 each. The treatment protocol for group-1 goats, was intravenous 7.5% sodium bicarbonate @ 0.9 ml/kg b.wt., for group-2 goats oral rumen buffer with live yeast culture (Buffkind®) @ 1 g/kg b. wt., for group-3, intravenous 7.5% sodium bicarbonate @ 0.9 ml/kg b.wt. in combination with Buffkind® @ 1 g/kg b. wt., for group-4 oral dry ginger powder @ 500 mg/kg b. wt., and for group-5 intravenous 7.5% sodium bicarbonate @ 0.9 ml/kg b.wt. in combination with oral dry ginger powder @ 500 mg/kg b. wt.. Treatment was given at 0 hour, 24 hour, 48 hour and 72 hour along with common supportive therapy comprising of fluid therapy, antibiotics, antihistaminics and multivitamins. 10 healthy goats were also selected as healthy control group.

Sampling Procedure

Collection of blood and serum

For haematological parameters, 5 ml blood was collected in sterilized test tube containing disodium salt of ethylene diamine tetra acetic acid (EDTA) as an anticoagulant from ruminal acidosis affected goats at 0 hour before, and at 24 hour, 48 hour and 72 hour after initiation of treatment. The blood samples were also collected from 10 healthy goats (Healthy control group) as described above and subjected for the estimation of haematological.

The data obtained were statistically analyzed for ANOVA [28]. Means showing significant differences were compared by Duncan's New Multiple Range Test [11]. Statistical significance was accepted at $p \leq 0.05$.

Results

Comparison between healthy control group and the Group - 1,2,3,4, and 5 (table-1) at 0 hour before treatment showed subnormal rectal temperature, significant increase in pulse rate, respiration rate, haemoglobin, packed cell volume, total leucocyte count, total erythrocyte count, differential leucocyte count, and significant decrease in lymphocytes, blood pH, rumen liquor pH. Similar findings were observed by earlier researchers [16, 8, 20, 4, 19].

Table 1: Comparison of healthy control with '0' hour (Before treatment) values

S. No.	Parameters	Healthy Group (N=10)	Group-1 (N=10)	Group-2 (N=10)	Group-3 (N=10)	Group-4 (N=10)	Group-5 (N=10)
1.	Hb	11.3±0.21^{aA}	13.28±0.33	13.55±0.29	14.47±0.21^{cC}	12.25±0.20	15±0.16^{dD}
2.	PCV	32.6±0.94^{aA}	39.94±0.63	41.15±0.66	43.5±0.70	35.9±0.58^{B}	46.5±1.06^{d}
3.	TLC	9.8±0.16^{aA}	12.4±0.33	13.2±0.35	14.1±0.41^{c}	12.6±0.22	15.35±0.29^{dD}
4.	TEC	11.1±0.30^{aA}	14.15±0.24	12.8±0.67	11.95±0.51^{b}	11.1±0.27	13.9±0.27^{C}
5.	Neutrophils	40.2±0.78^{aA}	60.9±0.91^{d}	60.4±0.76	61.1±0.72^{b}	60.8±0.53	58.2±0.87^{d}
6.	Lymphocytes	52.5±0.81^{aAB}	29.1±1.00^{a}	29.9±0.72^{a}	30±0.78^{a}	30.7±0.44^{a}	31.4±0.84^{a}
7.	Monocytes	3.15±0.21^{aA}	4.7±0.36	4±0.14	3.2±0.2	3.6±0.16	4.3±0.39
8.	Eosinophils	4.15±0.10^{aA}	5.3±0.21	5.7±0.15	5.7±0.15	4.9±0.17^{B}	6.1±0.17^{D}
15.	Blood pH	7.31±0.031^{aA}	6.9±0.025^{a}	6.88±0.02^{a}	6.85±0.02^{a}	6.79±0.08	6.88±0.03^{a}
16.	Rumen liquor pH	6.9±0.03^{aC}	4.7±0.3	5.1±0.16^{a}	4.85±0.16^{a}	4.5±0.29	5.04±0.84^{aB}
17.	Temperature	102.1±0.12^{aB}	100.9±0.23	100.9±0.23	101.19±0.30^{a}	101.2±0.2	102.4±0.19
18.	Pulse	76.4±1.51^{aA}	108.6±1.46^{d}	108.4±1.42	108.2±1.94^{d}	109.2±1.71^{cE}	104±1.76^{B}
19.	Respiration	28.4±1.25^{aA}	39.6±0.4	40±0.42	40.2±0.46^{c}	39.6±0.4	38.8±0.90

Mean bearing same superscript do not differ significantly

The therapeutic efficacy of various types of drugs used against ruminal acidosis in goats was assessed based on clinical improvement, resumed appetite, reduction in the degree of dehydration, consistency of faeces normal, normal temperature, respiration and pulse rate. Improvement in clinical, rumen liquor, haematological their reversal to normalcy and overall clinical recovery was observed after 72 hours of treatment within and between groups.

After treatment, acidosis affected goats in the treatment groups showed gradual improvement as indicated by the changes in the, Mean ± SE values of different parameters in order to assess the efficacy of treatment in the treated Groups, Mean ± SE values of 19 parameters were compared at 24 hours, 48 hours, and 72 hours after treatment in groups receiving treatment with healthy control Group.

Table 2: Comparison of healthy control with '24' hours (After treatment) values

S. No.	Parameters	Healthy Group (N=10)	Group-1 (N=10)	Group-2 (N=10)	Group-3 (N=10)	Group-4 (N=10)	Group-5 (N=10)
1.	Hb	11.1±0.48^{aA}	13±0.29	13.45±0.28	11±0.24^{bA}	12.95±0.26	13±0.16^{cB}
2.	PCV	32.4±0.97^{aA}	39.1±0.52	40.6±0.52^{C}	35.6±1.12^{b}	36.5±0.58	43.1±1.27^{c}
3.	TLC	9.6±0.49^{aA}	12±0.21	13±0.29	10.2±0.31^{b}	13.1±0.23	14±0.24^{c}
4.	TEC	10.9±0.54^{aAB}	13.05±0.05	12.6±0.65	10.15±0.38^{A}	11.6±0.30	13±0.26^{f}
5.	Neutrophils	40±0.98^{aA}	56±1.35^{bB}	58.2±0.64^{c}	40±1.01^{A}	56.3±0.51	54.8±0.92^{c}
6.	Lymphocytes	52±0.77^{aD}	34.4±1.48^{b}	32.6±0.63^{b}	52.2±0.96^{D}	35.5±0.5^{b}	35.9±0.84^{b}
7.	Monocytes	2.85±0.42^{aA}	4.7±0.15	3.6±0.16	3.1±0.1^{A}	3.6±0.16^{b}	3.9±0.27
8.	Eosinophils	3.95±0.39^{aA}	4.3±0.26	5.6±0.16	4.7±0.15	4.6±0.16	5.6±0.22
15.	Blood pH	7.24±0.05^{aE}	7.05±0.02^{b}	6.98±0.02	7.11±0.031^{b}	6.89±0.02^{A}	7.03±0.02^{b}
16.	Rumen liquor pH	6.85±0.05^{aD}	5.25±0.23^{B}	5.6±0.16	5.95±0.15	5.15±0.15	5.75±0.14^{b}
17.	Temperature	101.74±0.21^{aB}	101.09±0.12	100.93±0.13	102.02±0.26^{b}	100.91±0.24	102.85±0.13^{C}
18.	Pulse	75.3±1.24^{aA}	103.8±1.69^{c}	106±1.63^{E}	98.4±0.97^{c}	105.2±1.74	102±1.65^{b}
19.	Respiration	28±0.66^{aA}	37.6±0.4	39±0.33	32.2±1.13^{bB}	39.8±0.46	38.2±1.24

Mean bearing same superscript do not differ significantly

Table 3: Comparison of healthy control with '48' hours (After treatment) values

S. No.	Parameters	Healthy Group (N=10)	Group-1 (N=10)	Group-2 (N=10)	Group-3 (N=10)	Group-4 (N=10)	Group-5 (N=10)
1.	Hb	11.1 ± 0.48^{aB}	11.9 ± 0.17^{bB}	12.95 ± 0.25	9.6 ± 0.24	13 ± 0.29	11.15 ± 0.25^{b}
2.	PCV	32.2 ± 1.12^{aA}	38 ± 0.57^{C}	39.4 ± 0.58	31.4 ± 1.00^{A}	37.15 ± 0.43	39.9 ± 1.32^{b}
3.	TLC	9.6 ± 0.52^{aA}	11 ± 0.29	12.5 ± 0.16	9 ± 0.14^{A}	14.76 ± 0.22^{cC}	13 ± 0.36^{b}
4.	TEC	10.9 ± 0.54^{aB}	12 ± 0.21^{B}	12.1 ± 0.58	9.55 ± 0.32^{A}	11.7 ± 0.26	11.9 ± 0.27^{b}
5.	Neutrophils	40 ± 0.98^{aA}	50.9 ± 0.88^{c}	53.8 ± 0.81^{b}	38.7 ± 0.59^{A}	56.2 ± 0.64	45 ± 0.86^{bB}
6.	Lymphocytes	52.3 ± 0.78^{aD}	40.3 ± 0.88^{c}	35.4 ± 0.58^{cA}	54.3 ± 0.59^{D}	38.4 ± 0.81^{cB}	46.1 ± 0.92^{c}
7.	Monocytes	2.95 ± 0.43^{aA}	4.5 ± 0.16^{D}	3.35 ± 0.15	3 ± 0.0	3.5 ± 0.16	3.7 ± 0.3^{D}
8.	Eosinophils	3.85 ± 0.40^{A}	4.9 ± 0.37	5.05 ± 0.18	4 ± 0.0	4.3 ± 0.21	5 ± 0.0^{b}
15.	Blood pH	7.24 ± 0.04^{aC}	7.17 ± 0.03^{c}	7.08 ± 0.02	7.41 ± 0.01^{D}	7.07 ± 0.08	7.21 ± 0.02^{c}
16.	Rumen liquor pH	6.88 ± 0.05^{aC}	5.69 ± 0.16	5.95 ± 0.12	6.84 ± 0.06^{c}	5.6 ± 0.14	5.91 ± 0.09
17.	Temperature	101.6 ± 0.12^{aA}	101.61 ± 0.13	101.33 ± 0.09	102.83 ± 0.14^{cB}	101.62 ± 0.13	101.55 ± 0.15
18.	Pulse	77.3 ± 1.24^{aA}	98.4 ± 0.49^{b}	99.2 ± 0.32^{b}	90 ± 0.0^{bB}	104.4 ± 1.83^{E}	97 ± 0.80^{a}
19.	Respiration	29 ± 1.19^{aAB}	35 ± 0.68^{b}	37.4 ± 0.66	28.2 ± 0.55	39.6 ± 0.4^{D}	32.2 ± 1.13

Mean bearing same superscript do not differ significantly

Table 4: Comparison of healthy control with '72' hours (After treatment) values

S. No.	Parameters	Healthy Group (N=10)	Group-1 (N=10)	Group-2 (N=10)	Group-3 (N=10)	Group-4 (N=10)	Group-5 (N=10)
1.	Hb	11.1 ± 0.48^{aC}	10.1 ± 0.23^{aB}	11.9 ± 0.17^{a}	9.1 ± 0.20	13.5 ± 0.23	9.6 ± 0.16^{a}
2.	PCV	32.4 ± 1.07^{aB}	33.6 ± 1.04^{a}	35.2 ± 0.71^{a}	29 ± 1.22^{A}	37.15 ± 0.43	31.8 ± 1.00^{a}
3.	TLC	9.6 ± 0.52^{aA}	10.6 ± 0.26^{C}	11.5 ± 0.16^{aD}	8.7 ± 0.21^{A}	13.65 ± 0.13^{E}	9.9 ± 0.27^{a}
4.	TEC	10.9 ± 0.54^{aAB}	10 ± 0.21^{a}	11.1 ± 0.58	9.3 ± 0.26	12.56 ± 0.25^{CD}	9.7 ± 0.21^{a}
5.	Neutrophils	40 ± 0.98^{aAB}	40.8 ± 0.74^{a}	42 ± 0.69^{a}	38.4 ± 0.56^{A}	51.3 ± 1.21^{bC}	39 ± 0.93^{a}
6.	Lymphocytes	52.3 ± 0.86^{aBC}	51.6 ± 0.73^{d}	40.9 ± 1.19^{dA}	54.8 ± 0.57	50 ± 0.49^{d}	53.6 ± 1.13^{d}
7.	Monocytes	2.95 ± 0.48^{aA}	3.6 ± 0.16^{a}	3.1 ± 0.1	2.8 ± 0.13	3.5 ± 0.16	3.2 ± 0.13^{b}
8.	Eosinophils	3.95 ± 0.36^{aA}	4 ± 0.25	4.7 ± 0.15	4 ± 0.0	4.5 ± 0.22	4.2 ± 0.13^{a}
15.	Blood pH	7.23 ± 0.05^{aC}	7.28 ± 0.03^{dD}	7.17 ± 0.01^{B}	7.43 ± 0.02	7.03 ± 0.06^{A}	7.38 ± 0.02^{d}
16.	Rumen liquor pH	6.9 ± 0.03^{aB}	6.1 ± 0.03	6.2 ± 0.02	7.31 ± 0.03^{C}	5.95 ± 0.15^{b}	6.95 ± 0.05^{c}
17.	Temperature	101.75 ± 0.12^{aA}	102.01 ± 0.04	101.66 ± 0.14	103.38 ± 0.09^{Db}	101.45 ± 0.23	101.96 ± 0.12
18.	Pulse	77.4 ± 1.51^{aA}	93.4 ± 1.15^{aB}	95.8 ± 1.00	76.4 ± 1.51^{a}	102.6 ± 1.63^{C}	78 ± 2^{a}
19.	Respiration	27.1 ± 1.1^{aA}	29.2 ± 1.2^{a}	31 ± 1.16^{aB}	26 ± 0.66	36 ± 1.33^{C}	26.6 ± 0.52

Mean bearing same superscript do not differ significantly

Comparison between healthy control group and the Group-1 (Sodium bicarbonate) goats at 24 hours after treatment (table-2) showed significant difference ($p\leq0.05$) in four parameters (Neutrophils, lymphocytes, blood pH, pulse) out of thirteen parameters and non-significant difference in rest parameters. At 48 hours after treatment showed significant difference ($p\leq0.05$) in seven parameters (Hb, PCV, Neutrophils, lymphocytes, blood pH, pulse, and respiration) and non-significant difference are rest parameters. At 72 hours after treatment showed significant difference ($p\leq0.05$) in only two parameters (lymphocytes, blood pH) and non-significant difference are rest parameters. Comparison between healthy control group and the Group-2(Buffkind) goats at 24 hours after treatment showed significant difference ($p\leq0.05$) in two parameters (Neutrophils, lymphocytes) out of thirteen parameters and non-significant difference in rest parameters. At 48 hours after treatment showed significant difference ($p\leq0.05$) in three parameters (Neutrophils, lymphocytes, pulse) and non-significant difference in other parameters. At 72 hours after treatment showed significant difference ($p\leq0.05$) in only one parameter (lymphocytes) and non-significant difference are rest parameters.

Comparison between healthy control group with the Group-3(Sodium bicarbonate + Buffkind) goats at 24 hours after treatment showed highly significant difference ($p\leq0.05$) in eight parameters (Hb, PCV, glucose, TLC, blood pH, temperature, pulse, respiration) out of thirteen parameters and non-significant difference in rest parameters. At 48 hours after treatment showed highly significant difference ($p\leq0.05$) in three parameters (rumen liquor pH, temperature, and pulse) and non-significant difference in other parameters. At 72 hours after treatment showed significant difference ($p\leq0.05$) in only one parameter (temperature) and non-significant difference are rest parameters. Comparison between healthy control group and the Group-4 (Ginger) goats at 24 hours after treatment showed significant difference ($p\leq0.05$) in only two parameters (lymphocytes, monocytes) out of thirteen parameters and non-significant difference in rest parameters. At 48 hours after treatment showed significant difference ($p\leq0.05$) in two parameters (TLC, lymphocytes) and non-significant difference in other parameters. At 72 hours after treatment showed significant difference ($P\leq0.05$) in only three parameters (Neutrophils, lymphocytes, rumen liquor pH) and non-significant difference are rest parameters. This group showed increase in four parameters (Hb, PCV, TLC, and TEC) rather than decrease. While do not reach normalcy in ten parameters. Comparison between healthy control group and the Group-5(Sodium bicarbonate + Ginger) goats at 24 hours after treatment showed highly significant difference ($p\leq0.05$) in nine parameters (Hb, PCV, TLC, TEC, Neutrophils, lymphocytes, blood pH, rumen liquor pH, pulse) out of thirteen parameters and non-significant difference in rest parameters. At 48 hours after treatment showed highly significant difference ($p\leq0.05$) in eight parameters (Hb, PCV, TLC, TEC, Neutrophils, lymphocytes, Eosinophils, blood pH) and non-significant difference in other parameters. At 72 hours after treatment showed significant difference ($p\leq0.05$) in only four parameters (lymphocytes, monocytes, blood pH, rumen liquor pH) and non-significant difference in nine parameters.

Discussion

Group-1 showed gradual improvement in health status at 48 hours post treatment. Administration of intravenous Sodium bicarbonate neutralized the lactic acid produced locally inside the rumen to prevent chemical ruminitis and to restore normal ruminal pH, which reduced the effect of metabolic / systemic acidosis [30, 24, 7, 2, 9, 15, 17, 32].

Group-2 also showed gradual improvement in health status at 48 hours post treatment. Buffkind powder is a buffering oral drug containing ideal rumen buffer, metabolic booster and yeast are used for the management of ruminal acidosis. It's having alkalizing substances which cause increase in rumen liquor pH. Similar treatment was advocated by many earlier researchers [23, 15].

Group-3 and 5 showed gradual improvement in health status at 24 hours post treatment.

It was concluded that ruminal acidosis is a common disease of goats and its severity can be effectively reduced by combination of either Bufkind or ginger and sodium bicarbonate along with supportive therapy [33].

Group-4 goats receiving ginger treatment showed slow response as compared to other groups but combination with sodium bicarbonate had increased its efficacy.

Ginger has antioxidant, anti-inflammatory, antitumor, pain-relieving, liver-protecting activities and antimicrobial effect [22]. Ginger is one of most alkaline herbs [31]. Ginger stimulates the flow of saliva, bile, and gastric secretions and therefore is traditionally used to stimulate appetite, reduce flatulence, colic, and gastrointestinal spasms, and generally act as a digestive aid as opined by earlier workers [5]. In recent years, several studies have focused on ginger's potential in rumen fermentation modification [12, 29] but previous studies have not concentrated on ginger's impact on acid-base balance. A study was applied to investigate the effect of ginger powder (*Zingiber officinale*) @ 500 mg/kg bwt orally supplement for 5 days on (acid-base balance), rumen (physical, cellular,), and blood constituents in apparently healthy Egyptian sheep. Depending on changes in blood and rumen constituents it was recommended for using ginger supplementation as 500 mg/kg b. wt orally for 3-5days as an immune stimulant and in the treatment of rumen acidosis and respiratory affections in sheep [34].

Conclusion

Goats belonging to group 1,2,3,4 and 5 were observed during the therapy. Improvement in appetite, rumination and haemato parameters were noticed in group 3 and 5 next day after treatment. Whereas, the group 1 goats receiving Sodium bicarbonate, group 2 receiving bufkind and group 4 receiving ginger had shown slow recovery in symptoms at 48 and 72 hours post treatment as compared to group 3 and 5 goats. Improvement in haemato parameters, their reversal to normalcy and overall clinical recovery was also evaluated at 24, 48 and 72 hours of treatment within and between groups. Combination of Buffkind with Sodium bicarbonate and combination of Sodium bicarbonate with Ginger along with supportive therapy was found to produce remarkable changes in clinical signs, physical activity, rumen liquor parameters and haemato parameters and resumed to normalcy during the present study in goats. Hence, it is concluded that therapeutic regimen as formulated in present investigation can be recommended for the treatment of ruminal acidosis in goats under field conditions.

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