EFFICACY OF SODIUM BICARBONATE AND DETERMINATION OF HAEMATOLOGICAL PARAMETERS AGAINST FOOT-AND-MOUTH DISEASE VIRUS IN CATTLE

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Abstract

Foot-and-mouth disease (FMD) is the most economically important animal pathogen in Bangladesh. The present study was to investigate the effect of sodium bicarbonate against the FMD virus and determine the haematological parameters in cattle. In this study, 200 cattle were selected and divided into 5 groups in 7 different areas of Bangladesh to determine the preventive and therapeutic efficacy of sodium bicarbonate. Four groups of cattle were treated with sodium bicarbonate at 10 gm/L for a preventative dose and at 20 gm/L for a therapeutic dose and observed at 7 days' intervals. All the blood parameters were studied on day 0 (pre-treatment), day 14, and day 21. The morbidity and mortality rates of the cattle were significantly ($P < 0.001$) reduced during the period of use of sodium bicarbonate as a prophylactic and therapeutic agent in the 4 groups of cattle. In evaluating the efficacy of sodium bicarbonate as a preventive measure for FMD at a dose rate of 10 gm/L, water is better than the therapeutic measure. These findings indicate that the oral administration and wash with sodium bicarbonate affected the tongue and foot for 10 days and, as a result, significantly decreased the morbidity and mortality of the cattle. This preparation also increased the differential leukocytes count of the blood as a prophylaxis dose and decreased the lymphocyte as a therapeutic dose in the cattle.

Keywords: FMD virus, sodium bicarbonate, prophylaxis, therapeutic, blood parameter

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Introduction

Foot-and-mouth disease (FMD) is one of the major constraints for livestock development in Bangladesh. Outbreaks of this disease cause severe economic losses to the livestock industries in terms of loss of draft power, meat and milk production, and infant and adult animal mortality. About 1.5 million US$ in economic losses is incurred per year due solely to the outbreak of FMD in Bangladesh (Bangladesh Bureau of Statistics, 1999). Foot-and-mouth disease virus (FMDV), a member of the *Aphthovirus* genus within the Picornaviridae family, is the causative agent of FMD, one of the world's most important infectious animal diseases, responsible for huge global losses of livestock production and trade, as well as frequent and highly disruptive large-scale epidemics (Belsham, 1993; Knowles *et al*., 2003). The disease is characterised by a short-lasting fever, epithelial lesions on the tongue, dental pad, and inner mouth area leading to excessive salivation and drooling, and lesions on the feet causing lameness. Secondary infection of epithelial lesions can significantly increase the severity of the disease (Sobrino and Domingo, 2004; Ryan *et al*., 2008). According to the antigenic properties of the capsid proteins, FMDVs are classified into 7 serological types, namely O, A, C, Asia-1, and SAT 1, SAT 2, and SAT 3 (Murphy, 1999; Mittal *et al*., 2005). All FMD serotypes are immunogenically different and vaccination with 1 serotype does not develop immunity against another serotype or subtypes of a serotype (Paton *et al*., 2005). The genome of the FMDV is subject to a high rate of mutation because the FMDV RNA-dependent RNA polymerase lacks proofreading ability. Based on the phylogenetic analysis of the VP1 gene sequence, the FMDV serotype A is classified into 10 major genotypes (I–X) (Tosh *et al*., 2002; Kitching, 2005), the FMDV serotype O is classified into 10 topotypes, designated as Europe-South America (Euro-SA), Middle East-South Asia (ME-SA), Southeast Asia (SEA), Cathay (CHY), West Africa (WA), East Africa 1 (EA-1), East Africa 2 (EA-2), East Africa 3 (EA-3), Indonesia-1 (ISA-1), and Indonesia-2 (ISA-2) (Knowles *et al*., 2005), and the FMDV serotype Asia 1 is grouped into 6 genotypes (I-VI) [11] (Valarcher *et al*., 2009). The geographical distribution of the FMD serotypes is as follows: Asia (A, O, and Asia 1), Europe (A, O, and C), Africa (A, O, SAT- 1, SAT2, and SAT3), and South America (A, O, and C) (Fenner *et al*., 1993).

Despite regular vaccination, outbreaks of this disease have become regular events throughout the country every year. The frequent outbreaks of the disease may be due to the introduction of new mutant viruses which are the result of inappropriate serotypes used for vaccine preparation or importation of vaccines of heterologous strains from abroad. Moreover, significant numbers of cattle and buffaloes have been entering Bangladesh from India every year either through proper or improper channels which directly or indirectly serve as a source of the introduction of new viruses. According to Islam *et al*. (2000), serotypes A and O of the FMDV were prevailing at that time in the country. From the year 2000 until now, no systematic research has been conducted to study the molecular epidemiology of the FMDV in Bangladesh. We do not have any recent database about the serotypes of the FMDV currently circulating among the livestock population of Bangladesh. The epidemiology and aetiology of FMD have been extensively investigated (Barnett and Cox, 1999; Yang *et al*., 1999). However, there are few published reports on the haematological and biochemical parameters of cattle with FMD (Sahal *et al*., 1994; Elitok *et al*., 1999).

Therefore, this disease has become an alarming threat to livestock animals all over the world. The present study was aimed and designed to determine the efficacy of sodium-bicarbonate as a prophylactic and therapeutic agent against FMDVs and to find out the haematological parameters.

Materials and Methods

Study Area

This study was conducted in 7 different areas:- Amirandangory, Kazigram, Bayara, and Chakrampur Bahadurpur in Trishal Upazila and Noyabazar, Banghamari char (river island),

and Sadar in Mymensingh district, Bangladesh, during the period from September, 2007 to March, 2008.

Selection of Animals

Two hundred cattle were selected for study and were divided into 4 groups on the basis of age, sex, breed, and nutritional status. The groups were:- Group-A: 1-3 weeks; Group-B: 1-5 months; Group-C: 6-11 months; and Group-D: over 1 year on the basis of ages and sex. On the basis of breed, the cattle were divided into local breed and cross-breed. On the basis of nutritional status, the cattle were divided into healthy and cachexic. One group that was untreated with sodium bicarbonate was named as group E.

Selection of Drugs and Chemicals

The chemical which was selected for prevention and therapy uses was sodium bicarbonate. The routes of administration of the chemical were externally and internally. External administration of the chemical was a wash that affected the tongue and feet with a 2% sodium bicarbonate solution 3-5 times per day. Internal administration of the chemical was 2% sodium bicarbonate orally in 1 litre of water twice daily for 7-10 days. The dosage for the prophylaxis was 10 g/L of water for 7-10 days twice daily. The dosage for the therapeutic agent was 20 g/L of water for 7-10 days twice daily.

Use of Sodium Bicarbonate as a Prophylactic and Therapeutic Agent

Sodium bicarbonate was purchased from the local market under the name of sodi-bicarb (K.H. Chemicals, Bangladesh) and 20 gm sodi-bicarb was mixed with 1 litre of drinking water to make a 2% sodium bicarbonate solution; and to make a 1% sodium bicarbonate solution, 10 gm was mixed with 1 litre of water. Groups A, B, C, and D were treated with the sodium bicarbonate oral administration at the dose rate of 10 gm/L water (prophylactic dose) and 20 gm/L water (therapeutic dose) twice daily for 7-10 days and the blood parameters' total erythrocytes count (TEC), total leukocytes count (TLC), haemoglobin (Hb) %, and differential leukocytes count (DLC) at day 0, day 14, and day 21. Group E was the control group and was not treated.

Collection of Blood Samples

Blood was collected aseptically with a sterile syringe and needle from the jugular vein of the 5 groups of cattle at the time of the administration of the prophylactic and therapeutic doses on day 0, 14, and 21 after administration of the sodium bicarbonate. Immediately after collection, the blood was transferred to a sterile test tube containing an anticoagulant 1:10 (4% sodium citrate solution). The haematological studies were performed within as short a time as possible in the pharmacology laboratory of Bangladesh Agricultural University, Mymensingh, Bangladesh.

Determination of Various Haematological Parameters

The haematological parameters such as TEC, TLC, Hb%, and DLC were determined following the methodology of Coffin, 1955.

Statistical Analysis

The data were analyzed statistically between normal and treated values by the well-known Student's t-test.

Results and Discussions

The present study was undertaken to demonstrate the antiviral effects of sodium bicarbonate against FMD. To perform the experiment, cattle were randomly divided into 5 equal groups A, B, C, D, and E (control). After administration of sodium bicarbonate to 4 groups of cattle as a prophylactic dose of 10 gm/L water and as a therapeutic dose of 20 gm/L water, the control and treated groups of cattle were closely observed for 14 days after treatment and blood parameters were investigated as per schedule.

During prophylaxis, the pre-treatment mean values of the erythrocytes (million/ mm^3 of blood) were 5.89±0.04, 5.59±0.05, 5.58±0.03, and 5.69±0.02 in groups A, B, C, and D, respectively (Table 1). On the 21st day of the post-treatment, the mean values of the TEC had increased to 6.05±0.06, 5.65±0.03, 5.70±0.04, and 5.75±0.07 in groups A, B, C,

and D, respectively. In this study, changes in the TEC (million/ mm^3 of blood) were observed in the treated groups of cattle and this might be due to increased ruminal metabolism. The mean value of the TEC in group E (control group) was 5.69±0.08 but the mean value of the TEC gradually decreased and on the 21st day was 5.64±0.02 due to a decreased metabolism. The mean values of the TEC are in high agreement with the results reported by Whittington and Grant (1983).

Leukocyte values during pre-treatment (thousand per mm3) were 7.58±0.04, 6.89±0.08, 6.51±0.09, and 6.35±0.05 in groups A, B, C, and D, respectively. On the 21st day of the post-treatment, the mean values of the TLC had increased to 7.61±0.07, 6.95±0.04, 6.60±0.03, and 6.42±0.09 in groups A, B, C, and D, respectively (Table 1). In this study, changes in the TLC (thousand/ mm^3 of blood) were observed in the treated groups of cattle and this might be due to the development of natural immunity. The mean value of the TLC in group E (control group) was 6.33±0.06 but the mean value of the TLC gradually decreased and on the 21st day was 6.29±0.04 due to the vulnerability of immunity. These findings are in partial agreement with the results reported by Whittington and Grant (1983).

The pre-treatment mean values of hemoglobin percent were 8.23±0.07, 8.19±0.04, 8.13±0.05, and 8.14±0.06 in groups A, B, C, and D, respectively. On the 21st day of the post-treatment, the mean values of Hb% had increased to 8.30±0.04, 8.25±0.05, 8.18±0.06, and 8.20±0.04 in groups A, B, C, and D, respectively (Table 1). In this study, changes in the TEC (million/ mm^3 of blood) were

Table 1. Effect of sodium bicarbonate on different blood parameters during prophylactic and therapeutic doses in cattle

Group	Blood parameter	Pre- and Post-treatment period					
		Prophylactic value (Mean ± SE)			Therapeutic value (Mean ± SE)		
		Day 0	Day 14	Day 21	Day 0	Day 14	Day 21
A	TEC	5.89±0.04	6.01±0.03*	6.05±0.06**	6.24±0.04	7.35±0.09	8.50±0.05**
	TLC	7.58±0.04	7.60±0.03**	7.61±0.07**	8.26±0.08	8.20±0.05	8.15±0.08
	Hb%	8.23±0.07	8.25±0.07	8.30±0.04**	8.49±0.09	8.55±0.08	8.60±0.09**
B	TEC	5.59±0.05	5.60±0.02	5.65±0.03**	5.91±0.06	6.75±0.07	7.25±0.07**
	TLC	6.89±0.08	6.91±0.08*	6.95±0.04**	8.11±0.07	8.05±0.05	8.00±0.09
	Hb%	8.19±0.04	8.20±0.06	8.25±0.05**	8.48±0.07	8.55±0.05*	8.58±0.05**
C	TEC	5.58±0.03	5.63±0.07**	5.70±0.04**	6.16±0.07	7.25±0.06	8.30±0.06**
	TLC	6.51±0.09	6.55±0.07**	6.60±0.03**	8.02±0.09	8.00±0.06	7.90±0.06**
	Hb%	8.13±0.05	8.15±0.05**	8.18±0.06**	8.45±0.06	8.50±0.04**	8.55±0.05*
D	TEC	5.69±0.02	5.70±0.09**	5.75±0.07**	6.20±0.02	7.30±0.07	8.30±0.04**
	TLC	6.35±0.05	6.40±0.04**	6.42±0.09*	8.04±0.08	7.95±0.07	7.90±0.05
	Hb%	8.14±0.06	8.18±0.03**	8.20±0.04*	8.39±0.06	8.45±0.05**	8.49±0.07**
E (Control)	TEC	5.69±0.08	5.65±0.01	5.64±0.02	6.21±0.08	6.15±0.05	6.10±0.03
	TLC	6.33±0.06	6.30±0.04	6.29±0.04	8.25±0.06	8.50±0.05*	8.55±0.05*
	Hb%	8.22±0.04	8.20±0.04	8.15±0.07	8.42±0.05	8.30±0.06	8.25±0.07

*Significantly increased at ($P < 0.05$), **Significantly increased at ($P < 0.01$)

observed in the treated groups of cattle and this might be due to increased ruminal metabolism. The mean value of Hb% in group E (control group) was 8.22±0.04 but the mean value of Hb% gradually decreased and on the 21st day was 8.15±0.07 due to a decreased metabolism. The results of the study highly agree with the findings of Whittington and Grant (1983). Since the lymphocytes gradually increased, it indicates that the sodium bicarbonate enhanced the immunity of the body and the gradual increase in the eosinophils may be due to parasitic infestation (Table 2). The results of these findings partial agree with the results reported by Whittington and Grant (1983).

During the therapeutic treatment, the pre-treatment mean values of the TEC (million/ mm^3 of blood) were 6.24±0.04, 5.91±0.06, 6.16±0.07, and 6.20±0.02 in groups A, B, C, and D, respectively (Table 1). On the 21st day of the post-treatment, the mean values of the TEC had increased to 8.50±0.05, 7.25±0.07, 8.30±0.06, and 8.30±0.04 in groups A, B, C, and D, respectively. In this study, changes in the TEC (million/ mm^3 of blood) were observed in the treated groups of cattle and this might be due to the increased demands of the body. The mean value of the TEC in group E (control group) was 6.21±0.08 but the mean value of the TEC gradually decreased and on the 21st day was 6.10±0.03. The results of the study highly agree with the findings of Gokce *et al*. (2004).

The TLC values (thousand per mm^3.) were 8.26±0.06, 8.11±0.07, 8.02±0.09, and 8.04±0.08 in groups A, B, C, and D, respectively, during pre-treatment. On the 21st day of the post-treatment, the mean values of the TLC had decreased to 8.15±0.08, 8.00±0.09, 7.90±0.06, and 7.90±0.05 in groups A, B, C, and D, respectively (Table 1). In this study, changes in the TLC (thousand/ mm^3 of blood) were observed in the treated groups of cattle and this might be due to the antiviral effect of sodium bicarbonate. The mean value of the TLC in group E (control group) was 8.25±0.06 but the mean value of the TLC gradually increased and on the 21st day was 8.55±0.05. The results of the study were in high agreement with the findings of Kidd (1991), Jain (1993), and Cole *et al*. (1997).

The values of haemoglobin percent were 8.49±0.09, 8.48±0.07, 8.45±0.06, and 8.39±0.06 in groups A, B, C, and D, respectively, (Table 1) during pre-treatment. On the 21st day of the post-treatment, the mean values of Hb% had increased to 8.60±0.09, 8.58±0.05, 8.55±0.05, and 8.49±0.07 in groups A, B, C, and D, respectively. In this study, changes in the TEC (million/ mm^3 of blood) were observed in the treated groups of cattle and this might be due to the increased demands of the body. The mean value of the Hb% in group E (control group) was 8.42±0.05 but the mean value of the Hb% gradually decreased and on the 21st day was 8.25±0.07. The findings of this study disagreed with the findings of Gokce *et al*. (2004). The lymphocytes gradually decreased due to the antiviral activity of the sodium bicarbonate (Table 3). In control group E, the gradual increase of the lymphocytes indicates a severe viral infection. The increased values of neutrophils indicate a secondary bacterial infection. The TEC in the therapeutic treatment increased more rapidly than in the prophylactic treatment. The TLC gradually decreased in the therapeutic treatment but increased in the prophylactic treatment. These observations wer in highly agreement with the results reported by Kidd (1991), Jain (1993), and Cole *et al*. (1997).

Conclusions

The experiment supports the use of sodium bicarbonate as a preventive and therapeutic agent against FMD but further studies need to be conducted to elaborate on the mechanism of the antiviral effect of sodium bicarbonate and observe the side effects and adverse effects of it when taken as an antiviral drug for FMD in veterinary practice.

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Table 2. Effects of sodium bicarbonate on differential leukocyte count (DLC) during prophylactic dose

Group	Differential Leukocyte	Pre-treatment period	Post-treatment period	
		Day 0 DLC Value (Mean± SE)	Day 14 DLC Value (Mean± SE)	Day 21 DLC Value (Mean± SE)
A	Lymphocyte	65.25±0.24	66.25±0.44	68.00±0.14**
	Neutrophil	24.75±0.19	23.00±0.31	22.00±0.25*
	Eosinophil	3.5±0.06	4.00±0.01	5.25±0.03**
	Monocyte	6.5±0.03	7.75±0.03	4.50±0.06
	Basophil	0.25±0.01	0.25±0.02	0.25±0.02
B	Lymphocyte	63.25±0.04	65.25±0.51	66.25±0.61**
	Neutrophil	26.5±0.05	24.5±0.01	23.25±0.08*
	Eosinophil	5.55±0.02	6.25±0.01	7.50±0.05**
	Monocyte	5±0.04	5±0.01	4±0.01
	Basophil	0.25±0.04	0±0.00	0±0.00
C	Lymphocyte	63.25±0.04	64.00±0.00	65.25±0.57*
	Neutrophil	25.5±0.24	24.75±0.40	23.50±0.20
	Eosinophil	8.5±0.09	9.250±0.07	9.50±0.07**
	Monocyte	4.5±0.04	3.750±0.07*	3.500±0.02**
	Basophil	0±0.00	0±0.00	0±0.00
D	Lymphocyte	62.75±0.27	63.75±0.37**	65.50±0.27**
	Neutrophil	25±0.27	24±0.57*	23.25±0.47**
	Eosinophil	7.5±0.07	8.5±0.07**	9.5±0.07**
	Monocyte	4.5±0.07	4.0±0.07	3.25±0.07
	Basophil	0.50±0.00	0±0.00	0±0.00
E (Control)	Lymphocyte	62±0.17	61±0.67	60±0.37**
	Neutrophil	24±0.27	25±0.17	26±0.4**
	Eosinophil	6.5±0.06	5.5±0.05	4.5±0.07
	Monocyte	3.5±0.05	4.5±0.07	5.5±0.03**
	Basophil	0±0.00	0±0.00	0±0.00

*Significantly increased at ($P < 0.05$), **Significantly increased at ($P < 0.01$)

Table 3: Effects of sodium bicarbonate on differential leukocyte count (DLC) during therapeutic dose

Group of animals	Differential Leukocyte	Pre-treatment period	Post-treatment period	
		Day 0 DLC Value (Mean± SE)	Day 14 DLC Value (Mean± SE)	Day 21 DLC Value (Mean± SE)
A	Lymphocyte	56.5±0.36	52.00±0.53*	50.00±0.47**
	Neutrophil	33.75±0.17	35.75±0.24**	37.75±0.32**
	Eosinophil	5.5±0.03	6.5±0.05**	7.00±0.076**
	Monocyte	5.75±0.06	6.25±0.04**	6.50±0.05**
	Basophil	0±0.00	0±0.00	0±0.00
B	Lymphocyte	56.5±0.55	51.00±0.42**	50.00±0.27**
	Neutrophil	30.75±0.17	35.75±0.21**	36.75±0.23**
	Eosinophil	5±0.03	4±0.05	4±0.07
	Monocyte	8±0.04	9±0.06*	10±0.06**
	Basophil	0.5±0.01	0±0.00	0±0.00
C	Lymphocyte	57.75±0.23	55.75±0.31**	52.75±0.41*
	Neutrophil	30.75±0.37	32.75±0.66*	35.75±0.345**
	Eosinophil	5.5±0.02	5.0±0.05	5.0±0.06
	Monocyte	6±0.04	7.25±0.05	8.25±0.04**
	Basophil	0.25±0.07	0±0.00	0±0.00
D	Lymphocyte	61.25±0.42	55.25±0.42	52.50±0.53**
	Neutrophil	31.75±0.22	36.75±0.32	40.25±0.48
	Eosinophil	3±0.05	4±0.06	5±0.05**
	Monocyte	4±0.05	4±0.03	3±0.05
	Basophil	0±0.00	0±0.00	0±0.00
E (Control)	Lymphocyte	62±0.43	65.25±0.65	66.25±0.22**
	Neutrophil	30±0.22	31.25±0.21	32.25±0.13**
	Eosinophil	4.25±0.06	4.50±0.05	5.00±0.06**
	Monocyte	3.75±0.03	2.00±0.04	2.00±0.06
	Basophil	0.5±0.02	0.25±0.01	0.25±0.02

*Significantly increased at ($P < 0.05$), **Significantly increased at ($P < 0.01$)

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