Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2020; 9(1): 666-671
Received: 22-11-2019
Accepted: 24-12-2019

Rohini Gupta
Department of Veterinary Medicine, NDVSU, Jabalpur, Madhya Pradesh, India

Aditya Agrawal
Division of Animal Biochemistry, ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh, India

PC Shukla
Department of Veterinary Medicine, NDVSU, Jabalpur, Madhya Pradesh, India

Shailesh Kumar Patel
Division of Pathology, ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh, India

Naveen Kumar Verma
Division of Surgery, ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh, India

Kabita Roy
Department of Veterinary Medicine, NDVSU, Jabalpur, Madhya Pradesh, India

Corresponding Author:
Rohini Gupta
Department of Veterinary Medicine, NDVSU, Jabalpur, Madhya Pradesh, India

Therapeutic management of acute calf diarrhoea in pre-weaned buffalo calves with herbal electrolyte combination regimens

Rohini Gupta, Aditya Agrawal, PC Shukla, Shailesh Kumar Patel, Naveen Kumar Verma and Kabita Roy

DOI: https://doi.org/10.22271/phyto.2020.v9.i1k.10521

Abstract
Diverse pathobionts, undeveloped or disturbance in intestinal micro biota, unhygienic managemental practices, emergence of antibiotic resistant strain as a consequence of inappropriate use of antibiotic and various environment factors may account for acute calf diarrohea. Suppression of pathobionts and restoration of good intestinal health via use of herbal drug or synbiotics may be alternative strategy to combat diarrohea. The comparative therapeutic efficacy of different herbal-synbiotic formulations in combination with oral rehydration solution (ORS) were systematically evaluated in 24 diarrhoeic buffalo calves of either sex up to 12 weeks post-partum both in the organized and unorganized dairy farms in Jabalpur (Madhya Pradesh). The haemato-biochemical profiles of the diarrhoeic and apparently healthy calves were also monitored. The herbal anti-diarrhoreal agent (Kutaja/ Bael) in combination with synbiotics (prebiotics + probiotics) and ORS brought prompt relief to the diarrhoeic calves as evidenced by abatement of shooting diarrhoea, restoration of faecal consistency and the suckling impulse, improved skin tonicity and normal behaviour profile. The best results were obtained with the oral package: Kutaja+Synbiotic+ORS followed by Bael+Synbiotic+ORS clearly reflected in favourable changes in the internal milieu explored with the highly dependable haemato-biochemical indices.

Keywords: Diarrhoea, buffalo calves, therapy, herbal, synbiotics, ORS

Introduction
Calf diarrhoea (calf scouring) is a clinical condition associated with increased frequency, fluidity or volume of the faecal excreta and the patho-biochemical alterations characterized by imbalanced fluid, electrolyte and acid-base status [1]. Diarrhoea in the pre-weaned calves inflicts considerable long-term economic losses to the dairy farmers especially in the developing countries including India. In U.S. 57% (USDA, Dairy 2007 Part II) and in Korea 53.4% [2] calf mortality rate was reported earlier due to diarrhoea. Similarly, in Norway, the acute diarrhoea leads to huge economic loss around 10 million US dollars in 2006 [3]. Pathogenic bacteria, viruses and endoparasites often collaborate to induce diarrhoea in the susceptible malnourished or immune compromised calves [4, 5]. *Holarrhena antidysenterica*, Wall (Sanskrit, Kutaja), growing in the wild as a medium sized tree is important in the indigenous system of Medicine as a remedy for diarrhoea in humans [6], its bark exhibits astringent, anti-bacterial and anti-diarrhoreal activity [7]. A variety of photochemical, reducing sugars, tannins and marmelosin in the half-ripe fruit of *Aegle marmelos*, Linn (Bael) have remarkable astringent s activity [8] and subside irritation in the digestive tract of diarrhoeic calves [9], arising from histopathological degenerative changes in the lining epithelium [10]. The potent anti-bacterial activity of methanol extract of *Aegle marmelos* is on record [11].
Prebiotics are non-digestible food ingredients that benefit the host animal through stimulation of growth promoting beneficial gut micro-flora and micro-fauna [12]. On the other hand, probiotics are live microorganisms which markedly improve the health status in a similar biological mode. For example, *Lactobacillus* spp. is known to be highly beneficial to the growing calves, promoting the establishment of friendly cellulolytic rumen bacteria and stabilizing the itinerant consortium of micro-flora faster. Thus, the favourable bio-response to probiotic, *L. acidophilus, L. planatarum and L. acidiphilus* in terms of improved body weight gain concurrent with enhanced IgG titre in neonatal male calves is well-established [13, 14].
The protozoan population in the rumen develops subsequently, the process expedited in the calves fed *Streptococcus cerevisiae*. It is noteworthy that the remission of calf diarrhoea was associated with the reduced coliform counts (cfu/ml) following probiotic bacteria adhesion along with favourable changes in the gut histo-architecture.

Improved epithelial wall permeability and modulation of the immune function reduced the severity of calf diarrhoea [15]. A combination of probiotics with different modus operandi would amplify the bio-protective range of therapeutic preparations and thus the potentiated probiotics being more effective [16]. Synbiotics are synergistic blends of probiotics and prebiotics conferring health benefits to the pre-ruminant calves. The purpose of this paper is to use herbal drugs mainly *Holarrhena antidysenterica*, Wall (Kutaja) and *Aegle marmelos*, Linn (Bael)) along with synbiotic and ORS to relief animals from calf diarrhoea as well as may help to control the disease spreading in effectual manner.

Materials and Methods

A total 100 pre-weaned (1-3 months post-partum) buffalo calves from the Veterinary University Instructional Livestock Farm Complex (ILFC), Adhartal and some privately owned periurban dairy units in Jabalpur (MP) were screened for the prevalence of diarrhoea. Twenty four untreated diarrhoeic calves of either sex were randomly divided into 4 equal treatment groups (T_1-T_4). Six apparently healthy calves of the same age served as the control group (Tc). A separate line of treatment was given to each group which is mentioned in table 1. Composition of Oral Rehydration Solution (ORS) is mentioned in table 2.

Table 1: Experimental design of herbal drugs for therapeutic study on diarrhoeic calves

Treatment groups	No. of Animals	Treatment
T_c	6	Healthy (non-diarrhoeic) control group
T_1	6	*Aegle marmelos* (Bael) unripe fruit powder + Oral Rehydration Solution (ORS)
T_2	6	*Aegle marmelos* unripe fruit powder + synbiotics + ORS
T_3	6	*Holarrhena antidysenterica* (Kutaja) bark powder + ORS
T_4	6	*Holarrhena antidysenterica* bark powder + synbiotics + ORS

- The acute diarrhoeic calves of all the groups (T1-T5) were treated with ORS @ 50ml/kg b.i.d. for 5 days.
- Only group T2 and T4 were treated with synbiotics @ 5g t.i.d. for 5 days.
- *Aegle marmelos* (Bael) unripe fruit powder was given to group T1 andT2 @ 5g t.i.d. and *Holarrhena antidysenterica* bark powder was given to group T3 andT4 @ 5g t.i.d., for 5 days.

Table 2: Composition of oral rehydration solutions (ORS) used in acute diarrhoeic calves

Ingredients	Quantity (g)
Sodium chloride	3.5
Potassium chloride	1.5
D-glucose	20.0
Total weight	27.5
Solution	Dissolve in 1 litre of water

Clinical profile

The affected calves were clinically examined for all physical parameters i.e. rectal temperature, pulse rate, respiration rate and body weight .The faecal consistency tissue dehydration status and suckling reflex score (mild, moderate and severe) was mentioned in Table 3 and each calf score was recorded on day 0 (pre-treatment) and on day 5, 10 and 15 (post-treatment).

Table 3: Clinical scores of faecal consistency, tissue dehydration and suckling reflex recorded in calves under study

Score	Faecal consistency	Tissue dehydration status	Suckling reflex score
0	Normal	No dehydration	Normal vigorous suckles
1	Pasty faeces	Mild dehydration, skin tent < 3 sec.	Slight depression, calf suckles but not vigorously
2	Semi-liquid faeces	Moderate dehydration, skin tent >3 sec.	Moderate depression, calf unable to stand, suckling is weak or disorganized
3	Watery faeces	Severe dehydration, skin tent >8 sec.	Severe depression, unable to stand and suckle.

Haematology

From jugular vein, 10 ml of venous blood was aseptically collected from each calf in clean and dry glass tube at each interval out of which 5 ml was promptly transferred into a labeled glass vial containing 5mg EDTA followed by gentle shaken. The haematological parameters viz. total erythrocyte count (TEC), total leukocyte count (TLC), haemoglogin concentration, packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were determined using Auto Cell Analyzer (model MEDONIC CA 530).

Serum biochemical parameters

The remaining sampled blood (5 ml) was allowed to set in a slant (20 minutes) and clear, unhaemolysed serum was carefully aspirated off and transferred into a fresh labeled tube and preserved (4 ^{0}C). Serum sodium and potassium concentrations were estimated by flame photometric analysis (model Elico, CL 378) and the values were expressed in mEq/l. Serum chloride concentration was determined using the standard diagnostic kits and blood Chemistry Auto Analyzer (model Erba Mannheim CHEM-5 plus v2) and the values were expressed in mEq/l. Serum total protein (TP) and albumin (A) concentrations were estimated using the standard diagnostic kits and the specified Auto Analyzer. Serum globulin (G) concentration was estimated by calculation (TP-A=G) and the values were expressed in g/dl. The A/G ratio was also determined by simple calculation.

Statistical analysis

The data were analyzed with the Hierarchical model for the Analysis of Variance and the Mean values were compared with Duncan's Multiple Range Test [17].

Results and Discussion

Clinical profile of diarrhoeic calves after using ORS-cum-herbal anti-diarrhoeal preparations

The clinical profile of the diarrhoeic calves in general revealed anorexia, lethargy, dullness, depression and moderate (6-8% of body weight) dehydration. Some of the animals exhibited sunken eyes and congested visible mucous membranes. The faecal consistency varied from watery to pasty occasionally blood-tinged with foul odour. Our low cost home-made ORS-cum-herbal anti-diarrhoea preparations of Kutaja/ Bael in synergistic combination with synbiotics brought prompt relief to the diarrhoeic buffalo calves. Shooting diarrhoea in individual patients was effectively checked with improvement in posture and gait. Suckling impulse was restored and the calves became alert and playful (Table 4). The skin became supple and the muzzle appeared moist. The eyes looked bright as compared to previous. The best results on clinical appraisal of the overall body condition and covert signs of physical well-being were obtained with the combination therapy T_4 (Kutaja+Synbiotic+ORS) and closely followed by T_2 (Bael+Synbiotic+ORS). A therapeutic response of relatively less efficacy was observed with T_3 (Kutaja+ORS), and T_1 (Bael+ORS).

Table 4: Faecal consistency, tissue dehydration and suckling reflex (clinical score) of diarrhoeic calves in different treatment groups at different intervals.

Groups	day 0	day 5	day 10	day 15
Faecal consistency				
Tc	00.08 ±0.1	00.06 ±0.1	0.04 ±0.1	0.00 ±0.0
T_1	1.2 ±0.1	0.67^{Aa} ±0.1	0.33 ±0.1	0.24^{B} ±0.1
T_2	2.09^{b} ±0.1	0.78 ±0.2	0.52±0.1	0.13 ±0.1
T_3	2.02 ±0.1	0.88^{A} ±0.1	0.68^{C} ±0.1	0.18^{C} ±0.1
T_4	2.14 ±0.2	0.82 ±0.1	0.54 ±0.1	0.12 ±0.1
Tissue dehydration score				
Tc	00.08 ±0.0	00.06 ±0.0	0.03 ±0..0	0.00 ±0.0
T_1	1.76 ±0.2	1.64^{a} ±0.2	1.58^{c} ±0.1	1.34^{c} ±0.1
T_2	1.82^{a} ±0.2	1.54^{a} ±0.2	1.24 ±0.1	0.88^{A} ±0.1
T_3	1.82^{a} ±0.2	1.72^{a} ±0.2	1.43^{B} ±0.1	1.36^{b} ±0.1
T_4	1.68^{a} ±0.2	1.42^{a} ±0.1	1.08 ±0.1	0.75 ±0.1
Suckling reflex				
Tc	00.00a ±0.0	00.00 ±0.0	0.00a ±0.0	0.00a ±0.0
T_1	1.41^{b} ±0.1	1.36^{A} ±0.1	1.34^{c} ±0.1	1.24^{c} ±0.1
T_2	1.78^{a} ±0.1	1.62^{a} ±0.1	1.42^{a} ±0.1	1.36^{a} ±0.1
T_3	1.68^{a} ±0.2	1.47^{a} ±0.2	1.24^{a} ±0.1	1.04^{a} ±0.1
T_4	1.66^{a} ±0.2	1.37^{a} ±0.1	1.18^{ab} ±0.1	0.87^{a} ±0.1

Mean values between treatments (A,B,C) and between intervals (a,b,c) with different superscripts vary significantly ($P<0.05$).

Haematological parameters

There was a relative increase in haemoglobin, TEC and the PCV levels resulting from haemo-concentration associated with the loss of a large quantum of body fluids due to diarrhoea (Table 5). Similar findings have been reported in literature on this aspect [10, 18]. Remedial therapies especially T_4 and T_2 resulted in restoration of normal values on day 15 post-treatment (Table 5). Leucocytosis in calf diarrhea of varying intensity has been attributed to microbial infection and associated with neutrophilia. Presumably, the potent antibacterial agents in Kutaja/ Bael [19, 20] effectively blocked the rapid multiplication of pathogenic bacteria with no significant increase in TLC in the present clinical trial (Table 5). The observed increase in the value of MCV in the diarrhoeic buffalo calves in all four treatment groups compared to the healthy control group on day 0 (pre-treatment), though statistically not significant and may be related to accelerated release of immature large sized red blood cells [10]. The MCV exhibited a progressive declining trend and on day 15 near normal values were restored in all treatment groups (Table 5). Decreased MCH values concurrent with reduced haemoglobin concentration in the severely diarrhoeic buffalo calves observed might be a consequence of considerable faecal blood loss following notably damaged histo-architecture of the intestinal lining epithelium in autopsy tissue samples [10]. However, such a clinical contingency as evidenced by the haemogram did not arise in the present study.

Table 5: Haematological attributes in response to different remedial therapies in pre-weaned diarrhoeic buffalo calves in different interval

Indices / Groups	day 0	day 5	day 10	day 15
	Intervals (days)			
	Haemoglobin (g/dl)			
T_c	10.03^{C}±0.2	10.12^{B}±0.2	10.20^{B}±0.2	10.25^{B}±0.2
T_1	12.33^{A}±0.5	12.08^{A}±0.5	11.92^{A}±0.5	11.65^{A}±0.4
T_2	11.40^{A}±0.4	12.12^{AB}±0.5	10.87^{AB}±0.4	10.60^{AB}±0.4
T_3	11.33^{AB}±0.5	11.18^{AB}±0.5	11.10^{AB}±0.5	10.92^{AB}±0.5
T_4	10.85^{BC}±0.4	10.70^{B}±0.4	10.57^{B}±0.4	10.33^{B}±0.4
	Packed cell Volume (%)			
T_c	38.08^{B}±1.8	38.16^{C}±1.9	38.31^{C}±1.9	38.27^{C}±1.9
T_1	45.40^{Aa}±1.2	42.65^{Aab}±1.0	40.37^{bc}±0.5	39.15^{c}±0.4
T_2	44.53^{Aa}±1.2	40.60^{ABcb}±0.7	39.68^{b}±0.5	38.85^{b}±0.3
T_3	42.88^{Aa}±0.7	41.78^{ABa}±0.7	39.88^{ab}±0.4	38.12^{b}±0.4
T_4	43.53^{Aa}±1.1	39.00^{BCb}±0.7	38.69^{b}±0.6	38.20^{b}±0.5

	Total erythrocyte count (x 10^6/µl)			
T_c	7.35±0.3	7.47±0.3	7.60±0.3	7.87±0.3
T_1	8.83±0.2	8.72±0.4	8.58±0.6	7.78±0.6
T_2	9.31±0.5	8.82±0.6	8.47±0.6	8.07±0.7
T_3	8.98±0.6	8.64±0.6	8.55±0.6	7.85±0.6
T_4	9.27±0.5	8.63±0.6	8.15±0.5	7.93±0.5
	Total leucocyte count (x 10^3/µl)			
T_c	10.22±0.4	10.26±0.4	10.28±0.4	10.26±0.4
T_1	13.93±1.2	13.93±0.5	13.75±0.4	13.25±0.3
T_2	16.42±3.1	13.86±2.2	12.45±1.6	12.04±1.5
T_3	13.52±1.1	13.83±1.1	13.42±1.1	12.50±0.9
T_4	13.83±1.5	13.54±1.5	12.65±1.0	12.44±1.0
	MCV (fl)			
T_c	45.77±1.9	47.44±1.9	48.05±1.9	48.73±1.9
T_1	51.54±1.6	51.53±3.3	48.26±1.9	48.03±2.7
T_2	49.74±3.7	48.27±1.9	47.85±2.7	46.68±2.0
T_3	50.55±3.7	49.34±3.0	48.68±2.7	47.68±3.0
T_4	52.01±2.8	51.36±2.8	50.50±2.7	48.92±2.8
	MCH (pg)			
T_c	12.00±0.5	12.54±0.5	13.08±0.5	13.12±0.5
T_1	15.18±0.6	14.10±0.4	13.88±0.3	13.74±0.6
T_2	13.55±1.1	13.08±0.8	12.83±0.8	12.39±0.7
T_3	14.21±1.0	13.24±0.9	13.17±0.9	12.86±0.9
T_4	13.98±0.5	13.66±0.6	13.52±0.6	13.15±0.6
	MCHC (%)			
T_c	12.01±0.5	12.54±0.5	13.08±0.5	13.12±0.5
T_1	15.18±0.6	14.10±0.4	13.88±0.3	13.74±0.6
T_2	13.55±1.1	13.08±0.9	12.83±0.8	12.39±0.7
T_3	14.20±1.0	13.24±0.9	13.17±0.9	12.86±0.9
T_4	13.98±0.5	13.66±0.6	13.52±0.6	13.15±0.6

Mean values between treatments (A,B,C) and between intervals (a,b,c) with different superscripts vary significantly (P<0.05).

Biochemical parameters

The circulatory protein profile reflects the patho-physiological status/ nutritional plane of the animals. The apparently higher values of serum total protein (TP) in the treatment groups T_3 and T_4 (Table 6) as compared to the healthy control group T_c on day 0 pre-treatment (Table 6) is in conformity with the earlier reports [8, 10, 21]. There was a definitive end result of abnormal loss of body fluids in the clinical episode. Further the near normal values observed following effective remedial therapies reflect the restoration of water homeostasis. The best response was elicited in treatment groups T_4 and T_1 followed by T_3 and T_1. The significantly (P<0.05) higher serum albumin concentration in the diarrhoeic buffalo calves in all treatment groups compared to the healthy control group T_c on day 0 (pre-treatment) is in agreement with the earlier reports in literature [22]. This observation is also a direct consequence of abnormal loss of tissue fluids. However, the values decreased significantly (P<0.05) on day 5 in T_3 and T_4 and the declining trend persisted till near normal values were restored on day 15 post-treatment. The serum globulin fraction did not vary significantly in the diarrhoeic and non-diarrhoeic calves.

A significantly (P<0.05) lower circulatory sodium (Na^+) level pointing to hyponatremia in the diarrhoeic buffalo calves in all four treatment groups T_1, T_2, T_3 and T_4 as compared to the healthy control group T_c (Table 6) due to fecal loss which was consistent with the earlier reports in literature [10, 23, 24]. However, on day 5 post-treatment a significant (P<0.05) increase towards restoration of normalcy was recorded in the treatment group T_4 followed by T_2, T_3 and T_1. This trend continued and the values were virtually at par with that recorded in the healthy control group T_c on day 15 post-treatment. On the other hand, the circulatory (K^+) levels in the diarrhoeic buffalo calves in all four treatment groups: T_1, T_2, T_3 and T_4 was significantly (P<0.05) higher than the healthy control group T_c (Table 6) signifying hyperkalemia. This observation is in conformity with the earlier reports [22, 23, 24]. The values declined progressively in all treatment groups, significantly (P<0.05) in T_4 and T_2. Accentuated hyperkalemia may be a major factor contributing to the high mortality rate in calf diarrhoea [23], mainly because of cardiac arrhythmia [1]. This underscores the importance of early restoration of electrolyte balance in the diarrhoeic calves.

The significantly (P<0.05) higher circulatory chloride (Cl^-) concentration signifying hyperchloremia in the diarrhoeic buffalo calves in all treatment groups: T_1, T_2, T_3, and T_4 compared to the healthy control group T_c on day 0 (pre-treatment) is corroborated by the documented reports [24, 25]. Temporary hepatic malfunction may lead to increased capillary permeability and the associated passage of particulate colloidal protein into the tissues which may result in increased serum chloride concentration. Electrolyte imbalance marked by high [H^+] along with [Na HCO_3^-] depletion is implicated in metabolic acidosis [26] as a consequence of over production of H^+ ion, Cl^- ions were released from the circulating erythrocytes to maintain electrical neutrality in the cells by compensating loss of bicarbonate (HCO_3^-) leading to hyperchloremia. In all herbal-based treatment groups (present study), the Cl^- ion titre declined markedly and near normalcy was restored on day 10 or day 15. Similar observations were recorded earlier with synthetic anti-bacterials [24]. In brief, clinical profile along with haemato and biochemical alteration after treating with herbal synbiotic combination was measured.

Table 6: Biochemical attributes in response to different remedial therapies in pre-weaned diarrhoeic buffalo calves in different interval.

Indices / Groups	Intervals (days)			
	day 0	day 5	day 10	day 15
	Total protein (g/dl)			
T_C	7.10±0.3	7.04±0.8	7.19±0.3	7.14±0.3
T_1	7.79±0.4	7.78±0.5	7.13±0.4	7.15±0.3
T_2	7.71±0.2	7.74±0.3	7.37±0.2	7.17±0.2
T_3	7.70^{a}±0.1	7.32^{b}±0.1	7.25±0.1	7.08±0.1
T_4	7.94^{a}±0.3	7.34^{b}±0.2	7.14^{b}±0.2	6.99^{b}±0.2
	Albumin (g/dl)			
T_C	3.65^{A}±0.2	3.68±0.2	3.71±0.2	3.76±0.2
T_1	4.49^{B}±0.2	4.30±0.2	3.97±0.2	3.86±0.1
T_2	4.40^{B}±0.1	4.14±0.2	3.96±0.2	3.82±0.2
T_3	4.36^{BCa}±0.1	3.88^{ab}±0.1	3.84^{b}±0.2	3.79^{b}±0.1
T_4	4.88^{Ca}±0.1	4.12^{b}±0.2	3.95^{b}±0.2	3.71^{b}±0.2
	Globulin (g/dl)			
T_C	3.45±0.3	3.36±0.3	3.48^{b}±0.3	3.39^{b}±0.3
T_1	3.30±0.4	3.43±0.4	3.26±0.3	3.29±0.2
T_2	3.32±0.2	3.33±0.2	3.41±0.1	3.35±0.1
T_3	3.34±0.0	3.44±0.1	3.41±0.1	3.29±0.1
T_4	3.05±0.2	3.22±0.2	3.19±0.2	3.27±0.3
	Albumin/ Globulin (A/G) ratio			
T_C	1.06±0.2	1.09±0.2	1.07±0.2	1.11±0.2
T_1	1.36±0.2	1.25±0.1	1.22±0.1	1.17±0.1
T_2	1.33±0.1	1.24±0.1	1.16±0.0	1.14±0.1
T_3	1.30±0.0	1.13±0.0	1.13±0.0	1.15±0.1
T_4	1.60±0.1	1.78±0.1	1.24±0.1	1.13±0.1
	Sodium (m Eq/l)			
T_C	146.47^{A}±1.2	146.53^{B}±1.2	146.59^{A}±1.2	146.63^{A}±1.2
T_1	125.26^{Bd}±2.3	131.50^{Cc}±2.4	137.83^{CD}±2.5	142.25^{Ba}±1.8
T_2	127.67^{Bc}±2.3	138.74^{Bb}±0.9	143.33^{ABa}±0.9	144.4^{ABa}±1.0
T_3	126.44^{Bc}±0.9	134.60^{Bb}±0.8	141.00^{BCa}±0.9	143.24^{ABa}±0.8
T_4	128.36^{Bc}±0.6	142.23^{Bb}±1.0	145.19^{Aab}±0.9	146.35^{ABa}±0.8
	Potassium (m Eq/l)			
T_C	4.93^{Ba}±0.3	5.03^{Ba}±0.3	5.11^{Aa}±0.3	5.15^{Aa}±0.3
T_1	5.61^{Aa}±0.1	5.44^{Aa}±0.2	5.30^{Aa}±0.1	5.16^{Aa}±0.1
T_2	5.32^{Aa}±0.2	5.26^{ABb}±0.1	5.17^{Ab}±0.1	4.98^{Ab}±0.2
T_3	5.68^{Aa}±0.1	5.37^{ABab}±0.1	5.25^{Aab}±0.1	5.08^{Ab}±0.1
T_4	5.67^{Aa}±0.1	5.28^{ABa}±0.1	5.01^{Ab}±0.1	4.95^{Ab}±0.1
	Chloride (m Eq/l)			
T_C	95.85^{C}±1.1	95.80^{C}±1.0	95.74^{C}±1.0	95.69^{C}±1.0
T_1	112.60^{Ba}±2.1	110.87^{Aa}±0.7	105.74^{C}±1.0	100.42^{Ac}±0.5
T_2	114.10^{ABa}±1.4	105.08^{Bb}±1.1	101.15^{Bc}±0.4	97.64^{ABd}±0.3
T_3	113.10^{Ba}±1.4	109.37^{Ab}±0.2	102.30^{ABc}±0.3	98.62^{ABd}±0.5
T_4	117.10^{Aa}±2.3	108.37^{ABb}±0.5	100.74^{Bc}±0.5	96.74^{Bd}±0.3

Mean values between treatments (A,B,C) and between intervals (a,b,c) with different superscripts vary significantly ($P<0.05$).

Conclusion

In conclusion, the comparative therapeutic efficacy of different herbal-synbiotic formulations in combination with oral rehydration solution (ORS) revealed that the herbal anti-diarrhoreal agent (Kutaja/ Bael) in combination with synbiotic (prebiotics + probiotics) and own formula ORS was found to be most efficacious and lead to prompt relief to the diarrhoeic calves evidenced by improvement in clinical score i.e. tonicity of skin, suckling impulse, restoration of faecal consistency along with haemato-biochemical indices.

Ethical approval

All of the procedures of this experiment were approved by the Institutional Animal Ethics Committee (IAEC), College of Veterinary Science and Animal Husbandry, NDVSU, Jabalpur.

Acknowledgments

The authors are thankful to the Honorable Vice Chancellor of the University and Dean, College of Veterinary Sciences and Animal Husbandry Jabalpur for providing all the facilities and financial support to conduct the study. The assistance of all the hospital staffs including T.V.C.C. is duly acknowledged.

Conflict of interest

No potential conflict of interest was reported by the authors.

References

1. Radostits OM, Gay CC, Hinchcliff KW, Constable PD. In Veterinary Medicine: A Text Book of the Diseases of Cattle, Horses, Sheep, Pigs and Goats. 10th Ed, Saunders Elsevier, London, 2007, 851-876.
2. Hur TY, Jung YH, Choe CY, Cho YI, Kang SJ, Lee HJ *et al*. The dairy calf mortality: the causes of calf death during ten years at a large dairy farm in Korea. Korean Journal of Veterinary Research. 2013; 53:103-108.
3. Osteras O, Gjestvang MS, Vatn S, Solverod L. Perinatal death in production animals in the Nordic countries - incidence and costs. Acta Veterinaria Scandinavica. 2007; 49:S14.

4. Izzo MM, Kirkland PD, Mohler VL, Perkins NR, Gunn AA, House JK. Prevalence of major enteric pathogens in Australian dairy calves with diarrhoea. Australian Veterianry Journal. 2011; 89:167-173.
5. Bartels CJ, Holzhauer M, Jorritsma R, Swart WA, Lam TJ. Prevalence, prediction and risk factors of enteropathogens in normal and non-normal faeces of young Dutch dairy calves. Preventive Veterinary Medicine. 2010; 93:162-169.
6. Guha Bakshi DN, Sensarma P, Pal DC. A Lexicon of Medicinal Plants in India, Naya Prokash Publishers Kolkata, 2001; II:356-358.
7. Sujan Ganpathy PS, Sudeep HP, Padmalatha Rai S, Ramachandra VL. Screening of crude extracts of *Holarrhena antidysenterica*, Wall against clinically important pathogenic strains. Medicinal and Aromatic Plant Science and Biotechnology. 2008; 2:68-71.
8. Singh J, Shukla A, Singh SC, Jain SP, Sharma A, Khanuja SPA. Traditional uses of Aegle marmelos (Bilva). Journal of Medicinal and Aromatic Plant Science. 2007; 29:42-49.
9. Mir N. Rehydration and herbal therapy in calf diarrhoea. M.V.Sc. & A.H., Thesis (Veterinary Medicine) Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, 2009.
10. Ghanem MM, Fkhrany SF, Abd El-Roaf YM, El Attar, HM. Clinical and haematological evaluation of diarrhoeic neonatal buffalo calves (*Bubalas bubalis*) with reference to antioxidant changes. Benha Veterinary Medicine Journal. 2012; 23:275-288.
11. Phullan R, Khullar N. Antimicrobial evaluation of some medicinal plants for their anti-enteric potency against multi-drug resistant Salmonella typhi. Phytotherapy Research. 2004; 20:670-673.
12. Gibson GR, Probert HM, Loo JV, Rastall RA, Roberfroid MB. Dietary modulation of the human colonic microbiota updating the concept of pre-biotics. Nutrition Research Reviews. 2004; 17:259-275.
13. Al-Siaidy MY. Effect of probiotic bacteria on immune globulin G concentration and other blood components of new-born calves. Journal of Animal and Veterinary Advances. 2010; 9:604-609.
14. Bidarkar VK, Swain PS, Ray S, Dominic G. Probiotics: potential alternatives to antibiotics in the ruminants feeding. Trends in Veterinary and Animal Sciences. 2014; 1:1-4.
15. Galvao KN, Santos JE, Coscioni A, Villasenor M, Sischo WM, Berge SC. Effect of feeding live yeast products to calves with failure of passive transfer of transferon performance and pattern of antibiotic resistance in fecal Escherichia coli. Reproduction Nutrition Development. 2005; 45:427-440.
16. Musa HH, Wu SL, Zhu CH, Seri HI, Zhu GQ. The potential benefits of probiotics in animal production and health. Journal of Animal and Veterinary Advances. 2005; 8:313-321.
17. Snedecor GW, Cochran WG. Statistical Mehods. 8Th Edn., The IOWA State University Press, USA, 1994.
18. Santos RL, Tsolis RM, Baumler AJ, Adams G. Haematological and serum biochemical changes in *Salmonella typhimurium* infected calves. American Journal of Veterinary Research. 2002; 63:1145-1158.
19. Brijesh S, Daswani P, Tetali P, Anit N, Birdi T. Studies on the anti-diarrhoeal activity of Aegle marmelos unripe fruit: validating its traditional usage. BMC Complementary and Alternative Medicine. 2009; 9:47.
20. Kavitha D, Shilpa PN, Devraj SN. Antibacterial and anti-diarrhoeal effects of alkaloids of Holarrhena anti-dysenterica, Wall. Indian Journal of Experimental Biology. 2004; 42:569-574.
21. Eddy RG, Pinsent PJN. Diagnosis and differential diagnosis in the cow. In: Bovine Medicine, ed. Andrews, A.H. Blackwell Sciences Ltd., Oxford, U.K., 2004; 135-157.
22. Kaur K, Randhwa SS, Chhabra S. Haemato-biochemical profile of diarrhoeic calves affected with colibacillosis. Indian Journal of Veterinary Medicine. 2006; 26:9-11.
23. Seife HA, Mahri M, Shoorei E, Farzaneh N. Using haematology and serum biochemical findings as prognostic indicators in calf diarrhea. Comparative Clinical Pathology. 2006; 15:143-147.
24. Roy K, Fernandes CE. Patho-physiological significance of variation in serum electrolytes during clinical enterocolibacillosis. Intas Polivet. 2007; 8:153-154.
25. Malik S, Kumar A, Verma AK, Gupta MK, Sharma SD, Sharma AK, *et al*. Haematological profile and chemistry in diarrhoeic calves affected with colibacillosis. Journal of Animaml Health and Production. 2013; 1:10-14.
26. Gross DR. General concept of fluid therapy. In: Veterinary Pharmacology and Therapeutics, Eds., Booth, N.H. and Mc Donald, L.E., 6th edn., Iowa State University Press, Ames, Iowa, USA, 1988, 480-486.