The Pharma Innovation Journal 2022; SP-11(3): 1562-1566

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(3): 1562-1566

www.thepharmajournal.com
Received: 23-01-2022
Accepted: 26-02-2022

Manoj Kumar
Department of Veterinary Medicine, Ranchi Veterinary College (BAU) Kanke, Ranchi, Jharkhand, India

Abhishek Kumar
Department of Veterinary Medicine, Ranchi Veterinary College (BAU) Kanke, Ranchi, Jharkhand, India

Corresponding Author
Manoj Kumar
Department of Veterinary Medicine, Ranchi Veterinary College (BAU) Kanke, Ranchi, Jharkhand, India

Efficacy of herbal treatment on clinico-physiological observation in a *Colibacillosis* affected calves

Manoj Kumar and Abhishek Kumar

Abstract
A total no. of 60 *colibacillosis* poisitive calves (*Escherichia coli* positive) and six (06) clinically normal healthy calves (Healthy control) were taken to investigate the Clinico-physiological profiles. *E. coli* was isolated from the *colibacillosis* affected calves and the animals found positive were used for the study of Clinico-physiological profile. Faecal sample were cultured on MacConkey and EMB agar to diagnose *E. coli*. Analysis of Clinico-physiological observation of the *colibacillosis* affected calves revealed significant increase in Rectal temperature, Respiration rate and Pulse rate, and all the *colibacillosis* affected calves also found watery faecal consistency, anoretic, dry mucous membrane, alteration in behavior, dehydrated and enophthalmos condition. The experiment was conducted at Department of Veterinary Medicine, College of Veterinary Science and Animal Husbandry, Birsa Agricultural University, Kanke Ranchi.

Keywords: Calf, *colibacillosis*, *E. coli*, clinico-physiological profile

Introduction
Colibacillosis in farm animal especially in neonate calf is one of the challenging clinical syndromes encountered by practicing large animal's veterinary practitioners. *Colibacillosis* is a leading cause of economic losses to the cattle industries and major cause of calf mortality and morbidity during first few week of life (Radostits *et al*., 2000) [1]. Various antimicrobial agents have been the drugs of choice for the clinician Moreover, it has been observed that oral administration of antibiotics for prolong period is detrimental to the intestinal mucosa of the neonatal calves and may result in malabsorption and diarrohea due to direct modification of the intestinal mucosa even development of drugs resistant (Mero *et al.*,1985) [2]. Guava leaves, and Pomegranate peels have been widely used as potent antidiarrheal agent for the prevention and treatment of diarrhea by rural peoples (Lutterodt, 1989; [3] and Alnieida *et al.*, 1995) [4]. Thus the present work has been designed to assess the treatment efficacy of *Psidium guajava* leaves and *Punica granatum* rind extract in restoration of Clinico-physiological changes in *colibacillosis* calves.

Materials and Methods
Experimental design
On the basis of culture and sensitivity test the selected calves were randomly distributed into 3 equal groups i.e. group-A, group-B and group-C consist of 20 animals in each group. Group-A was treated with Ofloxacin tab. orally, group-B was treated with ethanolic extract of *Punica granatum* rind orally and group-C was treated with ethanolic extract of *Psidium guajava* leaf orally. The entire treatments are continued for upto 7 days along with supportive therapy consisting of 5% DNS, B-complex inj. and liver tonic inj.

Selection of animals
A total of 60 *colibacillosis* affected calves presented or reported at Veterinary Clinical Complex (RVC), Instructional bovine farm of Ranchi Veterinary College, and from local organized or unorganized Dairy farm situated in an around Ranchi Veterinary College with the history of passage of soft fluid faeces, abnormal colour of faeces (white to yellowish green and mucoid) along with rapid loss of body weight, animal becoming lean and dehydrated as well as abnormal rectal temperature, pulse and respiration rate was selected for the present study.

Clinico-physiological examination
A close and constant clinical examination was carried out as per the procedure described by

Radostitis *et al.* (2007) [5]. Rectal temperature in degree Fahrenheit (°F) was recorded by Digital clinical thermometer. The respiration rate (per minutes) at rest was counted by observing the nasal airflow and the movement of ribs and abdominal muscles. The pulse rate (per minutes) at rest was counted by palpating middle coccygeal artery.

Clinical manifestation viz. Faecal consistency, appetite, mucous membrane appearance, behavior, skin elasticity and enophthalmos were recorded as per standerd methods described by Brooks**,** 1997 [6].

Statistical analysis: Statistical difference between respective means for various parameters was evaluated using tow way Anova as per the method described by Snedecor and Cochran (2004) [7].

Result and Discussion

Rectal temperature

A significant elevation in the rectal temperature of *colibacillosis* affected calves was observed among all the treatment group- A (103.420±0.163 °F), group-B (103.640±0.154°F) and group-C (103.580±0.159°F) on 0 day (pre-treatment) in comparison to healthy control calves 100.900±0.329°F. Following treatment on subsequent days a similar type of decreasing trends towards restoration of normal rectal temperature (100.900±0.329°F) was noticed among the treatment group-A, group-B and group-C. An early and significant decrease to normal rectal temperature (100.910±0.157°F) was noticed from 6th day of observation in group-C, whereas a comparable higher values of 101.380±0.083°F and101.160±0.117°F, respectively in Group-A and group-B were observed till end of the study. Thus an increase in rectal temperature might be occurred due to association of infectious agent, *E. coli* which causes toxaemia, dehydration, hyperthermia and diarrohea (Wray and Thromblinson, 1972) [8] as diarrohea and dehydration may lead to inadequate body fluidto sustain the loss of body heat by evaporation process (Radostitis *et al.,* 2007) [5]. The present trends of results of the present work are in agreement with Chand (2012) [9] Hassan *et al.,* (2014) [10], Mehesare (2018) [11] and Tarunpreet *et al.,* (2018) [12].

Respiration rate

An increased respiration rate (breath/min) in *colibacillosis* affected calves was observed among all the treatment group-A (38.900±1.080 breath/ min.), group-B (39.300±0.836 breath /min.) and group-C (41.100±1.015 breath/ min) on 0 day (pre-treatment) in comparison to healthy control calves 28.33±1.20 breath/min. An observation showed that increased respiration rates followed a significant (p≤0.01%) decreasing trend towards restoration of normal respiration rate within the same treatment group. A normal respiration rate in the entire treatment group was achieved on 8th day of observation as 29.900±0.340 breaths/minute, 29.300±0.300 breaths/minute and 30.450±0.393 breaths/minute in the treatment group-A, group-B and group-C, respectively. A non-significant variation in respiration rates among the calves of different treatment group-A, group-B and group-C was observed throughout the study. An elevation in mean values of respiration rates observed due to stimulation of respiratory centre and dissipation of heat through evaporation due to high temperature which has occured due to pathophysiological effect of *colibacillosis* in calf (Radostitis *et al.,* 2010).[13] A severe dehydration occurred during *collibacillosis* may also lead to hyperpnoea and polypnoea as reported earlier by Ershaduzzaman *et al.,* (2013) [14] in goat kids, Uetake (2013) [15] in calves and Hassan *et al.,* (2014) [10] in lambs. The results of present findings during course of study in *colibacillosis* affected calves corroborate with Hassan *et al*., (2014) [10], Mehesare (2018) [11], Tarunpreet *et al.,* (2018) [12] and Manu *et al*., (2019) [16] who also reported increased respiration rates during *collibacillosis* infection in calf.

Pulse rate

An increase in pulse rate (beats/min.) of *colibacillosis* affected calves was observed among all the treatment groups- A (114.300±0.756 beats/min.), group-B (113.500±0.540 beats/min.) and group-C (112.750±0.572 beats/min.) on 0 day (pre-treatment). Following different treatment regimen an increased pulse rate followed a significant (p≤0.01%) decreasing trends towards restoration of normal pulse rate within the same treatment group. A normal pulse rate in the entire treatment group was achieved on 8th day of observation as 89.250±1.046 beats/min, 90.100±1.161 beats/min. and 91.400±0.407 beats/min. in the treatment group-A, group-B and group-C, respectively. An elevation in mean pulse rate among all *colibacillosis* affected calves might have happened due to pathophysiological effect of *E.coli* infection on gastrointestinal tract and other vital organs causing severe diarrhea, excess loss of intracellular as well as extracellular fluid and ultimately severe dehydration (Demigne *et al.,* 1980) [17], reduction in blood volume (White, 1993; [18] Bhalerao et *al.,* 2000; [19] and possible tachycardia (Radostitis *et al.,* 2010) [13]. These findings during present course of investigation are in corroboration with the findings of Shaheen *et al.,* (2002) [20], Devkate *et al.,* (2010) [21], Chand (2012) [19] and Manu *et al.,* (2019) [16].

Faecal consistency

A total of 93.33% calves showed watery diarrhea and only 6.66% calves showed loose diarrhea before treatment, which are in agreement with Arora *et al.,* (2010) [22], Devkate (2010) [21], and Kumar *et al.,* (2010) [23]. Result also indicates that following subsequent days of treatment faecal consistency improved from 2nd days in the entire group-A, group-B and group-C. However improvement was more in number of calves of group-C (85%) than group-B(80%) and group-A(75%) on 4th day of observation which might have occurred due to chemical constituent of *Psidium guajava and Punica granatum* such as coumarins, essential oils, flavonoid, triterpins and ellagitanins which are known to have antimicrobial properties as well as antidiarrheal properties (Adeyemi 2008; [24] Sapkota *et al*., 2012; [25] Dixit *et al*., 2013; [26] Farhana *et al*., 2017) [27]. Our findings of enhanced yellowish-green to whitish color, semi-solid to watery and mucoid diarrhea in case of *colibacillosis* calves are in agreement with Jesse *et al.,* 2016; [28] Tarunpreet *et al*., 2018 [12] and Manu *et al*., 2019 [16].

Appetite

It was found that 93.33% *colibacillosis* affected calves depicted anorexic behavior, meanwhile 6.66% calves showed inappetance before the treatment i.e. on day 0(pre-treatment).The present findings were in corroboration to the previous scientific endeavor of Radostits *et al.,* 2000 [29] who also narrated that the diarrheic calves become anorexic to inappetance due to disruption of digestive and absorptive function of the intestine, interference with destruction of the cells lining of the intestine, as a result of *colibacillosis*

infection. Result also indicates that following subsequent days of treatment all the affected calves regain their normal appetite from 2nd day. However improvement was more in number of calves of group-C (45%) than group-B (40%) and group-A (20%) which might be due to several compounds have been isolated from *Punica granatun* such as Punicalagin and tannin having antiproliferative and antioxidant activities (Noda *et al*., 2002: [30] Schmidt *et al.*, 2005, [31] Seeram *et al*., 2005) [32] and anti-spasmotic (Lozoya *et al.*, 2002) [33] properties of *Psidium guajava*. Such findings during present study among all diarrheic calves were in agreement with the observations of Asati *et al.*, (2008) [34], Devkate *et al.*, (2010) [21] ; Kumar *et al.*, (2010); [23] Nguyen *et al*,. (2011) [35] and Manu *et al.*, (2019) [16] who also observed anorexia, inappetance, dull, depressed, lethargic, severe diarrhoea and dehydration in *colibacillosis* affected calves.

Mucous membrane appearance

During the present course of study 85% *colibacillosis* affected calves showed dry mucous membrane on 0 day (i.e. pre-treatment) which might be due to loss of fluid from interstitial as well as from intra cellular space, which are in agreement with Radostitis *et al.*, (2007) [5]. Michell *et al.*, (1989) [36] reported that mucous membrane become sticky and viscid due to dehydration and as the circulation gradually get depressed the cyanosis (blue discoloration) may also be observed. Result also indicated that the following subsequent days of treatment altered appearance of mucous membrane showed normal appearance in colour among the calves of groups-A, group-B and group-C from 2nd day of observation. The recovery was more in number of calves of group-B (90%) than group-C (85%) and group- A (70%) on 4th day of observation, which might be due to abundance of chemical constituents rich in *Punica granatum* rind and *Psidium guajava* leaves such as flavonoid, phenols, triterpenes, ellagitannins, trepenoids, saponins, anthraquinone, glycoside and tannins (Sapkota *et al.*, 2012; [25] Bhalodia *et al.*, 2012) [37]. From 6th day onwards all the calves recovered to normal appearance of mucous membrane showing moist and pink in colour. Our findings of enhanced dryness of mucous membrane in case of *colibacillosis* calves were in agreement with Asati *et al.*, (2008) [34], Tikoo and soodan (2009) [38] and Arora *et al.*, (2010) [22].

Behavior (Demeanor)

About 96.66% of *colibacillosis* affected calves showed dull or pathetic condition and only 3.33% calves showed bright and alert behavior on 0 day i.e. pre-treatment. These altered behaviors during *colibacillosis* in calves might be occurred due to decrease in circulating blood volume owing dehydration leading to decreased mental alertness along with varying degree of muscular weakness (Radostitis *et al.*, 2007) [5]. Following subsequent days of treatment result also indicate that altered behavior of *colibacillosis* affected calves showed relief to act as normal from 4th day onwards. On 2nd day of observation an equal improvement (i.e. in 20%) in condition was noted in calves of group-B and group-C while it remains in 10% of calves of group-A. Such finding shows beneficial effect of herbal medicine *Punica granatum* rind and *Psidium guajava* leaves over chemical drugs Ofloxacin. The chemical compounds like flavonoid, phenols triterpenes, ellagitannins, trepenoids, saponins, anthraquinone, glycoside and tannins present in *Punica granatum* rind and *Psidium guajava* leaves might had helped in early improvement in behavior of *colibacillosis* affected calves as also reported earlier by (Sapkota *et al.*, 2012; [25] Bhalodia *et al.*,2012) [37]. Our findings during present research work in *colibacillosis* affected calves were in corroboration with Sukare (2007) [39], Asati *et al.*, (2010) [40], Jesse *et al.*, (2016) [28] and Manu *et al.*, (2019) [16] who also observed altered behavior in *colibacillosis* affected calves.

Skin elasticity (Time elapsed to normal after tenting)

A total of 68.33% of *colibacillosis* affected calves showed severe dehydration with increase in skin tenting time (5-10 seconds) in which 31.66% calves showed mild dehydration with skin tenting time 2-4 second on 0 day (pre-treatment). The reason behind increase in skin elasticity time observed in *colibacillosis* affected calves might be due to fluid loss from the interstitial and intracellular space (Radostitis *et al.*, 2007; [5] Kumar *et al.*, 2002; [41] Michell *et al.*, 1992; [42] Thorontal *et al.*, 1973) [43]. It was observed that the loss of normal skin elasticity in *colibacillosis* affected calves recover after subsequent days of treatment in the treatment groups- B and C from 4th day onwards, while mild dehydration with skin elasticity time (2-4 seconds) remains in 95% calves of treatment group-A. These improvements in group-B and group-C might be occurred due to chemical constituents such as flavonoid, phenols triterpenes, ellagitannins, trepenoids, saponins, anthraquinone, glycoside and tannins which are known to have antidiarrheal as well as antimicrobial and antioxidant properties of *Punica granatum* rind and *Psidium guajava* leaves (Sapkota *et al.*, 2012; [25] Bhalodia *et al.*,2012) [37]. The observation pertaining to skin elasticity during the present course of investigation in *colibacillosis* affected calves corroborated with the findings of Tikoo and Soodan (2009) [38], Arora *et al.*, (2010) [22], Manu *et al.*, (2019) [16] and Xavier *et al.*, (2020) [44] who found an increase of skin elasticity to 07 second in *colibacillosis* affected calves.

Enophthalmos

Sunken eyes were observed in 75% of *colibacillosis* affected calves and 25% had normal in enophthalmos on 0 day (pre-treatment). Enophthalmos can be clearly visible in diarrhoeic calves where the eye is usually prominent in its orbit (Michell *et al.*, 1989; [36] Constable *et al.*, 1996; [45] Kumar and Mandial, 2002) [46].The reason for sunken eye might be due to decrease in the volume of post orbital fat deposits (Radostitis *et a*l., 2007) [5]. Result also indicates that the following subsequent days of treatment enophthalmos of *colibacillosis* affected calves regain in the entire group-A, group-B and group-C from 2nd day of observation. On 4th day of observation the recovery was more in group-C (100%) than group-B(95%) and group-A(80%), which might be due to chemical constituent rich in *Punica granatum* rind and *Psidium guajava* leaves such as flavonoid, phenols, triterpenes, ellagitannins, trepenoids, saponins, anthraquinone, glycoside and tannins (Sapkota *et al.*, 2012; [25] Bhalodia *et al.*, 2012) [37]. From 6th day onwards all the calves recovered to normal from enophthalmos was observed. Our findings during present research work in *colibacillosis* affected calves are in agreement with Sukare (2007) [39], Asati *et al.*, (2008) [34], Tikoo and Soodan (2009) [38] and Jesse *et al.*, (2016) [28].

Conclusions

After, critical analyzing the various features of *colibacillosis*, it was concluded that treatment with *Psidium guajava* leaf extract @ 40 mg/kg b.wt. for upto 4th days can prove to be

more beneficial than *Punica granatum* rind extract and Ofloxacin in achieving 100% recovery in Clinico-physiological changes that have occurred due to *colibacillosis* in calves.

Acknowledgement
The authors are thankful to the Department of Veterinary Medicine, Ranchi Veterinary College (BAU), for providing necessary facilities to carry out this work.

Reference

1. Radostits OM, Gay CC, Blood DC, Hinchcliff KW. Veterinary Medicine: A Textbook of the Diseases of Cattle, Sheep, Pigs, Goats and Horses. WB Saunders, New York, USA, 2000.
2. Mero KN, Rollin RE, Phillips R.W. Malabsorption due to selected oral antibiotics, Veterinary Clinics North American Food Animal Practice. 1985;1:581-588.
3. Lutterodt GD. Inhibition of gastrointestinal release of acetylcholine by quercetin as a possible mode of action of *Psidium guajava* leaf extracts in the treatment of acute diarrhoeal diseases. Journal of Ethnopharmacology. 1989;25:235-247.
4. Alnieida CC, Karnikowski MG, Flieto R, Baldisserotto B. Analysis of antidiarrhoic effect of plantsused in popular medicine. Revista De Saude Publica. 1995;29:428-433.
5. Radostitis OM, Gay CC, Hincheliff KW, Constable PD. Veterinary Medicine, A textbook of the diseases of cattle, sheep, goats, pigs and horse.10th ed. Elsevier Saunders, Landon, UK. 2007.
6. Brooks HW, White DG, Wagstaff AJ, Michell AR. Evaluation of aglutamine containing oral rehydration solution for the treatment of calf diarrhoea using an E. coli model. Vet. J., 1997;153:163-170.
7. Snedecor GW, Cochran WG. Statistical Methods.8th Edn. Oxford and IBH Publishing Co. Pvt. Ltd., Kolkata. 2004.
8. Wray C, Thromblinson JR. The effect of E.coli endotoxin in calves. Res. Vet. 1972;13:546.
9. Chand PK. Clinico-biochemical and therapeutic studies on Colibacillosis in Buffalo calves: M.V.Sc. thesis submitted to department of clinical veterinary medicine, ethics & jurisprudence Sri Venkateswara Veterinary University, Tirupati. 2012.
10. Hassan N, Sheikh GN, Hussian SA, Nazir G. Variation in clinical findings associated with neonatal colibacillosis in lambs before and after treatment. Vet. World. 2014;7(4):262-265.
11. Mehesare SS. Phytopharmacological and therapeutic study of polyherbal antidiarrhoeal formulation in goats. Ph.D. Thesis, submitted to Maharashtra Animal and Fishery Science University, Nagpur. 2018.
12. Tarunpreet SK, Sharma AP, Singh Deepika Goklaney. Prevalence of colibacillosis disease and clinico-haemato biochemical changes in lambs in Southern part of Rajasthan. Veterinary Practitioner. 2018;20(1):95-99.
13. Radostitis OM, Gay CC, Blood DC, Hinchcliff KW. Disease of the alimentary tract. A Textbook of Disease of Cattle, Sheep, Pigs, Goats and Horses. 10th Edn., Saunders Publication co., Oxford, Landon, 2010, 92-93.
14. Ershaduzzaman M, Taimur MJFA, Das T, Mamunul MH, Mahmudur MR. Epidemiological studies on kid diseases associated with morbidity and mortality in intensive and semi intensive systems in Bangladesh. Int. J Innovation Appl. Stud. 2013;3(2):456-462.
15. Uetake K. Newborn calf welfare: A review focusing on mortality rates. Anim. Sci. J. 2013;84:101-105.
16. Manu Jaiswal PC, Shukla Alok Mishra, Preeti Bisht. Clinical score and haemato-biochemical alterations in acute diarrhoea in calves. The Pharma Innovation Journal. 2019;8(2):529-532.
17. Demigne C, Chartier F, Remesy C. Evidence of different type of acidosis associated with diarrhoea in neonatal calf. Annals of Veterinary Research. 1980;11:267-72.
18. White DG. Some logical aspects of the treatment of lacticacidosis in twocalves.Vet. Rec., 1993;132:275-276.
19. Bhalerao DP, Navade RN, Jagadish S, Samad A, Keshar DV. Neonatal calf diarrhoea: Therapeutic approach. Indian Vet. J., 2000;77(9):817-818.
20. Shaheen M, Pampori ZA, Matto FA, Shah RA. Neonatal calf enteritis in Kashmir and its management. Indian Vet. J., 2002;79:723-724.
21. Devkate BR, Bhikane AU, Bhonsale AV, Awaz KB, Syed AM. Clinico-therapeutic aspects of bacterial diarrhoea in bovines. Intas Polivet, 2010;11(2):228-232.
22. Arora N, Rajora VS, Shukla SK, Singh JL. Evaluation of a poly herbal formulation in treatment of calf diarrhoea. Indian Vet. J. 2010;87(10):1043-1044.
23. Kumar BK, Shekher P, Kumar N. A clinical study on neonatal calf diarrhoea. Intas Polivet, 2010;11(2):233-235.
24. Adeyemi OO, Akindele AJ. Antidiarrhoeal activity of the ethyl acetate extract of *Baphia nitida* (Papilionaceae). Journal Ethnopharmocology. 2008;116:407–412.
25. Sapkota R, Dasgupta R, Nancy Rawat DS. Antibacterial Effects of Plants Extracts. International Journal of Applied Biology and Pharmaceutical Technology. 2012;2:926-936.
26. Dixit PK, Panchal P, Mittal S. Antimicrobial activity of ethanolic, methanolic and hot aqueous extract of Punica granatum peel. International Journal of Pharmacy and Life Sciences. 2013;4:2905-2907.
27. Farhana J, Md. FarukHossain, MF Mowla A. Antibacterial Effects of Guava (*Psidium guajava* L.) Extracts Against Food Borne Pathogens. International Journal of Nutrition and Food Sciences. 2017;6:1-55.
28. Jeese FFA, S MA, Abba Y, Chung ELT, Adamu L, Bitrus AA, Hambali DU. Clinico-Pathological Findings of Septicaemic Colibacillosis in a Calf. J. Dairy Vet. Anim. Res. 2016;4(3):2016.
29. Radostits OM, Gay CC, Blood DC, Hinchcliff KW. Veterinary Medicine: A Textbook of the Diseases of Cattle, Sheep, Pigs, Goats and Horses. WB Saunders, New York, USA, 2000.
30. Noda Y, Kaneyuki T, Mori A, Packer L. Antioxidant activities of pomegranate fruit extract and its anthocyanidins: Delphinidin, cyaniding and pelargonidin. Journal of Agricultural Food Chemistry. 2002;50:166-171.
31. Schmidt A, Mordhorst T, Nieger M. Investigation of a betainic alkaloid from Punica granatum. Natural Product Researh, 2005;19:541-546.
32. Seeram NP, Adams LS, Henning SM, Niu Y, Zhang Y, Nair, *et al*. *In vitro* antiproliferative, apoptotic and antioxidant activities of punicalagin, ellagic acid and a total pomegranate tannin extract are enhanced in combination with other polyphenols as found in pomegranate juice. Journal Nutritional Biochemistry.

2005;16:360-367.
33. Lozoya X, Reyes-Morales H, Chavez-Soto MA, Martinez-Garci a MC, Soto-Gonzalez Y, Doubova SV. Intestinal anti-spasmodic effect of a phytodrug of Psidium guajava folia in the treatment of acute diarrhoeic disease. J Ethnopharmacol. 2002;83:19-24.
34. Asati CK, Roy S, Roy M. Haemato-biochemical study and diagnosis of colibacillosis in calves. Intas Polivet. 2008;9(2):245-248.
35. Nguyen TD, Vo TT, Vu-Khac H. Virulence factors in *Escherichia coli* isolated from calves with diarrhea in Vietnam. J Vet Sci. 2011 ;12:159-164.
36. Michell AR, Bywater RJ, Clarke KW, Hall LW, Water AE. Veterinary fluid Therapy. Black well Scientific Publications, London. 1989.
37. Bhalodia NR, Nariya PB, Acharya RN, Shukla VJ. *In vitro* antibacterial and antifungal activities of Cassia fistula Linn. fruit pulp extracts. Ayurved University. 2012;33:123-129.
38. Tikoo A, Soodan JS. Colibacillosis in neonatal calves and its management. Intas Polivet. 2009;10(2):212-213.
39. Sukare Prashant Ganesh. Evualation of Herbal Antidiarrhoeal with oral rehydration in calf diarrhoea of cow calf. Thesis submitted to Maharashtra Animal and Fishery Sciences University, Nagpur, 2007.
40. Asati CK, Roy S, Roy M. Evaluation of oral rehydration solution and amoxicillin–salbactam treatment of colibacillosis in calves. Indian Vet. J. 2010;87(5):454-456.
41. Kumar R, Mandial RK. Clinico-biochemical and therapeutic studies on clinical colibacillosis in crossbred calves. Indian Vet. J. 2002;79:672-676.
42. Michell AR, Brooks HW, White DG, Wagstaff AJ. The comparative effectiveness of three commercial oral solutions in correcting fluid, electrolyte and acid base disturbances caused by calf diarrhoea. Br. Vet. J. 1992;148:507-522.
43. Thornton JR, Butler DG, Willoughby RA. Blood urea nitrogen concentration and packed cell volume of normal calves with diarrhoea. Aus. Vet. J. 1973;49:20-22.
44. Xavier Mathew, Janus A, Deepa PM, Bipin KC, Biju P, Habeeb, Abdul Azeez CP. Haemato-biochemical alterations in colibacillosis affected calves in Wayanad, Kerala. The Pharma Innovation Journal SP. 2020;9(8):64-66.
45. Constable PD, Gohar HM, Morin DE, Thurmon JC. Use of hypertonic saline dextran solution to resuscitate hypovolemic calves with diarrhoea. Am. J Vet. Res. 1996;57:97-104.
46. Kumar R, Mandial RK. Clinico-biochemical and therapeutic studies on clinical colibacillosis in crossbred calves. Indian Vet. J. 2002;79:672-676.