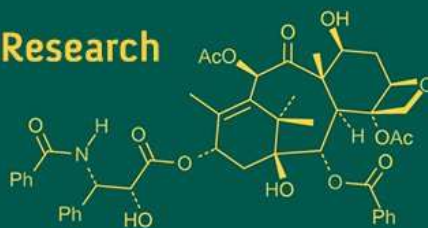
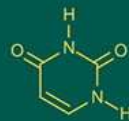
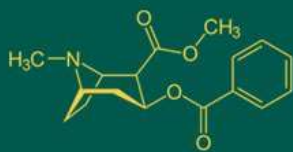


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(5): 105-110
www.biochemjournal.com
Received: 07-02-2026
Accepted: 10-03-2026

Amani Sankhye
M.V.Sc Scholar, Department of
Veterinary Pharmacology &
Toxicology, P.V. Narsimha Rao
Telangana Veterinary University,
Rajendranagar, Hyderabad,
Telangana, India

Vanitha Sree K
Associate Professor Veterinary
Pharmacology & Toxicology,
Additional C.O.E Administrative
Office, PVNRTVU-Rajendranagar,
Telangana, India

Kasturi Devi K
Associate Professor Veterinary
Pharmacology & Toxicology- C.V.Sc.
Rajendranagar, Telangana, India

Y Ravi Kumar
Associate Professor & Head-
Veterinary Pathology, C.V.Sc.,
Korutla, Telangana, India

Shireesha Koolla
M.V.Sc Scholar, Department of
Veterinary Pharmacology &
Toxicology, P.V. Narsimha Rao
Telangana Veterinary University,
Rajendranagar, Hyderabad,
Telangana, India

Ch. Priya
M.V.Sc Scholar, Department of
Veterinary Pharmacology &
Toxicology, P.V. Narsimha Rao
Telangana Veterinary University,
Rajendranagar, Hyderabad,
Telangana, India

Y Poojitha
M.V.Sc Scholar, Department of
Veterinary Pathology, P.V. Narsimha
Rao Telangana Veterinary University,
Rajendranagar, Hyderabad,
Telangana, India

Hanuman D
Ph.D., Scholar, Department of
Veterinary Pharmacology &
Toxicology, P.V. Narsimha Rao
Telangana Veterinary University,
Rajendranagar, Hyderabad,
Telangana, India

Gopala Reddy A
Professor and University Head-
Veterinary Pharmacology &
Toxicology C.V.Sc. Rajendranagar,
Telangana, India

Corresponding Author:
Amani Sankhye
M.V.Sc Scholar, Department of
Veterinary Pharmacology &
Toxicology, P.V. Narsimha Rao
Telangana Veterinary University,
Rajendranagar, Hyderabad,
Telangana, India

Evaluation of Apigenin and Piperine against DSS-induced colitis in mice using body weight, colon weight, colon length and disease activity index

Amani Sankhye, Vanitha Sree K, Kasturi Devi K, Y Ravi Kumar, Shireesha Koolla, Ch. Priya, Y Poojitha, Hanuman D and Gopala Reddy A

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i5b.8323>

Abstract

An experimental study was undertaken to assess the protective effects of Apigenin and Piperine against dextran sodium sulfate (DSS)-induced colitis in BALB/c mice. Thirty male mice were randomly divided into five groups (n = 6) and treated for 14 days. Group I served as control, while Group II received 2% DSS orally. Groups III and IV were treated with DSS along with Apigenin (5 and 10 mg/kg b.wt) and Piperine (12.5 and 25 mg/kg b.wt), respectively. Group V received DSS with dexamethasone sodium (1 mg/kg b.wt, i.p.). Body weight and disease activity index (DAI) were monitored throughout the study. On day 14, the colon length and weight were recorded post-sacrifice. The findings indicated that co-administration of Apigenin and Piperine, particularly at higher doses, significantly ($p < 0.05$) attenuated DSS-induced alterations, as evidenced by reduced body weight loss, prevention of colon shortening, restoration of colon weight, and a marked decrease in disease activity index, thereby demonstrating their protective efficacy against colitis.

Keywords: Dextran Sodium Sulfate (DSS), Apigenin, Piperine, colon

Introduction

Ulcerative colitis (UC) is a chronic inflammatory bowel disease that affects the inner lining of the colon and rectum, leading to persistent inflammation. Colitis more broadly refers to inflammation of the colon, marked by mucosal damage, loss of epithelial integrity, infiltration of immune cells, and increased intestinal permeability (Owusu *et al.*, 2020) [1]. Experimentally induced colitis closely resembles human ulcerative colitis, presenting with diarrhoea, rectal bleeding, weight loss, colon shortening and tissue changes. Persistent inflammation of the colonic lining impairs intestinal function, sustaining chronic disease and relapse (Beiranvand and Dehghan, 2025) [2]. Ulcerative colitis (UC) is a major cause of persistent vomiting and diarrhoea in animals, particularly dogs, cats, and pigs. In growing pigs, diarrhoea resulting from colon inflammation poses a serious challenge for the swine industry, as it compromises animal welfare, slows growth, and increases feed conversion ratios (Panah *et al.*, 2021) [3].

DSS, a sulfated polysaccharide, triggers colonic inflammation by directly damaging epithelial cells, disrupting tight junctions, and compromising the mucosal barrier (Naveen *et al.*, 2023) [4]. Corticosteroids are widely used as standard anti-inflammatory treatments for ulcerative colitis because of their strong immunosuppressive effects. Dexamethasone, a synthetic glucocorticoid, helps by reducing inflammatory cytokine production, inhibiting immune cell activity, and easing mucosal inflammation. However, long-term corticosteroid use can lead to complications such as metabolic imbalances, weakened immunity, delayed wound healing, and greater infection risk. These drawbacks highlight the need for safer alternatives, especially those derived from natural sources (Radlovic *et al.*, 2025) [5].

Apigenin is a naturally occurring flavonoid found in many fruits, vegetables, and medicinal plants. It has been widely studied for its anti-inflammatory, antioxidant, and protective effects. These benefits arise from its ability to suppress pro-inflammatory cytokines, block inflammatory signalling pathways, and reduce oxidative stress (Singh *et al.*, 2025) [6].

Piperine, the primary alkaloid in *Piper nigrum*, is recognized for its strong anti-inflammatory and antioxidant properties. It has been shown to suppress the release of inflammatory mediators, thereby contributing to its protective effects (Sree *et al.*, 2025) [7]. Piperine also enhances the bioavailability of other compounds, thereby boosting their therapeutic effectiveness when co-administered (Han *et al.*, 2023) [8]. Recent studies indicate that combining natural compounds can provide stronger protection against colitis by addressing multiple disease mechanisms, including epithelial barrier disruption, oxidative stress, and inflammatory cytokine production (Boobalan *et al.*, 2015) [9].

Considering the importance of the DSS-induced colitis model, the challenges of corticosteroid therapy, and the promising pharmacological properties of apigenin and piperine, this study aims to evaluate their protective effects against dextran sodium sulfate (DSS)-induced colitis in mice.

Materials and Methods

Drugs

Dextran sodium sulfate was procured from BLD Pharma tech, India-(Cat. No.BD123894), Apigenin from Tokyo Chemical Industry, Japan-(Cat. No. A1514) and Piperine from Tokyo Chemical Industry, Japan-(Cat. No. P0460).

Experimental Animals

Thirty adult male BALB/c mice (25-30 g) were obtained from Jeeva Life Sciences and housed under standard laboratory conditions (22-24 °C temperature, 30-70% humidity, 12 h light/dark cycle). After one week of acclimatisation, animals were maintained on a standard pellet diet with ad libitum access to water. All procedures were approved by the Institutional Animal Ethics Committee (Approval No. 06/30/C.V.Sc, Hyd.IAEC). Mice were randomly divided into five groups (n = 6) and treated for 14 days.

Table 1: Experimental Design

Group	Treatment	No. of mice
I	Sham (Normal saline for 14 days)	6
II	Dextran Sodium Sulfate (DSS) (2%) in drinking water per orally (1 st day to 14 th day)	6
III	DSS (2%) per orally from 1 st day to 14 th day + Apigenin (5 mg/kg b.wt per orally from 1 st day to 14 th day) + Piperine (12.5 mg/kg b.wt per orally from 1 st day to 14 th day)	6
IV	DSS (2%) per orally from 1 st day to 14 th day + Apigenin (10 mg/kg b.wt per orally from 1 st day to 14 th day) + Piperine (25 mg/kg b.wt per orally from 1 st day to 14 th day)	6
V	DSS (2%) per orally from 1 st day to 14 th day + Dexamethasone sodium (1 mg/kg b.wt from 1 st day to 14 th day i/p)	6

Body weights

The body weights (g) were recorded on day 0 and subsequently on 7th and 14th days of the experimental period using an electronic weighing balance (Shimadzu Pvt. Ltd.).

Disease Activity Index (DAI)

The Disease Activity Index (DAI) was applied to assess the severity of intestinal injury, with scoring performed according to the DSS-induced damage criteria outlined by Zhao *et al.* (2023) [10]. Assessment of DAI is based on the weight change, faecal trait and stool occult blood (Table 2).

Colon weight and length

At the end of the experiment, the experimental animals were anesthetized with 4% chloral hydrate. The colon was collected, measured the length and weighed.

Table 2: Assessment of disease activity index (Zhao *et al.*, 2023)

Parameter	Observation	Score
Percentage loss in body weight (%)	No loss	0
	1-5%	1
	6-10%	2
	10-20%	3
	≥21%	4
Stool consistency	Normal stool	0
	Loose stool	1-2
	Watery diarrhoea	3-4
Percentage of bloody stool	No bloody stool	0
	Slight bleeding	1-2
	Excessive bleeding	3-4

Statistical analysis

Data were expressed as mean±SE (n = 6). Statistical analysis was performed using SPSS software (version 21) by one-way ANOVA, followed by Duncan's multiple range

test for post hoc comparisons. A value of $p < 0.05$ was considered statistically significant.

Results

Body weights

The body weights of mice in Group I were significantly ($p < 0.05$) higher than those in all other groups throughout the experimental period. Group II showed a significant reduction in body weight compared to the control group on days 7 and 14. In contrast, Groups III and IV exhibited a significant ($p < 0.05$) improvement in body weight when compared to Group II. Furthermore, no significant difference was observed between Groups IV and V, indicating comparable effects on body weight. The findings are outlined in Table 3 and graphically represented in Figure 1.

Disease activity index (DAI) of colon

The disease activity index (DAI) in Group II was significantly ($p < 0.05$) higher compared to Group I. Treatment groups III and IV showed a significant ($p < 0.05$) reduction in DAI in a dose-dependent manner when compared to Group II. However, a significant ($p < 0.05$) difference was also observed between Groups IV and V, with Group V exhibiting a greater reduction in DAI (Table 4; Fig. 2).

Colon length (cm)

A significant ($p < 0.05$) decrease in colon length was observed in Group II compared to the control group. In contrast, Groups III and IV demonstrated a significant ($p < 0.05$) restoration of colon length in a dose-dependent manner relative to Group II. Furthermore, Group V showed a significantly ($p < 0.05$) higher colon length compared to Group IV (Table 5; Fig. 3).

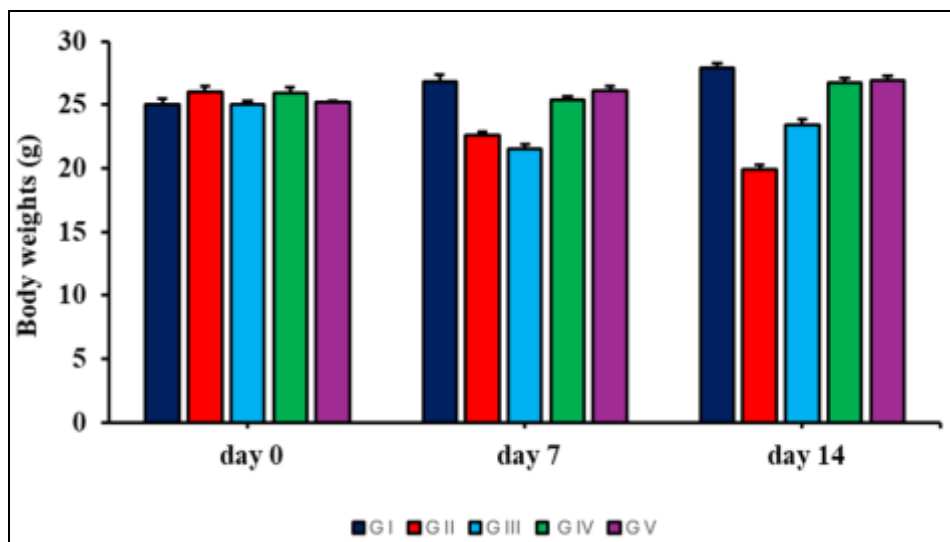
Colon Weight (mg)

Colon weight in Group II was significantly ($p<0.05$) reduced compared to Group I. In contrast, Groups III and IV showed a significant ($p<0.05$) increase in colon weight

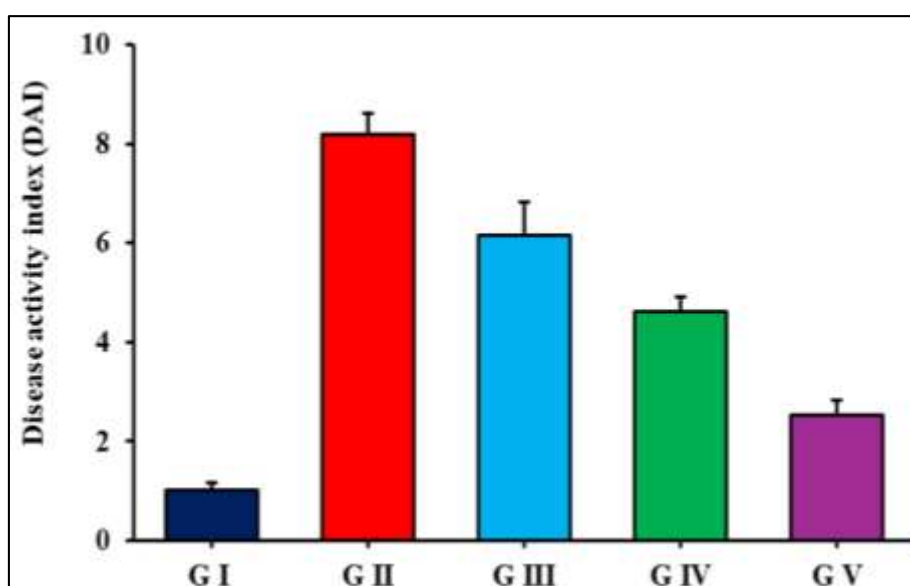
when compared to Group II. However, no significant difference was observed between Groups IV and V (Table 6; Fig. 4).

Table 3: Weekly body weights (g) in different groups of mice

Group	Treatment	day 0	day 7	day 14
I	Sham	25.08±0.56 ^a	26.81±0.61 ^c	27.96±0.48 ^c
II	Dextran Sodium Sulfate (DSS) 2% in drinking water p.o/daily	26.01±0.50 ^a	22.61±0.32 ^a	19.98±0.49 ^a
III	DSS + Apigenin (5 mg/kg b.wt) + Piperine (12.5 mg/kg b.wt) p.o/daily	25.03±0.30 ^a	21.51±0.43 ^a	23.41±0.53 ^b
IV	DSS + Apigenin (10 mg/kg b.wt) + Piperine (25 mg/kg b.wt) p.o/daily	25.91±0.50 ^a	25.43±0.34 ^b	26.73±0.40 ^c
V	DSS + Dexamethasone sodium (1 mg/kg b.wt i/p daily)	25.28±0.17 ^a	26.15±0.48 ^{bc}	26.96±0.46 ^c

**Fig 1:** Weekly body weights (g) in different groups of mice**Table 4:** Disease Activity Index (DAI) of colon of different groups of mice

Group	Treatment	14 th day
I	Sham	1.03±0.13 ^a
II	Dextran Sodium Sulfate (DSS) 2% in drinking water p.o/daily	8.20±0.42 ^e
III	DSS + Apigenin (5 mg/kg b.wt) + Piperine (12.5 mg/kg b.wt) p.o/daily	6.16±0.66 ^d
IV	DSS + Apigenin (10 mg/kg b.wt) + Piperine (25 mg/kg b.wt) p.o/daily	4.63±0.28 ^c
V	DSS + Dexamethasone sodium (1 mg/kg b.wt i/p daily)	2.53±0.29 ^b

**Fig 2:** Disease Activity Index (DAI) of colon of different groups of mice**Table 5:** Mean values of colon length (cm) in different groups of mice

Group	Treatment	14 th day
I	Sham	9.85±0.32 ^e
II	Dextran Sodium Sulfate (DSS) 2% in drinking water p.o/daily	4.01±0.34 ^a
III	DSS + Apigenin (5 mg/kg b.wt) + Piperine (12.5 mg/kg b.wt) p.o/daily	5.96±0.54 ^b
IV	DSS + Apigenin (10 mg/kg b.wt) + Piperine (25 mg/kg b.wt) p.o/daily	7.31±0.42 ^c
V	DSS + Dexamethasone sodium (1 mg/kg b.wt i/p daily)	8.55±0.29 ^d

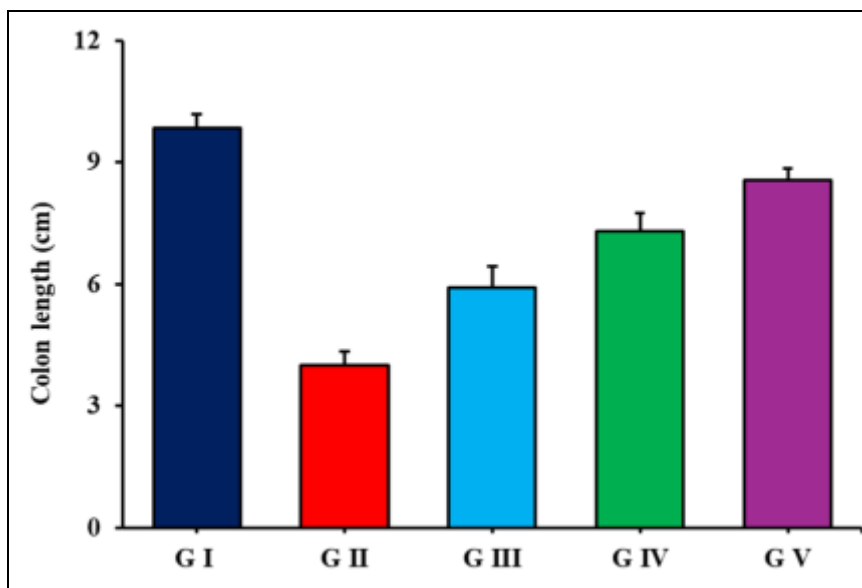


Fig 3: Mean values of colon length (cm) in different groups of mice

Table 6: Mean values of colon weight (mg) in different groups of mice

Group	Treatment	14 th day
I	Sham	823.33±32.52 ^d
II	Dextran Sodium Sulfate (DSS) 2% in drinking water p.o/daily	121.33±11.11 ^a
III	DSS + Apigenin (5 mg/kg b.wt) + Piperine (12.5 mg/kg b.wt) p.o/daily	285.01±22.47 ^b
IV	DSS + Apigenin (10 mg/kg b.wt) + Piperine (25 mg/kg b.wt) p.o/daily	515.02±47.66 ^c
V	DSS + Dexamethasone sodium (1 mg/kg b.wt i/p daily)	610.01±48.64 ^c

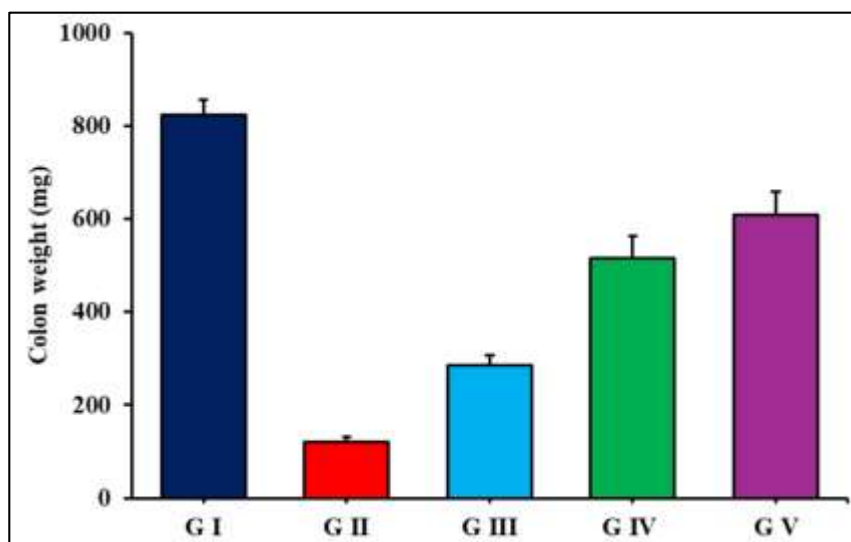


Fig 4: Mean values of colon weight (mg) in different groups of mice

Discussion

Inflammatory bowel disease (IBD) comprises a group of chronic disorders marked by recurrent intestinal inflammation, affecting both humans and domestic animals such as dogs and cats (Pratscher *et al.*, 2024) ^[11]. The DSS-induced colitis model is a well-established method for studying ulcerative colitis (UC) (Yang and Merlin, 2024) ^[12]. DSS causes damage to the colonic epithelium and

disrupts barrier function, facilitating the entry of bacteria and inflammatory substances into the mucosa, which initiates the disease process (Eichele and Kharbanda, 2017) ^[13]. Management of UC largely targets the reduction of abdominal discomfort and control of immune-mediated inflammation (Sandborn, 2013) ^[14]. Apigenin, a dietary flavonoid abundant in plant-derived foods and beverages, possesses significant pharmacological

activities (Siddiquee *et al.*, 2025) ^[15]. Oral administration has been shown to alleviate DSS-induced colitis through protection of the intestinal barrier and improvement in colon structure (Hu *et al.*, 2023) ^[16]. Piperine, the bioactive compound of black pepper and long pepper, possesses significant pharmacological and anti-inflammatory activities. It has been reported to attenuate colorectal inflammation and enhance barrier function in experimental colitis models, including DSS-induced colitis (Gupta *et al.*, 2015; Hu *et al.*, 2025) ^[17, 18].

In this study, mice in disease control group II showed a significant reduction in body weight over 14 days compared to other groups, likely due to impaired gastrointestinal absorption and fluid loss during diarrhoea, consistent with previous reports (Qu *et al.*, 2021; Kalyankumarraju *et al.*, 2021; Zheng *et al.*, 2021) ^[19, 20, 21]. In contrast, treatment groups III and IV exhibited marked weight gain relative to group II, indicating the protective effects of apigenin and piperine. This improvement may be attributed to epithelial repair, restoration of metabolic activity, increased goblet cell numbers, and enhanced cellular biosynthesis. These findings agree with earlier studies (Hu *et al.*, 2015; Mascaraque *et al.*, 2015; Hu *et al.*, 2023; Ji *et al.*, 2025) ^[22, 23, 24, 25].

A significant reduction in colon weight and length was observed in disease control group II compared to group I, likely due to acute inflammation and epithelial cell loss. This is supported by gross lesions showing severe congestion and mucosal erosions. These findings are consistent with earlier reports (Mao *et al.*, 2022; Deng *et al.*, 2022; Simeonova *et al.*, 2025) ^[26, 27, 28]. In contrast to this, a marked improvement in colon weight and length was observed in treatment groups III and IV, supported by histological evidence of epithelial regeneration and normalization of villi structure. This protective effect is likely due to the anti-inflammatory actions of apigenin and piperine, consistent with reported findings (Fu *et al.*, 2022; Hu *et al.*, 2025) ^[29, 18].

Disease severity assessed using the Disease Activity Index (DAI), based on weight loss, stool consistency, and faecal blood, was markedly elevated in group II compared to group I, reflecting mucosal injury, impaired absorption, and intestinal bleeding. These findings are consistent with previous reports (Tian *et al.*, 2020; Lv *et al.*, 2020; Niu *et al.*, 2022) ^[31, 32, 33]. Treatment groups III and IV showed significant improvement, with reduced DAI scores, weight gain, and alleviation of diarrhoea, likely due to the anti-inflammatory and mucosal-protective effects of apigenin and piperine, as supported by earlier studies (Hu *et al.*, 2015; Ji *et al.*, 2025) ^[22, 25]. Group V demonstrated further improvement, with greater reduction in weight loss and bloody stools compared to group IV.

Conclusion

In conclusion, the present study revealed that DSS (2% per orally from 1st day to 14th day) effectively induced colitis, as evidenced by body weight loss, colon shortening, and elevated disease severity assessed by the Disease Activity Index (DAI), based on weight loss, stool consistency, and faecal blood. Treatment with apigenin and piperine synergistically ameliorated colitis, as demonstrated by restoration of colon weight, colon length, body weight, and a significant reduction in Disease Activity Index (DAI) scores.

Acknowledgements

The authors are thankful to the College of Veterinary Science, P. V. Narsimha Rao Telangana Veterinary University (PVNRTVU), Rajendranagar, Hyderabad for providing the necessary facilities to carry out the research work.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

- Owusu G, Obiri DD, Ainooson GK, Osafo N, Antwi AO, Duduyemi BM, *et al.* Acetic acid-induced ulcerative colitis in Sprague Dawley rats is suppressed by hydroethanolic extract of *Cordia vignei* leaves through reduced serum levels of TNF- α and IL-6. *Int J Chronic Dis.* 2020;2020:8785497.
- Beiranvand M, Dehghan G. A review on ulcerative colitis induction models and the protective mechanism of carbon quantum dots as a novel anti-inflammatory and anti-ulcer agent. *Discov Pharm Sci.* 2025;1(1):14.
- Panah FM, Lauridsen C, Højberg O, Nielsen TS. Etiology of colitis-complex diarrhea in growing pigs: a review. *Animals (Basel).* 2021;11(7):2151.
- Naveen L, Devarasetti AK, Jayasri A, Reddy AG, Murtuza MS, Kumar YR. Ameliorative effects of lactoferrin and dexamethasone sodium on acetic acid-induced ulcerative colitis in Wistar rats. [Journal details not provided].
- Radlović A, Safiye T, Mahmutović E. The use of corticosteroids in the treatment of ulcerative colitis: a brief overview. *Arch Pharm.* 2025;75(3):167-180.
- Singh A, Singh J, Parween G, Khator R, Monga V. A comprehensive review of apigenin, a dietary flavonoid: biological sources, nutraceutical prospects, chemistry and pharmacological insights and health benefits. *Crit Rev Food Sci Nutr.* 2025;65(23):4529-4565.
- Sree KV, Rani MU, Reddy AG, Rajender B, Hanuman DD, Rao K, *et al.* Galangin and piperine attenuate bleomycin-induced pulmonary fibrosis by modulating oxidative stress and MPO-mediated inflammation. *J Adv Biol Biotechnol.* 2025;28(11):1375-1385.
- Han J, Zhang S, He J, Li T. Piperine: chemistry and biology. *Toxins (Basel).* 2023;15(12):696.
- Boobalan G, Dileep R, Rani MU, Kumar CS, Kumar MV, Reddy AG. Protective role of curcumin and flunixin against acetic acid-induced inflammatory bowel disease via modulating inflammatory mediators and cytokine profile in rats. *J Environ Pathol Toxicol Oncol.* 2015;34(4):[page numbers not provided].
- Zhao T, Zhou YX, Wang RJ, Wan P, Li Y, Zhou LL, *et al.* Fluoxetine ameliorates the aggravation of UC symptoms in C57BL/6 mice induced by CUMS. *Curr Med Sci.* 2023;43(5):1033-1042.
- Pratscher B, Kuropka B, Csukovich G, Doulidis PG, Spirk K, Kramer N, *et al.* Traces of canine inflammatory bowel disease reflected by intestinal organoids. *Int J Mol Sci.* 2024;25(1):576.
- Yang C, Merlin D. Unveiling colitis: a journey through the dextran sodium sulfate-induced model. *Inflamm Bowel Dis.* 2024;30(5):844-853.
- Eichele DD, Kharbanda KK. Dextran sodium sulfate colitis murine model: an indispensable tool for advancing our understanding of inflammatory bowel

- diseases pathogenesis. *World J Gastroenterol*. 2017;23(33):6016-6029.
14. Sandborn WJ. The future of inflammatory bowel disease therapy: where do we go from here? *Dig Dis*. 2013;30(Suppl 3):140-144.
 15. Siddiquee R, Mahmood T, Ansari VA, Ahsan F, Bano S, Ahmad S. Apigenin unveiled: an encyclopedic review of its preclinical and clinical insights. *Discov Plants*. 2025;2(1):11.
 16. Hu Y, Guan X, He Z, Xie Y, Niu Z, Zhang W, *et al*. Apigenin-7-O-glucoside alleviates DSS-induced colitis by improving intestinal barrier function and modulating gut microbiota. *J Funct Foods*. 2023;104:105499.
 17. Gupta RA, Motiwala MN, Dumore NG, Danao KR, Ganjare AB. Effect of piperine on inhibition of FFA-induced TLR4 mediated inflammation and amelioration of acetic acid-induced ulcerative colitis in mice. *J Ethnopharmacol*. 2015;164:239-246.
 18. Hu Y, Wang Y, Gao H, Yang G, Xie J, He Z, *et al*. Piperine improves DSS-induced colitis in mice via inhibition of inflammation and modulation of gut microbiota. *Phytother Res*. 2025;39(7):3197-3211.
 19. Qu Y, Li X, Xu F, Zhao S, Wu X, Wang Y, *et al*. Kaempferol alleviates murine experimental colitis by restoring gut microbiota and inhibiting the LPS-TLR4-NF- κ B axis. *Front Immunol*. 2021;12:679897.
 20. Kalyankumaraju M, Puppala ER, Ahmed S, Kumar GJ, Tene K, NP S, *et al*. Zanthoxylum alatum seed extract ameliorates stress-aggravated DSS-induced ulcerative colitis in mice: plausible role on NF- κ B signaling axis. *J Ethnopharmacol*. 2021;279:114385.
 21. Zheng X, Xiong TX, Zhang K, Zhou FC, Wang HY, Li B, *et al*. Benefit effect of *Dendrobium officinale* ultrafine powder on DSS-induced ulcerative colitis rats by improving colon mucosal barrier. *Evid Based Complement Alternat Med*. 2021;2021:9658638.
 22. Hu D, Wang Y, Chen Z, Ma Z, You Q, Zhang X, *et al*. The protective effect of piperine on dextran sulfate sodium-induced inflammatory bowel disease and its relation with pregnane X receptor activation. *J Ethnopharmacol*. 2015;169:109-123.
 23. Mascaraque C, González R, Suárez MD, Zarzuelo A, de Medina FS, Martínez-Augustín O. Intestinal anti-inflammatory activity of apigenin in two rat colitis models induced by trinitrobenzenesulfonic acid and dextran sulphate sodium. *Br J Nutr*. 2015;113(4):618-626.
 24. Hu Y, Guan X, He Z, Xie Y, Niu Z, Zhang W, *et al*. Apigenin-7-O-glucoside alleviates DSS-induced colitis by improving intestinal barrier function and modulating gut microbiota. *J Funct Foods*. 2023;104:105499.
 25. Ji ZH, Guo HX, Wang B, Ren WZ, Hu JP, Chen C, *et al*. Apigenin alleviates dextran sulfate sodium-induced ulcerative colitis via regulation of endoplasmic reticulum stress in goblet cells. *Int Immunopharmacol*. 2025;162:115164.
 26. Mao X, Sun R, Wang Q, Chen D, Yu B, He J, *et al*. L-isoleucine administration alleviates DSS-induced colitis by regulating TLR4/MyD88/NF- κ B pathway in rats. *Front Immunol*. 2022;12:817583.
 27. Deng L, Guo H, Wang S, Liu X, Lin Y, Zhang R, *et al*. The attenuation of chronic ulcerative colitis by (R)-salbutamol in repeated DSS-induced mice. *Oxid Med Cell Longev*. 2022;2022:9318721.
 28. Simeonova R, Mihaylova R, Gevrenova R, Savov Y, Zheleva-Dimitrova D. Ulceroprotective effects of *Epilobium angustifolium* extract in DSS-induced colitis in mice. *Curr Issues Mol Biol*. 2025;47(6):444-[end page not provided].
 29. Fu R, Wang L, Meng Y, Xue W, Liang J, Peng Z, *et al*. Apigenin remodels the gut microbiota to ameliorate ulcerative colitis. *Front Nutr*. 2022;9:1062961.
 30. Tian M, Ma P, Zhang Y, Mi Y, Fan D. Ginsenoside Rk3 alleviated DSS-induced ulcerative colitis by protecting colon barrier and inhibiting NLRP3 inflammasome pathway. *Int Immunopharmacol*. 2020;85:106645.
 31. Lv WJ, Liu C, Yu LZ, Zhou JH, Li Y, Xiong Y, *et al*. Melatonin alleviates neuroinflammation and metabolic disorder in DSS-induced depression rats. *Oxid Med Cell Longev*. 2020;2020:1241894.
 32. Niu S, Jing M, Wen J, Wei S, Li H, Li X, *et al*. Jatrotrrhizine alleviates DSS-induced ulcerative colitis by regulating the intestinal barrier function and inhibiting TLR4/MyD88/NF- κ B signaling pathway. *Evid Based Complement Alternat Med*. 2022;2022:3498310.