**REVIEW ARTICLE**

# Therapeutic benefits of fecal microbiota transplantation in animals

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## ABSTRACT

**Introduction:** gastrointestinal diseases in animals are associated with intestinal dysbiosis, which has driven the search for innovative therapies such as fecal microbiota transplantation.
**Objective:** to evaluate the therapeutic benefits of fecal microbiota transplantation in animals, describing its clinical efficacy and current limitations.
**Methods:** a systematic review of the scientific literature was conducted across various databases. The search was performed using an algorithm with keywords and Boolean operators, allowing the identification of relevant sources. The selected studies, after applying inclusion and exclusion criteria, were critically analyzed considering timeliness, methodological quality, and thematic relevance, and were integrated into the final synthesis of the review.
**Development:** fecal microbiota transplantation restores intestinal bacterial diversity, increases species producing short-chain fatty acids, and improves epithelial barrier function. In dogs with acute diarrhea or parvoviral enteritis, a reduction in hospitalization time and better clinical recovery have been reported. In cases of refractory inflammatory bowel disease, a decrease in clinical activity and an increase in beneficial bacteria such as Faecalibacterium and Clostridium *hiranonis* have been observed. However, controversies remain regarding the dual role of Fusobacterium and the lack of standardized protocols for donor selection, dosage, and routes of administration.
**Conclusions:** fecal microbiota transplantation represents a promising alternative for the management of enteropathies in animals, with encouraging results in microbial restoration and clinical improvement. Nevertheless, further research is required to establish standardized guidelines that ensure safety, reproducibility, and long-term efficacy in veterinary medicine.

**Keywords:** Gastrointestinal Diseases; Dysbiosis; Veterinary Medicine; Fecal Microbiota Transplantation.

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# INTRODUCTION

The intestinal tract of dogs and cats is inhabited by approximately 100 trillion microbial cells distributed across different segments of the digestive tract, including bacteria, archaea, fungi, and protozoa, collectively referred to as the gut microbiota.[1,2] This gut microbiota benefits the host by performing various essential functions crucial for health.[3]

The gut microbiota can be severely disrupted by acute and chronic inflammatory gastrointestinal diseases, as well as by medications such as proton pump inhibitors and/or antibiotics. Although it remains unclear whether the gut microbiota acts as a trigger or merely a passive observer in the pathogenesis of chronic intestinal diseases, the resulting dysbiosis has measurable metabolic effects that may negatively impact host health.[1,4,5]

Dysbiosis is characterized by a reduction in host-beneficial microorganisms such as *Faecalibacterium*, *Fusobacterium*, *Blautia*, *Turicibacter*, and *Clostridium hiranonis*, along with an increased concentration of *E. coli* compared to healthy dogs.[6,7,8] Although fecal transplantation—also known as fecal microbiota transplantation (FMT)—has been recognized for centuries, it has only recently become a mainstream therapy in humans and is now being seriously considered for other species.

In veterinary medicine, FMT has emerged as a promising treatment for various gastrointestinal conditions in dogs, including intestinal dysbiosis, inflammatory bowel disease, and other disorders difficult to manage with conventional therapies. Recent studies propose FMT as a potent alternative for veterinarians, suggesting its use as a complementary treatment for canine parvovirus and hemorrhagic enteritis, and continuing to explore its potential as an innovative therapy for other gastrointestinal conditions.[1,3,5,7]

This revolutionary technique involves transferring healthy intestinal microbiota from a donor to a recipient with the aim of restoring microbial balance in the digestive tract and promoting intestinal health.[4,6] Although gastrointestinal diseases are the most commonly treated with FMT, recent research has demonstrated promising potential in treating or preventing conditions beyond the gastrointestinal tract, underscoring the importance of the gut microbiota in the patient's overall health.[1]

The beneficial effects of FMT on the gut microbiota and the host have not yet been fully elucidated. Increased microbiome richness and a shift in the recipient's microbial profile toward that of the healthy donor are recognized as essential benefits of FMT. The transplanted fecal microbiota may also help restore intestinal barrier integrity by secreting mucin to support the mucus layer separating epithelial cells from the intestinal lumen.[4]

Guidelines regarding donor characteristics and screening for infectious diseases are scarce, and there is no absolute consensus on FMT preparation, dosing, or administration in dogs. It is crucial to urgently address these issues to facilitate the creation of comparable and extensive databases, especially if multicenter trials are to be conducted.[3,4,6] Given the above, this review was conducted with the objective of evaluating the therapeutic benefits of FMT in animals, describing its clinical efficacy and current limitations.

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## METHODS

This work was structured as a systematic literature review to evaluate the therapeutic benefits of FMT in animals. The search period spanned from 2010 to 2024, encompassing recent and relevant studies in veterinary medicine. Information sources included PubMed, SciELO, ScienceDirect, Redalyc, Scopus, and Google Scholar, as well as grey literature from institutional repositories and secondary references.

The search strategy employed algorithms combining keywords and Boolean operators: "fecal microbiota transplantation" OR "trasplante de microbiota fecal" AND "veterinary medicine" OR "animal health" AND "dysbiosis" OR "gastrointestinal disease." Articles in Spanish, English, and Portuguese were considered to integrate multilingual evidence.

Inclusion criteria were: articles published within the defined timeframe, original studies using animal models, clinical or experimental trials, and publications with full-text access. Duplicates, articles without full text, narrative reviews lacking empirical data, and studies not directly addressing FMT in animals were excluded.

The selection process occurred in several stages: identification of records, title and abstract screening, and full-text analysis. Initially, 45 records were obtained; 12 were removed due to duplication and 8 due to lack of full access. Finally, 25 articles met the inclusion criteria and were incorporated into the analysis. The procedure was represented using a PRISMA flow diagram detailing the phases of identification, screening, eligibility, and inclusion.

Data extraction included variables such as author, year, animal species, methodological design, intervention applied, and main outcomes. Analysis was performed qualitatively, integrating findings on clinical efficacy, microbial balance restoration, and methodological limitations. No meta-analysis was conducted due to heterogeneity in study designs and species, although common patterns were identified that suggest the therapeutic potential of FMT in veterinary medicine.

## DEVELOPMENT

The gastrointestinal tract of animals is colonized by approximately 100 trillion microorganisms, collectively termed the microbiota, composed of bacteria, fungi, viruses, and protozoa.[8,9] The gut microbiota benefits the host by performing essential health-related functions, including local and systemic immune system development and support, production of metabolites with nutritional value for enterocytes, maintenance of intestinal homeostasis (by preserving epithelial barrier integrity), and resistance to pathogenic bacterial colonization through competitive exclusion. These functions are critically important and exert a fundamental positive influence on the host's overall health.[1,3]

FMT is a strategy based on restoring the altered intestinal microbiota of an animal by introducing microbiota from a healthy donor, thereby reversing microbial dysbiosis by increasing beneficial intestinal bacterial diversity (*Faecalibacterium*, *Fusobacterium*, *Blautia*, *Turicibacter*, and *Clostridium hiranonis*) and reducing pathogenic microorganisms (especially *E. coli*) or aiding tissue recovery after pathological processes.[8,10]

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*Fusobacterium* is a bacterium that produces butyric acid, a substance crucial for epithelial cells of the colonic mucosa, as it serves as a significant energy source. This acid also possesses antitumor properties by inhibiting colorectal cancer cell growth and promoting their differentiation and apoptosis. Additionally, butyric acid supports the maturation of adaptive immune system cells, which are essential for reducing inflammation and preventing allergic reactions. It also exerts an inhibitory effect on the production of pro-inflammatory cytokines.(8)

However, several studies have reported that *Fusobacterium* is a pro-inflammatory pathogen, showing high abundance in patients with inflammatory bowel disease and in murine models of inflammatory bowel disease. Other studies have concluded that *Fusobacterium nucleatum* may promote colon neoplasia by negatively regulating antitumor T-cell–mediated adaptive immunity. Although *Fusobacterium* may be a risk factor for colorectal carcinoma in mice and humans, a low proportion of *Fusobacterium* appears beneficial.(11,12)

In studies conducted in dogs with diarrhea, two treatment groups were established. The first group received FMT, while the second received metronidazole for seven days. The presence of different microorganisms was assessed on days 7 and 28 in the fecal microbiota of affected animals. Results showed that *Faecalibacterium*, a bacterium associated with health, increased in the FMT group and was significantly higher than in dogs treated with metronidazole on both days 7 and 28. However, the abundance of this bacterium remained considerably lower in both groups compared to healthy dogs. This bacterium is key in converting primary to secondary bile acids in dogs, showing an increase in the FMT group and no significant difference compared to healthy dogs by day 28. In contrast, dogs treated with metronidazole experienced a decrease in *C. hiranonis* abundance on both day 7 (end of metronidazole treatment) and day 28 compared to healthy dogs.(10)

In an FMT study involving nine dogs with refractory inflammatory bowel disease (IBD) unresponsive to elimination diets, antibiotics, corticosteroids, or cyclosporine, a significant reduction in the canine chronic enteropathy clinical activity index was observed in all dogs following FMT, along with a significant increase in fecal *Fusobacterium* spp. abundance.(8) Bacteria such as *Faecalibacterium*, *Fusobacterium*, *Blautia*, and *Turicibacter* are important producers of short-chain fatty acids (SCFAs). SCFAs exert anti-inflammatory effects in the gut, provide energy to colonocytes, enhance epithelial barrier function and tight junctions, and contribute to normal intestinal motility. The abundance of SCFA-producing intestinal bacteria, as well as *Clostridium hiranonis* (which converts primary to secondary bile acids in the gut), is typically reduced in dogs with chronic enteropathies.(13)

Currently, there is no consensus or evidence-based guidance on donor selection, FMT dosing, or optimal protocols. Despite this lack of consensus, FMT is considered a relatively safe treatment in dogs with acute or chronic gastrointestinal disorders and has the potential to reduce disease severity in many cases.(4)

The donor should be a clinically healthy animal with no signs of chronic GI disease; essentially, the goal is to identify a donor with abundant beneficial microbiota and no potential fecal pathogens. Additionally, the animal should not consume raw food, should not be on long-term pharmacological treatment, and should not have received antibiotics in at least the last six months—preferably longer. In cats, donors should ideally have no outdoor access to avoid exposure to parasites from small rodents, etc. All potential donors must be screened for intestinal parasites, including *Giardia intestinalis*.(13)

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FMT in animals represents an innovative technique in veterinary medicine but still lacks a standardized protocol regarding dosing and handling of donor fecal microbiota. The amount of feces used in FMT in dogs can vary considerably. Reports describe doses of 5 g of donor feces per kg of recipient body weight (BW) for cats and dogs up to 30 kg; for recipient dogs over 30 kg, 2–3 g of feces per kg BW is used.(14) Fecal transplantation can be administered via the upper or lower GI tract. In dogs, published cases show that the rectal route is by far the most common, either via retention enema or colonoscopy. Fresh or frozen feces may be used, thawed overnight in the refrigerator. Feces are blended and mixed with sterile saline solution (20–120 mL) to achieve a desirable consistency, then filtered through a strainer. The filtrate is drawn into a sterile 60-mL syringe and may be left at room temperature or warmed in a water bath to reach body temperature.

In veterinary medicine, FMT has been shown to benefit puppies with parvovirus enteritis and also appears promising in dogs with chronic diarrhea.(14,15) However, few reports exist on its use in cats.(16)

In another study involving 18 dogs with acute diarrhea, one group received a single FMT at presentation, while the other received metronidazole treatment. Clinical assessment at seven days showed no difference between groups. By day 28, fecal consistency was significantly better in the FMT group compared to the metronidazole group. Moreover, by day 28, FMT had helped restore the intestinal microbiome to healthy levels, whereas dogs treated with metronidazole exhibited significant dysbiosis compared to both FMT-treated and healthy dogs.(10)

However, in a small pilot study with 8 dogs with acute hemorrhagic diarrhea, no clinical benefit was observed in dogs receiving FMT compared to the placebo group.(13) In cats, as of the writing of this article, only one case report was found: a 10-year-old cat with a history of chronic, bloody diarrhea and normal hematological and biochemical analyses. Intestinal biopsies revealed extensive ulceration and loss of mucosal architecture consistent with severe ulcerative colitis.(16)

Initial treatment included a combination of oral medications: metronidazole, sulfamethoxazole/trimethoprim, prednisone, maropitant, sulfasalazine, mirtazapine, ranitidine, chlorambucil, and cobalamin. Dietary modifications included high-fiber and hypoallergenic formulas along with probiotics, but no improvement in chronic diarrhea was observed. After 12 months without response to prior treatments, FMT was considered as a last therapeutic option before euthanasia. The cat was taken off all medications for one week, and feces from a healthy donor cat were used. The procedure was performed without complications, and although initial bloody diarrhea occurred, stools gradually improved.(16)

One study reports the use of 3 g/kg of donor feces dissolved in Ringer's solution. The mixture is filtered through sterile gauze and administered at a dose of 10 mL/kg of the filtered solution to recipients.(8) This method stands out for its simplicity and use of a widely available sterile solution, but it provides no details on final solution consistency or preparation and administration time. Dissolving in Ringer's solution may offer a practical way to dilute and administer fecal microbiota, but the lack of standardization in fecal quantity and final concentration may influence treatment efficacy. Additionally, preparation and filtration must be carefully performed to avoid contamination and ensure a homogeneous mixture. In other studies, fresh frozen feces are used at a dose of 5–7 g/kg of recipient body weight. Feces are thawed at room temperature, mixed with 20–120 mL of sterile saline to achieve appropriate consistency, and then filtered for rectal administration.(8,10,14)

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This method allows consistency adjustment according to procedural needs but requires more complex preparation and precise handling of saline volume. The use of frozen feces may be advantageous for storage and availability, but the thawing and mixing process requires precision to ensure proper integration into the saline solution. Variability in saline volume may affect viscosity and thus ease of administration and transplant efficacy.(16)

The increased abundance of *Faecalibacterium* and *C. hiranonis* observed in FMT-treated dogs is notable, as *Faecalibacterium* is associated with intestinal health benefits, including anti-inflammatory and antitumor properties. *C. hiranonis*, in turn, plays a crucial role in converting primary to secondary bile acids—a process important for intestinal health.(10) These results suggest that FMT can restore key aspects of the intestinal microbiota, at least at the level of certain bacterial species.

In contrast, metronidazole treatment showed reduced *C. hiranonis* abundance, indicating that FMT may be superior to this antibiotic in restoring beneficial microbiota. However, the persistent reduction in *Faecalibacterium* abundance in both treated groups (FMT and metronidazole) compared to healthy dogs underscores the need for further research to optimize therapy and better understand how FMT can achieve complete microbiota normalization.

The fact that, in a study of dogs with refractory inflammatory bowel disease, a significant decrease in disease activity index and an increase in *Fusobacterium* spp. were observed after FMT highlights FMT's efficacy in treating chronic inflammatory conditions. However, *Fusobacterium* has a dual nature: although it may contribute to intestinal health by producing butyric acid, it has also been associated with inflammation and neoplasia in certain contexts.(8,11,12) This dual role presents a paradox in its therapeutic use—while its increase may be beneficial in some cases, its role as a pro-inflammatory pathogen in other situations must not be ignored.

Short-chain fatty acid (SCFA)–producing bacteria such as *Faecalibacterium*, *Fusobacterium*, *Blautia*, and *Turicibacter* are essential for intestinal health, providing energy to colonocytes, improving epithelial barrier function, and regulating intestinal motility.(13) The reduction of these bacteria in dogs with chronic enteropathies—and their increase after FMT—highlights the importance of SCFAs in modulating inflammation and intestinal function. This finding reinforces FMT's role in microbiota restoration and gastrointestinal health improvement through SCFA production.

## CONCLUSIONS

FMT offers an effective strategy for restoring altered intestinal microbiota in dogs with inflammatory diseases and other pathological conditions. Although initial results are promising—with improvements in bacterial diversity and abundance of key bacteria—it is essential to consider the complexity of the microbial profile and the potentially adverse effects of certain bacteria, such as *Fusobacterium*. Ongoing research is necessary to establish standardized treatment protocols and to better understand the underlying mechanisms of FMT and its long-term impact on intestinal health in veterinary medicine.

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