



A review of the role of gut microbiota in the health and disease of dogs and cats

Melika ghotbi nejad^{1,*}

¹ Clinician, Private Pet Veterinary Clinic, Tehran, Iran

ABSTRACT

The gut microbiota is a complex and dynamic community of microorganisms residing in the gastrointestinal tract of dogs and cats. This review explores its pivotal role in maintaining health and contributing to disease. A balanced microbiome is essential for digestion, nutrient absorption, immune support, and overall well-being. It aids in preventing inflammation, gastrointestinal disorders, and metabolic diseases while influencing behavior via the gut-brain axis. Conversely, dysbiosis can lead to conditions such as inflammatory bowel disease, obesity, diabetes, and weakened immunity. This paper highlights the importance of preserving microbiota balance for promoting health and preventing disease in canine and feline populations.

Keywords: Gut microbiota, Dog, Cat

1. INTRODUCTION

Gut microbiota refers to the trillions of microorganisms, such as bacteria, viruses, fungi, and other microbes, that live in the digestive tract, mainly in the intestines(1). These tiny inhabitants play an essential role in breaking down food, absorbing nutrients, and producing key substances like vitamins and short-chain fatty acids(2). Beyond digestion, gut microbiota significantly influence the immune system, metabolism, and even brain health through the gut-brain axis(3). A balanced gut microbiota supports overall health, while an imbalance can be linked to various diseases, including gastrointestinal disorders, obesity, and mental health issues. It's a fascinating ecosystem that's vital for both humans and animals(4).

Dogs and cats have intriguing gut physiology and microbiota that are essential for their health. The gastrointestinal (GI) tract of these animals is adapted to their dietary needs(5). Cats are obligate carnivores, requiring a meat-based diet, while dogs are omnivores and can process a wider range of foods. Both species have relatively short GI tracts, which are specialized for digesting proteins and fats(6). Their stomachs produce strong acids to break down proteins and destroy harmful bacteria. The small intestine is where most nutrients are absorbed, and cats are less efficient at digesting carbohydrates compared to dogs(2). The large intestine primarily focuses on water absorption, with a smaller role in fermentation compared to herbivores(7).

The gut microbiota, a community of microorganisms residing in the digestive tract, plays a vital role in digestion, immunity, and overall health. These microbes help break down complex nutrients, producing beneficial compounds(8). They support immune system development and help prevent infections. An imbalance in gut microbes can lead to health issues like inflammation and obesity. Dogs and cats harbor a variety of bacteria, including Firmicutes and Bacteroidetes(9).

Several factors influence the composition and function of gut microbiota in dogs and cats, including diet, medications, age, and environment(5). High-protein diets support the needs of both species, but dietary changes can impact microbial balance. Maintaining a healthy gut through proper nutrition and care is crucial for the well-being of dogs and cats. The aim of this study is review of role of gut microbiota in health and disease condition in dogs and cats.



2. METHODS AND MATERIALS

This study is a narrative review method by searching the keywords "Microbiota", "Gut", "Dog" and "Cat" in the databases GoogleScholar, ScienceDirect, Pubmed, SID, Magiran, Civilica and free search in Google search, Relevant data were used in this study..

3. DOGS GUT MICROBIOTA

The gut microbiota of dogs is a fascinating and complex ecosystem that plays a vital role in their overall health. It consists of trillions of microorganisms, including bacteria, viruses, fungi, and protozoa, residing in the gastrointestinal tract(10). These microbes interact with the host in a symbiotic relationship, influencing digestion, immunity, and even behavior(11). The majority of the gut microbiota in dogs belongs to five main bacterial phyla: Firmicutes, Bacteroidetes, Fusobacteria, Proteobacteria, and Actinobacteria. These microbes contribute to breaking down food, producing essential nutrients like short-chain fatty acids, and protecting against harmful pathogens. The composition of the microbiota varies along different sections of the gastrointestinal tract, with unique microbial communities in the stomach, small intestine, and colon(12).

Factors such as age, diet, and environment significantly influence the diversity and balance of the gut microbiota. For instance, a diet rich in fiber can promote the growth of beneficial bacteria, while antibiotics can disrupt the microbial balance, leading to a condition known as dysbiosis. Dysbiosis has been linked to various health issues, including gastrointestinal disorders, obesity, and immune dysfunction(13). Emerging therapies like probiotics, prebiotics, and fecal microbiota transplantation are being explored to restore and maintain a healthy gut microbiota in dogs. These interventions aim to enhance microbial diversity and support the host's health. The study of canine gut microbiota is still evolving, and ongoing research continues to uncover its intricate connections to health and disease. It's a reminder of how interconnected life is, even at the microscopic level(9).

Firmicutes ferment dietary fibers into short-chain fatty acids, providing energy for intestinal cells and supporting gut health(14). Fusobacteria play a role in protein metabolism, breaking down amino acids and aiding nutrient absorption. Bacteroidetes digest complex carbohydrates and proteins, enhancing nutrient extraction. Proteobacteria, while beneficial in some strains, help regulate gut immunity, though overgrowth may indicate dysbiosis. Actinobacteria support the gut barrier and promote immune function by producing short-chain fatty acids(14).

3.1 CATS GUT MICROBIOTA

The gut microbiota in cats is a dynamic ecosystem of microorganisms, including bacteria, viruses, fungi, and protozoa, residing in their gastrointestinal tract(9). These microbes play essential roles in digestion, nutrient absorption, immune system support, and overall health. Cats, being obligate carnivores, have gut microbiota adapted to their protein-rich diets. Key bacterial phyla include Firmicutes, Bacteroidetes, Actinobacteria, and Proteobacteria(9).

Maintaining a balanced gut microbiome is crucial for cats, as imbalances can lead to digestive issues, inflammation, or weakened immunity. Factors such as diet, antibiotics, stress, and environmental exposures can influence the microbiome(15).

Lactobacillus maintains a healthy gut environment by fermenting lactose, producing lactic acid, and supporting the intestinal lining(16). Clostridium ferments complex carbohydrates and produces short-chain fatty acids, such as butyrate, essential for colon health. Bacteroides breaks down proteins and carbohydrates, improving nutrient absorption. Bifidobacterium strengthens gut barrier integrity and supports immune function through beneficial short-chain fatty acids(17).



3.2 ROLE OF GUT MICROBIOTA OF DOGS AND CATS IN HEALTH

The gut microbiota in dogs and cats plays a crucial role in their overall health. It aids in digestion by breaking down complex nutrients, supports the immune system by defending against harmful pathogens, and contributes to the production of essential vitamins and short-chain fatty acids(5). Additionally, a balanced gut microbiota helps maintain a healthy gut barrier, reducing inflammation and preventing gastrointestinal disorders. It also influences metabolism and can even impact behavior and mood through the gut-brain axis. Maintaining a diverse and balanced microbiota is key to promoting the well-being of both dogs and cats(18).

Gut microbiota imbalances, known as dysbiosis, can contribute to various diseases in dogs and cats. These include gastrointestinal disorders like inflammatory bowel disease (IBD), where an altered microbiome triggers inflammation. Dysbiosis can also lead to metabolic issues, such as obesity or diabetes, by affecting nutrient absorption and energy regulation(19). Additionally, imbalances in gut microbiota may weaken the immune system, making pets more susceptible to infections. Emerging research suggests links between gut microbiota and neurological conditions, highlighting its role in the gut-brain axis. Maintaining a balanced microbiome is crucial for preventing these diseases and promoting overall health(19).

4. DISCUSSION AND CONCLUSION

The gut microbiota plays a fundamental role in the health and disease of dogs and cats, underlining its significance in veterinary science(20). A balanced microbiota is essential for digestion, nutrient absorption, and the maintenance of a robust immune system, while also influencing metabolic regulation and even behavior through the gut-brain axis(21). On the other hand, dysbiosis or microbial imbalance has been associated with various diseases, including inflammatory bowel disease, obesity, and diabetes. These conditions not only impact gastrointestinal health but also systemic health, demonstrating the far-reaching effects of the microbiome(22). Furthermore, environmental factors, diet, and medical interventions such as antibiotics can significantly alter the microbiota, presenting both challenges and opportunities for therapeutic interventions. A deeper understanding of microbial compositions and their functional contributions is necessary to develop targeted probiotics, prebiotics, and dietary strategies to restore balance and support overall health(23).

The gut microbiota is an integral component of canine and feline health, influencing a wide range of physiological processes and disease outcomes. Maintaining a balanced microbiota is critical for preventing diseases and promoting well-being. Future research should focus on elucidating the complex interactions within the microbiome and identifying personalized interventions to optimize gut health in dogs and cats. By advancing our understanding of this intricate ecosystem, we can improve health outcomes and quality of life for these companion animals.

REFERENCES

- [1] 1. Pushpanathan P, Mathew GS, Selvarajan S, Seshadri KG, Srikanth P. Gut microbiota and its mysteries. *Indian Journal of Medical Microbiology*. 2019;37(2):268-77.
- [2] 2. Saha SK, Pathak NN, Saha SK, Pathak NN. Digestion, absorption and metabolism of nutrients. *Fundamentals of Animal Nutrition*. 2021:219-46.
- [3] 3. Chakrabarti A, Geurts L, Hoyles L, Iozzo P, Kraneveld AD, La Fata G, et al. The microbiota–gut–brain axis: pathways to better brain health. Perspectives on what we know, what we need to investigate and how to put knowledge into practice. *Cellular and Molecular Life Sciences*. 2022;79(2):80.
- [4] 4. Prescott SL, Millstein RA, Katzman MA, Logan AC. Biodiversity, the human microbiome and mental health: moving toward a new clinical ecology for the 21st century? *International Journal of Biodiversity*. 2016;2016(1):2718275.
- [5] 5. Wernimont SM, Radosevich J, Jackson MI, Ephraim E, Badri DV, MacLeay JM, et al. The effects of nutrition on the gastrointestinal microbiome of cats and dogs: impact on health and disease. *Frontiers in Microbiology*. 2020;11:1266.
- [6] 6. Tazerji S, Elahinia A, Akhtardanesh B, Kabir F, Vazir B, Duarte P, et al. Nutritional risks and consequences of meat-only diets for dogs and cats. *Ger J Vet Res*. 2024;4(1):62-76.



- [7] 7. H. Karasov W, Douglas AE. *Comparative digestive physiology. Comprehensive Physiology.* 2013;3(2):741-83.
- [8] 8. Sahu N, Vasu D, Sahu A, Lal N, Singh S. *Strength of microbes in nutrient cycling: a key to soil health. Agriculturally important microbes for sustainable agriculture: Volume I: Plant-soil-microbe nexus.* 2017:69-86.
- [9] 9. Deng P, Swanson KS. *Gut microbiota of humans, dogs and cats: current knowledge and future opportunities and challenges. British Journal of Nutrition.* 2015;113(S1):S6-S17.
- [10] 10. Hoffmann AR, Proctor L, Surette M, Suchodolski J. *The microbiome: the trillions of microorganisms that maintain health and cause disease in humans and companion animals. Veterinary pathology.* 2016;53(1):10-21.
- [11] 11. Abraham C, Medzhitov R. *Interactions between the host innate immune system and microbes in inflammatory bowel disease. Gastroenterology.* 2011;140(6):1729-37.
- [12] 12. Gu S, Chen D, Zhang J-N, Lv X, Wang K, Duan L-P, et al. *Bacterial community mapping of the mouse gastrointestinal tract. PloS one.* 2013;8(10):e74957.
- [13] 13. Scott KP, Gratz SW, Sheridan PO, Flint HJ, Duncan SH. *The influence of diet on the gut microbiota. Pharmacological research.* 2013;69(1):52-60.
- [14] 14. Wang M, Wichienchot S, He X, Fu X, Huang Q, Zhang B. *In vitro colonic fermentation of dietary fibers: Fermentation rate, short-chain fatty acid production and changes in microbiota. Trends in food science & technology.* 2019;88:1-9.
- [15] 15. Rinninella E, Cintoni M, Raoul P, Lopetuso LR, Scaldaferri F, Pulcini G, et al. *Food components and dietary habits: keys for a healthy gut microbiota composition. Nutrients.* 2019;11(10):2393.
- [16] 16. Pessione E. *Lactic acid bacteria contribution to gut microbiota complexity: lights and shadows. Frontiers in cellular and infection microbiology.* 2012;2:86.
- [17] 17. Dong TS, Gupta A. *Influence of early life, diet, and the environment on the microbiome. Clinical Gastroenterology and Hepatology.* 2019;17(2):231-42.
- [18] 18. Grześkowiak Ł, Endo A, Beasley S, Salminen S. *Microbiota and probiotics in canine and feline welfare. Anaerobe.* 2015;34:14-23.
- [19] 19. Honneffer JB, Minamoto Y, Suchodolski JS. *Microbiota alterations in acute and chronic gastrointestinal inflammation of cats and dogs. World journal of gastroenterology: WJG.* 2014;20(44):16489.
- [20] 20. Blake AB, Suchodolski JS. *Importance of gut microbiota for the health and disease of dogs and cats. Animal Frontiers.* 2016;6(3):37-42.
- [21] 21. Wiertsema SP, van Bergenhenegouwen J, Garssen J, Knippels LM. *The interplay between the gut microbiome and the immune system in the context of infectious diseases throughout life and the role of nutrition in optimizing treatment strategies. Nutrients.* 2021;13(3):886.
- [22] 22. Kim A. *Dysbiosis: a review highlighting obesity and inflammatory bowel disease. Journal of Clinical Gastroenterology.* 2015;49:S20-S4.
- [23] 23. Peng M, Tabashsum Z, Anderson M, Truong A, Houser AK, Padilla J, et al. *Effectiveness of probiotics, prebiotics, and prebiotic-like components in common functional foods. Comprehensive reviews in food science and food safety.* 2020;19(4):1908-33.