

Article review: The role of probiotics in maintaining balance intestinal microbiota on diarrhea infection therapy

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ABSTRACT

Diarrhea infections are a significant global health problem, especially in developing countries and can be caused by bacterial, viral or parasitic infections. Antibiotics are often given times ineffective in long-term use and risk disrupting the balance of intestinal microbiota. So that probiotics are needed that come from living microorganisms that provide health benefits if consumed in sufficient quantities. Review This article aims to review the role of probiotics in maintaining the balance of intestinal microbiota and their effectiveness in diarrheal infection therapy. Through literature analysis, several probiotic strains such as Lactobacillus and Bifidobacterium have shown their ability to inhibit the growth of pathogens, such as Escherichia coli and Clostridium difficile, through nutrient competition, production of antimicrobial substances, and immune modulation. This article concludes that probiotics have great potential as an additional therapy that is safe, effective and has minimal side effects in treating diarrheal infections. However, further studies are needed to determine the optimal dose, duration of use, and effectiveness of probiotics in various populations and types of diarrhea.

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INTRODUCTION

Diarrheal infections are a significant global health problem, especially in developing countries. According to the World Health Organization (WHO), diarrhea is the leading cause of death in children under the age of five, with more than 443,832 deaths each (Puteri, Syahfitri, Isnaeni, & Yusrustin, n.d.), (Wulandari & Permadani, 2024). These infections are usually caused by pathogens such as bacteria, viruses, and parasites. The gut microbiota plays an important role in maintaining digestive health, metabolic function, and immune regulation. An imbalance in the gut microbiota, known as dysbiosis, can worsen diarrhea symptoms and prolong patient recovery time. The use of antibiotics is often the main choice in treating diarrheal infections. However, the use of antibiotics can cause side effects, such as antimicrobial resistance and more severe damage to the gut microbiota, therefore safer and more effective alternative therapies are needed, such as probiotics (Gupta, Paul, & Dutta, 2017). Abnormalities in the composition of the microbiota

(dysbiosis) can trigger digestive system disorders and increase susceptibility to infections, including diarrhea, which is one of the major global health problems (Iancu et al., 2023).

Probiotics are living microorganisms that provide health benefits when consumed in sufficient amounts (Gul & Durante-Mangoni, 2024). In addition, studies have shown that probiotics can help enhance intestinal integrity by modulating the expression of tight junction proteins, thereby reducing intestinal permeability and preventing pathogens from entering the systemic circulation (Ulfah et al., 2022). Probiotics are able to modulate the gut microbiota, enhance local immunity, and accelerate recovery in diarrhea patients (Hill et al., 2014). Various probiotic strains, such as *Lactobacillus*, *Bifidobacterium* have been studied extensive clinical trials showing potential to maintain gut microbiota balance which can be used as a therapy for diarrhea infections (Goldenberg et al., 2017).

In the study of Kau et al., 2011 showed that individuals with balanced gut microbiota have a better immune response to infection compared to microbiota experiencing dysbiosis (Kau et al., 2011). Gut microbiota experiencing dysbiosis can be overcome with probiotics through mechanisms that support the restoration of the microbial ecosystem in the digestive tract. The importance of probiotics in the treatment of diarrhea is also evident from evidence showing that they can alleviate symptoms of gastroenteritis and reduce the incidence of diarrhea (Cameron et al., 2017). In this article review will be discussed the role of Probiotics in maintaining the balance of gut microbiota against diarrhea infection therapy. Thus, it is hoped that this article can provide better insight into the importance of probiotics in maintaining the balance of gut microbiota in human health especially in preventing diarrhea infection.

RESEARCH METHOD

This study uses article review to analyze the role of Probiotics in maintaining the balance of gut microbiota against diarrhea infection therapy. Data were collected from research journals published between 2014 and 2024 through searches in databases such as PubMed, Scopus, and Google Scholar using the keywords "Probiotics", "gut microbiota" and "diarrhea infection". Only peer-reviewed articles from highly reputable journals, which present statistical data related to the relationship between gut microbiota and diarrhea prevalence. Key information from selected research articles was recorded in a dedicated data collection form, and qualitatively analyzed to identify key themes, such as the mechanisms of microbiota against diarrheal infections.

RESULTS AND DISCUSSIONS

Probiotics have an important role in maintaining the balance of intestinal microbiota that can be used as a therapy for diarrhea infection. In probiotics there are good bacteria that help improve digestive health, regulate the immune system and balance the intestinal microbiota. Here are some research results that support the role of probiotics in maintaining the balance of intestinal microbiota in diarrhea infections (Table 1).

Table 1. The role of probiotics in maintaining the balance of gut microbiota

Journal Citation	Pathogen	Probiotics	Mechanism
(Vogt & Brett Finlay, 2017)	<i>Clostridium difficile</i> <i>Salmonella enterica</i>	<i>Lactobacillus</i>	Inhibits pathogens through competition for nutrients.
(Jiang et al., 2017)	Rotavirus	<i>Lactobacillus rhamnosus</i> GG	regulates the maturation and differentiation of dendritic cells and increase the secretion of inflammatory factors, which is effective in preventing diarrhea due to rotavirus

Journal Citation	Pathogen	Probiotics	Mechanism
(Azagra-Boronat et al., 2020)	Rotavirus	Bifidobacterium & Lactobacillus	modulates the intestinal immune response, which is important in fighting rotavirus infection by stimulating the production of secretory immunoglobulin A (IgA) in the intestinal mucosa, which functions as a barrier against viral replication and prevents attachment of rotavirus to intestinal epithelial cells
(Dong et al., 2021)	Escherichia coli	Lactobacillus	Inhibits pathogens through competition for nutrients
(Gallo et al., 2016)	Clostridium difficile	Bifidobacterium	reduces the frequency of diarrhea

In table 1, there is the role of probiotics in maintaining the balance of intestinal microbiota to protect the body from diarrheal infections, such as Lactobacillus and Bifidobacterium. can inhibit the growth of pathogens by producing sialidase enzymes that utilize sialic acid as an energy source, thereby reducing the availability of sialic acid for pathogens. Pathogens such as Clostridium difficile and Salmonella enterica are very limited in utilizing sialic acid for their growth so that they cannot reproduce optimally in the intestine. This makes Lactobacillus one of the effective probiotics to inhibit infections of these pathogens (Vogt & Brett Finlay, 2017). This study was strengthened by Afzaal et al (2017)., who stated that the probiotic Lactobacillus will consume nutrients quickly, reducing the availability of nutrients for pathogenic microbes. This competition can create an environment that is less supportive for the growth of harmful microorganisms, such as Clostridium difficile and Salmonella enterica (Afzaal et al., 2022). In addition, microbiota also help improve the immune response by maturing dendritic cells and stimulating cytokine secretion, thereby preventing diarrhea caused by rotavirus (Jiang et al., 2017). This statement is reinforced by researchers Tan et al., 2014 who stated that gut microbiota affect the development and function of the immune system by maintaining a balance between pro-inflammatory and anti-inflammatory immune responses, where there is a role for dendritic cells that are tasked with processing antigens and presenting them to T lymphocytes, thus initiating an adaptive immune response. Gut microbiota can affect the maturation of dendritic cells through the metabolites they produce, such as short chain fatty acids (SCFA). SCFAs have been shown to stimulate dendritic cell maturation and increase the expression of costimulatory molecules important for T lymphocyte activation (Tan et al., 2014).

The microbiota can also increase the production of proinflammatory cytokines such as IL-6 and Tumor necrosis factor-alpha (TNF- α) to fight pathogenic infections. A balanced gut microbiota helps limit rotavirus infection by enhance intestinal mucosal protection and local immune response. Several studies have shown that certain probiotics such as Lactobacillus rhamnosus GG can reduce the severity and duration of rotavirus diarrhea through immune modulation and competition with pathogens (Jiang et al., 2017) . In the Azagra-Bronat et al. study. (2020) revealed that Bifidobacterium and Lactobacillus have the ability to modulate the immune response to fight rotavirus infection by stimulating the production of immunoglobulin A (IgA) which functions as a barrier to virus replication and prevents attachment to the intestinal epithelial surface, thereby reducing the ability of the virus to infect target cells Lactobacillus and Bifidobacterium also produce antimicrobial substances such as lactate and bacteriocins which create an uncomfortable environment for pathogens including rotavirus(Azagra-Boronat et al., 2020). Based on research by Dong et al. (2021), it is said that it can inhibit the growth of pathogenic bacteria such as Escherichia coli through its competition in consuming nutrients. In addition, Lactobacillus can produce metabolites such as lactic acid and antimicrobial peptides that make the environment inhospitable to pathogens, thus reducing the colonization of Escherichia coli bacteria (Dong et al., 2021). However, probiotic activity depends on the strain and the right dose, where

certain strains can be more effective for certain pathogens, so it is important to determine the optimal combination of probiotics through further clinical trials (Rigo-Adrover et al., 2018). In addition to the use of probiotics, another emerging approach is fecal microbiota transplantation (FMT), which has been shown to be effective in restoring the balance of the microbiota in cases of chronic diarrhea due to *Clostridium difficile*. This intervention shows potential as a microbiotabased therapy for gastrointestinal infections (Gallo et al., 2016).

CONCLUSION

Probiotics have great potential as a safe, effective and minimal side effect additional therapy in treating diarrheal infections. Probiotic strains such as *Lactobacillus* and *Bifidobacterium* have effective mechanisms in inhibiting the growth of pathogens. The presence of a balanced microbiota not only helps in protecting the body from infections but also contributes to overall health. Thus, further studies are needed to determine the optimal dose, duration of use, and effectiveness of probiotics in various populations and types of diarrhea.

The use of probiotics in diarrhea management has several practical implications for health workers, particularly in designing strategies based on gut microbiota balance. Health workers can incorporate probiotics into patient education to promote healthier diets and gut-friendly habits while reducing unnecessary antibiotic use that can worsen dysbiosis. Probiotic strains such as *Lactobacillus* and *Bifidobacterium* can be integrated into clinical guidelines as adjunct therapies to shorten recovery time, reduce symptom severity, and prevent recurrence, especially in vulnerable populations. In public health settings, probiotics can support preventive programs in communities with poor hygiene or high diarrhea incidence. Additionally, health workers can monitor patient outcomes, ensure appropriate dosing, and contribute to real-world data collection to improve evidence-based recommendations for probiotic use across diverse populations and diarrhea etiologies.

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References

- Afzaal, M., Saeed, F., Shah, Y. A., Hussain, M., Rabail, R., Socol, C. T., ... Rusu, A. V. (2022). Human gut microbiota in health and disease: Unveiling the relationship. *Frontiers in Microbiology*, *13*, 999001.
- Alou, M. T., Lagier, J.-C., & Raoult, D. (2016). Diet influence on the gut microbiota and dysbiosis related to nutritional disorders. *Human Microbiome Journal*, *1*, 3-11.
- Azagra-Boronat, I., Massot-Cladera, M., Knipping, K., Garssen, J., Ben Amor, K., Knol, J., ... Pérez-Cano, F. J. (2020). Strain-specific probiotic properties of bifidobacteria and lactobacilli for the prevention of diarrhea caused by rotavirus in a preclinical model. *Nutrients*, *12*(2), 498.
- Cameron, D., Hock, Q. S., Kadim, M., Mohan, N., Ryoo, E., Sandhu, B., ... Guarino, A. (2017). Probiotics for gastrointestinal disorders: proposed recommendations for children of the Asia-Pacific region. *World Journal of Gastroenterology*, *23*(45), 7952.
- Dey, P., Mukherjee, S. K., & Parai, D. (2023). Association of Probiotics and Prebiotics with Human Microbiome and the Functioning of Immune System. In *Probiotics, Prebiotics, Synbiotics, and Postbiotics: Human Microbiome and Human Health* (pp. 101-115). Springer.
- Dong, H., Liu, B., Li, A., Iqbal, M., Mehmood, K., Jamil, T., ... Wu, Q. (2021). Microbiome analysis reveals the attenuation effect of lactobacillus from yaks on diarrhea via modulation of gut microbiota. *Frontiers in Cellular and Infection Microbiology*, *10*, 610781.
- Fadillah, A. (n.d.). PENGARUH PEMBERIAN VITAMIN D3 TERHADAP EKSPRESI TNF- α DAN TGF- β

SERTA PERBAIKAN MUKOSA KOLON PADA MENCIT MODEL KOLITIS.

- Gallo, A., Passaro, G., Gasbarrini, A., Landolfi, R., & Montalto, M. (2016). Modulation of microbiota as treatment for intestinal inflammatory disorders: an uptodate. *World Journal of Gastroenterology*, 22(32), 7186.
- Goldenberg, J. Z., Yap, C., Lytvyn, L., Lo, C. K., Beardsley, J., Mertz, D., & Johnston, B. C. (2017). Probiotics for the prevention of Clostridium difficile-associated diarrhea in adults and children. *Cochrane Database of Systematic Reviews*, (12).
- Gul, S., & Durante-Mangoni, E. (2024). Unraveling the puzzle: health benefits of probiotics – a comprehensive review. *Journal of Clinical Medicine*, 13(5), 1436.
- Gupta, V. K., Paul, S., & Dutta, C. (2017). Geography, ethnicity or subsistence-specific variations in human microbiome composition and diversity. *Frontiers in Microbiology*, 8, 1162.
- Hill, C., Guarner, F., Reid, G., Gibson, G. R., Merenstein, D. J., Pot, B., ... Salminen, S. (2014). Activity of cecropin P1 and FA-LL-37 against urogenital microflora. *Nature Reviews Gastroenterology and Hepatology*, 11(8), 506.
- Iancu, M. A., Profir, M., Roșu, O. A., Ionescu, R. F., Crețoiu, S. M., & Gaspar, B. S. (2023). Revisiting the intestinal microbiome and its role in diarrhea and constipation. *Microorganisms*, 11(9), 2177.
- Jiang, Y., Ye, L., Cui, Y., Yang, G., Yang, W., Wang, J., ... Huang, H. (2017). Effects of Lactobacillus rhamnosus GG on the maturation and differentiation of dendritic cells in rotavirus-infected mice. *Beneficial Microbes*, 8(4), 645–656.
- Kim, C. H. (2021). Control of lymphocyte functions by gut microbiota-derived short-chain fatty acids. *Cellular & Molecular Immunology*, 18(5), 1161–1171.
- Li, Y., Xia, S., Jiang, X., Feng, C., Gong, S., Ma, J., ... Yin, Y. (2021). Gut microbiota and diarrhea: an updated review. *Frontiers in Cellular and Infection Microbiology*, 11, 625210.
- Mahajan, P., Kulkarni, A., Bandre, A., Subramanian, S., & Mahajan, S. (2021). Role of gut microbiota in autoimmune diseases: a review. *J Vaccines Immunol*, 6(163), 1–14.
- Puteri, A. D., Syahfitri, C. A., Isnaeni, L. M. A., & Yusristin, D. (n.d.). Faktor-Faktor Penyebab Kejadian Diare Pada Balita Di Wilayah Kerja Puskesmas Air Tiris.
- Raheem, A., Liang, L., Zhang, G., & Cui, S. (2021). Modulatory effects of probiotics during pathogenic infections with emphasis on immune regulation. *Frontiers in Immunology*, 12, 616713.
- Rigo-Adrover, M. D. M., Van Limpt, K., Knipping, K., Garssen, J., Knol, J., Costabile, A., ... Pérez-Cano, F. J. (2018). Preventive effect of a synbiotic combination of galacto-and fructooligosaccharides mixture with Bifidobacterium breve M-16V in a model of multiple rotavirus infections. *Frontiers in Immunology*, 9, 1318.
- Sánchez, B., Delgado, S., Blanco-Míguez, A., Lourenço, A., Gueimonde, M., & Margolles, A. (2017). Probiotics, gut microbiota, and their influence on host health and disease. *Molecular Nutrition & Food Research*, 61(1), 1600240.
- Tan, J., McKenzie, C., Potamitis, M., Thorburn, A. N., Mackay, C. R., & Macia, L. (2014). The role of short-chain fatty acids in health and disease. *Advances in Immunology*, 121, 91–119.
- Ulfah, M. M., & Kusumawati, N. R. D. (2022). Pengaruh Pemberian Probiotik Terhadap Integritas Usus pada Obesitas: Uji Coba pada Tikus Sprague Dawley. *Sari Pediatri*, 24(3), 157–164.
- Vogt, S. L., & Finlay, B. B. (2017). Gut microbiota-mediated protection against diarrheal infections. *Journal of Travel Medicine*, 24(suppl_1), S39–S43.
- Wulandari, P., & Permadani, A. A. (2024). Pengaruh Sanitasi Dasar dan Sosial Ekonomi Terhadap Penyakit Diare pada Balita di Wilayah Kerja Puskesmas Sukabumi. *BALABA*, 20(2), 65–73.