Current Therapeutic Research 99 (2023) 100721

Contents lists available at ScienceDirect

Current Therapeutic Research

journal homepage: www.elsevier.com/locate/curtheres

Methods of Determining Irritable Bowel Syndrome and Efficiency of Probiotics in Treatment: A Review

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ARTICLE INFO

Article history:
Received 30 June 2023
Accepted 13 October 2023

Key words:
Blastocystis
Gut–brain axis
Gut microbiota
Irritable bowel syndrome
Probiotics
Saccharomyces boulardii

ABSTRACT

Background: Irritable bowel syndrome (IBS) is a prevalent lifestyle-associated ailment linked to the gut microbiota that significantly influences patients' quality of life. A notable correlation exists between *Blastocystis* infections and susceptibility to IBS, with infected individuals exhibiting an increased likelihood of developing the condition. Despite promising results from using probiotics to modulate the gut microbiota and manage IBS, the precise mechanisms and potential risks remain unclear.

Objective: This review aims to explore the therapeutic potential of probiotics, particularly *Saccharomyces boulardii*, in the management of IBS, highlighting the role of the gut microbiota and the gut–brain axis in IBS pathophysiology.

Methods: A comprehensive literature survey was conducted to examine the association between gut microbiota and IBS, the role of probiotics in managing IBS, the mechanisms of their action, and the potential risks associated with their long-term use. Additionally, this study addresses the influence of *Blastocystis* infections on IBS susceptibility and evaluates various ongoing clinical trials investigating probiotic use for IBS.

Results: *S boulardii*, a yeast species with probiotic properties, has demonstrated effectiveness in both the treatment and prophylaxis of IBS. Its administration is associated with a decrease in the proinflammatory cytokine interleukin 8 and an increase in the anti-inflammatory cytokine interleukin 10. Probiotics appear to function by inhibiting the growth of pathogenic microorganisms and regulating neurotransmitter activity, influencing the gut–brain axis. However, selecting appropriate probiotic strains and dosing regimens is crucial because of potential adverse effects, such as infections and allergic reactions.

Conclusions: Probiotics, specifically *S boulardii*, offer a promising avenue for IBS management by modulating gut microbiota. However, further research is necessary to delineate the precise mechanisms of action, optimal strains, dosing regimens for IBS treatment, and potential risks associated with long-term use. A comprehensive approach incorporating probiotics, a low-FODMAP diet, and cognitive-behavioral therapy may provide effective management of IBS symptoms.

Introduction

Irritable bowel syndrome (IBS) is a prevalent gastrointestinal disorder, influencing 10% to 20% of the population in most countries, with particularly high incidence rates in Western Europe and North America.[1] Notably, some disparities in the demographic and clinical presentations of IBS have been observed between Western countries and other regions.[2] The human intestine harbors a vast and diverse microbial community collectively termed the gut microbiota. Recent research has implicated gut microbiota dysbiosis in the pathogenesis of lifestyle diseases, including IBS.[3] IBS can manifest in several subtypes, including diarrhea-predominant, constipation-predominant, mixed diarrhea and constipation, and unclassified. Common symptoms include abdominal pain, defecation difficulties, and alterations in stool frequency and consistency.[4] Psychological stress has been identified as a significant factor in IBS development,[5] and patients often exhibit reduced levels

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https://doi.org/10.1016/j.curtheres.2023.100721

of norepinephrine and serotonin.[6] In some cases, alterations in gut microbiota composition have been linked to IBS onset.[7]

The prevalence of IBS has been estimated to be 9.2%.[8] The HTF (High Taxonomic Fingerprint) microbi-array technique has been employed to compare the fecal microbiota profiles of patients with IBS and healthy individuals, revealing bacterial populations such as *Clostridium* clusters IV (25%) and XIV (21%), *Bacteroides* (9.1%), lactic acid bacteria (7.8%), *Veillonella* (5.7%), Bacilli (2.9%), and bifidobacteria (1.2%).[9] The human gut is home to a heterogeneous microbial ecosystem that includes commensal microorganisms. Yeasts constitute a minor component (<0.1%) of the total gut microbiota; however, because their size is 10 times larger than that of bacteria, they can exert steric hindrance on various bacterial species.[10]

Blastocystis, a common intestinal protozoan, has been implicated in IBS development. Other contributory factors include family history, maltreatment, bullying, and gender disparities.[11] Probiotics, live microorganisms, consumed as part of the diet, have been shown to modulate the gut microbiota composition, with daily doses ranging from 10^6 to 10^{10} CFU. In recent years, manipulation of gut microbiota via prebiotics and probiotics has emerged as a promising therapeutic strategy for IBS.[12]

Probiotic efficacy in the treatment of IBS has been assessed in clinical trials using a heterogeneous array of products.[4] *Saccharomyces boulardii*, a yeast species, has been used as a probiotic for both the prevention and treatment of IBS. Various formulations of *S boulardii*-containing probiotics are available, including lyophilized, heat-dried powder and mixed-strain capsules.[13] However, the precise mechanisms by which these probiotics alleviate IBS symptoms remain elusive.[14]

The novelty of this review article lies in its comprehensive evaluation of the various methods employed in the diagnosis of IBS and the potential of probiotics in its treatment. This article highlights the role of gut microbiota in the development of IBS, specifically the correlation between *Blastocystis* infections and IBS susceptibility. Additionally, machine learning methodologies have been employed to create a large database that elucidates the relationship between gut microbiota and various diseases, including IBS, inflammatory bowel disease (IBD), and *Clostridioides difficile* infection. This review also focuses on the effectiveness of probiotics, especially *S boulardii,* in treating and preventing IBS, highlighting the microbial composition modulation properties of probiotics that underlie their efficacy. Furthermore, the article suggests a multifaceted approach to managing IBS symptoms by combining probiotics with a low-FODMAP diet and cognitive behavioral therapy. This article postulates that the precise mechanisms by which probiotics alleviate IBS symptoms are yet to be fully understood. Therefore, future research endeavors to further delineate this complex interplay are recommended. Overall, this review article provides a broad context and a better understanding of the potential use of probiotics in IBS treatment, offering a promising therapeutic strategy that could improve the quality of life of patients with IBS.

Low-FODMAP Diet

A low-FODMAP diet is a dietary approach specifically designed to manage symptoms of IBS and other gastrointestinal disorders. The term *FODMAP* refers to fermentable oligosaccharides, disaccharides, monosaccharides, and polyols. These are specific types of carbohydrates that can be poorly absorbed in the small intestine and might act as fermentable substrates for gut bacteria, potentially leading to gas production, bloating, and altered bowel habits. The low-FODMAP diet involves 3 phases: elimination, reintroduction, and personalization. In the elimination phase, high-FODMAP foods are avoided for 2 to 6 weeks and then gradually reintroduced in the reintroduction phase to identify which FODMAP-containing foods triggers symptoms. A customized diet is formed based on individual tolerance levels in the personalization phase. The low-FODMAP diet is effective in reducing IBS symptoms in many patients.[15] It is worth noting that the low-FODMAP diet is not considered a lifelong dietary regimen but rather a short-term intervention aimed at identifying personal dietary triggers to manage IBS symptoms better.

IBS

IBS is a disorder primarily affecting the large intestine and characterized by recurrent abdominal pain accompanied by defecation disturbances.[16] Common symptoms of IBS include bloating, gas, incomplete evacuation, abdominal pain, nausea, diarrhea, constipation, and regurgitation (Figure 1). Notably, incomplete evacuation is particularly pronounced in patients with IBS.[17] Although IBS is a chronic condition that requires long-term management, only a minority of patients present with severe signs and symptoms.[18]

IBS has been associated with various triggering factors, including trauma, physiological factors, and gastrointestinal infections (Figure 2). The diagnostic criteria for IBS stipulate that recurrent abdominal pain must persist for a minimum of 3 months, with an onset preceding 6 months, and be accompanied by alterations in stool frequency.[16] Individuals with parental history of IBS tended to exhibit more severe symptoms. Furthermore, the children of mothers with IBS are more likely to present with gastrointestinal symptoms and require clinical intervention.[19]

IBS is different from functional diarrhea

Functional diarrhea is characterized by loose stool consistency and accelerated intestinal transit, with the potential for exacerbation due to stress and prior instances of infectious gastroenteritis.[20] A key differentiating factor between functional diarrhea and IBS is the presence of predominant abdominal pain. Whereas functional diarrhea is not accompanied by significant abdominal pain, IBS is characterized by notable abdominal discomfort.[21]

Biomarkers

The etiology and persistence of IBS may be associated with the human gut microbiota. In this study,[22] the authors compared the gut microbiota of patients with IBS with that of a control group of individuals showing no symptoms of digestive distress, considering factors such as age and sex. They collected fecal samples from the subjects every 3 months, examined the total bacterial DNA using 20 quantitative real-time polymerase chain reaction tests, which encompassed approximately 300 bacterial species. The analysis revealed substantial individual variation in the gut microbiota in both the patients with IBS and the control group. Patients with IBS were categorized based on their dominant symptoms: diarrhea, constipation, or alternating types. It was found that fecal samples from patients with diarrhea-predominant IBS had lower levels of *Lactobacillus* spp, whereas samples from patients with constipation-predominant IBS showed a higher prevalence of *Veillonella* spp. Upon evaluating the average results from three fecal samples, they noted differences in the levels of *Bifidobacterium catenulatum* and *Clostridium coccoides* subgroups between patients with IBS and controls. They did not detect any signs of *Helicobacter* spp, *C difficile*, or any of the 2 intestinal infections previously associated with IBS. However, they identified 1 instance of *Campylobacter jejuni* after sequencing the samples.[22]

Blastocysts

Blastocystis is a microscopic parasite that inhabits the digestive tract and can be transmitted through contaminated food or water or exposure to human or animal feces. A significant association

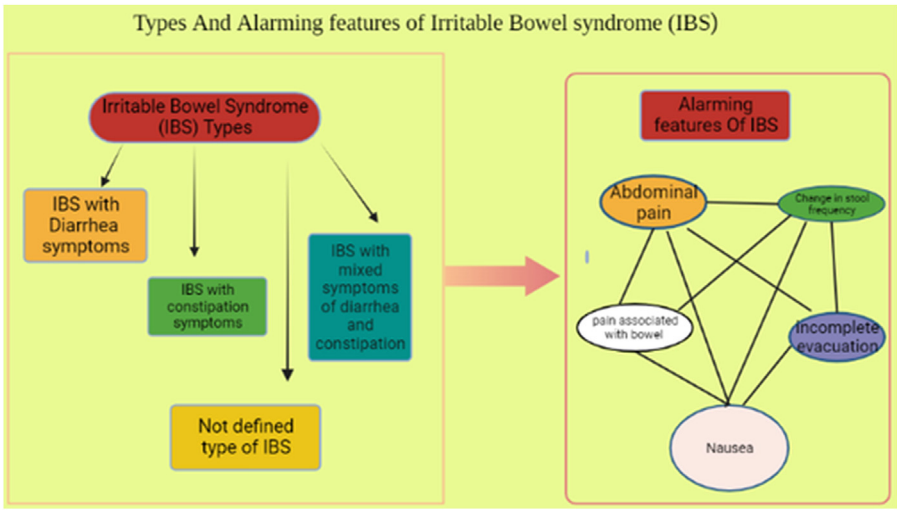

Figure 1. Types and alarming features of irritable bowel syndrome (IBS).

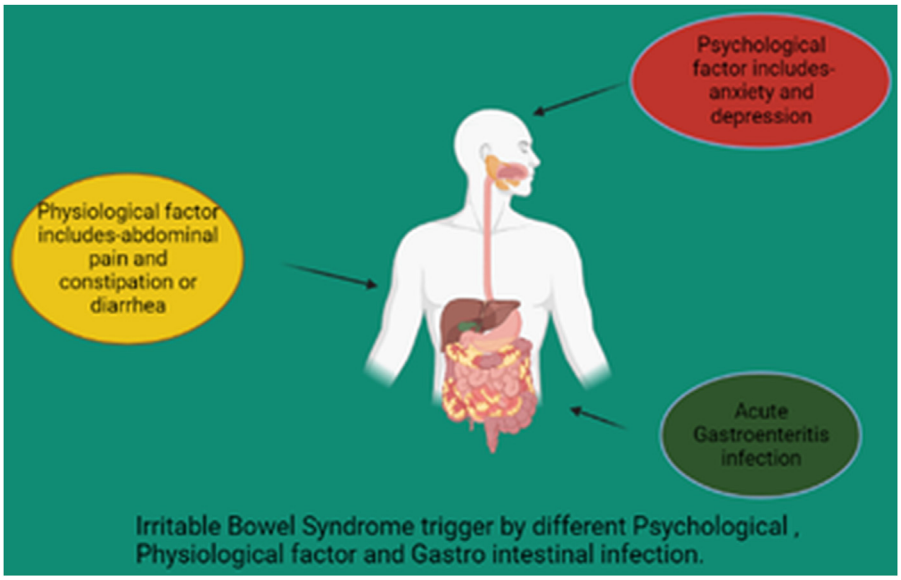

Figure 2. Irritable bowel syndrome triggered by different factors.

has been observed between the presence of *Blastocystis* spp and IBS cases with diarrhea, although the pathogenesis of this parasite remains elusive.[11]

The gut–brain axis refers to the bidirectional biochemical signaling processes that occur between the central nervous system and gastrointestinal tract.[23] Neurotransmitters such as serotonin and norepinephrine play critical roles in the gut–brain axis and their involvement has been linked to IBS.[6] IBS and dyspepsia are considered disorders of gut–brain interactions, with postcoronavirus disease 2019 manifestations related to disturbances in gut–brain interactions.[24]

Method of Determining IBS

A Delphi process involving a panel of Belgian experts sought to establish a consensus on the symptoms, pathophysiology, and treatment of IBS within the context of Belgian health care specificities. The study comprised 75 statements, divided into 12 categories. Owing to the absence of definitive diagnostic tests for IBS, a thorough examination of patient history, limited diagnostic testing, and physical examination are required. Food allergies were classified as a subgroup of IBS, with elevated titers of immunoglobulin G and immunoglobulin G4 detected in patients with IBS. The resultant consensus provides guidance on the identification, diagnosis, and treatment of IBS.[25] Lifestyle modifications, including a low-FODMAP diet, probiotics, and cognitive behavioral therapy, were shown to alleviate IBS symptoms. The study concluded that recurrent abdominal pain lasting at least 3 months, with an onset preceding 6 months, and changes in stool frequency constituted the criteria for IBS. The Delphi method compiled comprehensive information on IBS triggered by trauma, physiological factors, and gastrointestinal infections.[16]

To examine the features of IBS, researchers have employed the High Taxonomic Fingerprint (HTF)-microbi array oligonucleotide method. The investigation included 568 contributors, comprising 63% of the female population and 37% of their male counterparts. HTF-microbi array oligonucleotide probes were used in this investigation. An imbalance in the commensal intestinal microbiota of patients with IBS was observed using HTF-microbi array oligonucleotide probes. Subsequently, a questionnaire was administered to patients. A study revealed that incomplete evacuation was more prominent in patients with IBS.[18]

Table 1
Clinical trials for the treatment of irritable bowel syndrome (IBS) by different methods.

Author (year)	Method of study	Sample size and treatment	Variables	Finding
Zhu et al (2022)[3]	OTU table	7565 Probiotic given	Age, sex, height, weight, body mass index, taking alcohol or doing exercise, and residence location	Human variables and gut microbiota together help best in predicting IBS
Zhang et al (2022)[7]	Polymerase chain reaction	394 (including 205 IBS patients and 189 healthy controls. Antidepressant for 1 month	Psychological and mental disorders	Leukocyte telomere length is longer in a person having an antidepressant for the past month compared with a person having no antidepressant
Kesuma et a1 (2019)[11]	Microscopic examination of stool	454	Different school students	An association found between the blastocystis, and IBS found with risk factor 2.9
Choi et al (2011)[9]	Rome III criteria and randomization	142 Multi-strain probiotic fermented milk for 4 wk	Different age group	Soluble fiber showed favorable results in IBS-related constipation

Machine learning methodologies have been employed to elucidate the relationship between the gut microbiota and IBS, leading to the creation of an extensive database. Gut microbiota has been shown to be significantly associated with various diseases. A combination of gut microbiota and human variables has yielded improved predictive outcomes for conditions such as IBS, IBD, and *C difficile* infection. The heterogeneity of the microbial composition is higher in the gastrointestinal tract of patients with IBS than in healthy individuals. The study Table 1 included 7565 patients with IBS and 189 healthy controls, accounting for variables such as sex, age, weight, body mass index, alcohol consumption, exercise habits, and residential location.[26] The operational taxonomic unit table served as the methodological approach for the study. Certain microbes function as biomarkers for differentiating IBS from other diseases. This study aimed to determine the influence of the overall gut microbiota rather than focusing on a single type of microbe influencing diseases. This methodology also helped to explore the influence of gut microbiota on various ailments, including inflammatory bowel disease, mental health disorders, diabetes, cardiovascular diseases, and *C difficile* infections.[7]

Leukocyte telomere length (LTL) has been implicated in mental or psychiatric disorders, which are crucial factors in the development of IBS. In a telomere study involving IBS, quantitative polymerase chain reaction was performed on 394 samples comprising 205 patients and 189 healthy controls. The study demonstrated a connection between LTL and IBS, with patients with IBS exhibiting shorter LTL than healthy controls. Patients who had been using antidepressants for a month exhibited longer LTL than those not taking antidepressants.[27]

In numerous instances of IBS with diarrhea, *Blastocystis* has been associated with IBS. However, the pathogenesis of *Blastocystis* infection remains unclear. A study was conducted to analyze *Blastocystis* and its subtypes in patients with IBS. The methodology involved microscopic examination of stool samples. A total of 207 stool samples from patients with IBS were smeared on glass slides with Lugol's solution and examined at 40 × magnification under a microscope to detect the presence of *Blastocystis*. The patients were recruited from various schools. A significant association between *Blastocystis* subtype ST-1 and IBS with diarrhea was discovered, and individuals with *Blastocystis* infections were found to be 2.9 times more likely to develop IBS.[11]

IBS with diarrhea and functional diarrhea is characterized by diarrhea. A Delphi consensus was conducted involving experts from 10 European countries to differentiate between the two conditions. IBS differs from functional bowel disorders in terms of its influence on physical and psychological states.[28] The Delphi consensus group voted on various statements to assist physicians with disease treatment. The experts agreed on the overlapping symptoms and diagnosis of IBS and functional diarrhea. Comprehensive evaluations included blood count, fecal calprotectin, serology for celiac disease, bile acid diagnosis, and colonoscopy of the colons.[23]

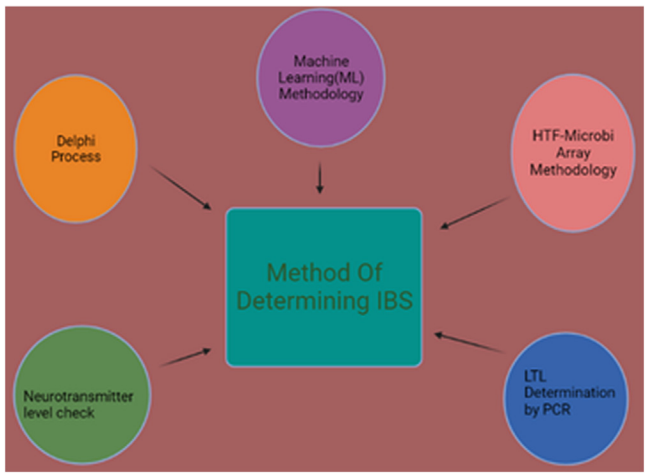

Figure 3. Method for determining irritable bowel syndrome (IBS). LTL = leukocyte telomere length; ML = machine learning; PCR = polymerase chain reaction.

Patients with IBS can be distinguished from healthy controls based on their neurotransmitter levels. The study observed 40 patients with IBS and 20 healthy controls, accounting for variables such as age, marital status, race, and sex. A comparative investigation of randomized clinical trials was conducted to study the influence of serotonin and norepinephrine (neurotransmitters) on IBS. Notably, the levels of neurotransmitters, anxiety, and depressive symptoms were higher in patients with IBS than in healthy controls (Figure 3). This study demonstrated that anxiety and depression were more prevalent in patients with IBS than in healthy controls.[6]

Gut Microbiota and IBS

Numerous studies have been conducted in the past decade to elucidate the relationship between gut microbiota and the development of IBS. IBS is characterized by multifactorial pathogenesis. Two methods were employed in the study: a systematic examination of clinical trials using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses method for IBS from 2011 to 2021 and the Multi-criteria Decision Making Analysis method.[29]

To examine the effect of gut microbiota manipulation on IBS, various factors were considered, including prior infections, diet, genetics, and altered enteroendocrine cells. The fecal microbiota transplantation method was used as the study methodology. Disrupted gut microbiota (such as bacterial overgrowth, carbohydrate malabsorption, and altered strains), long-term infections, diet, and

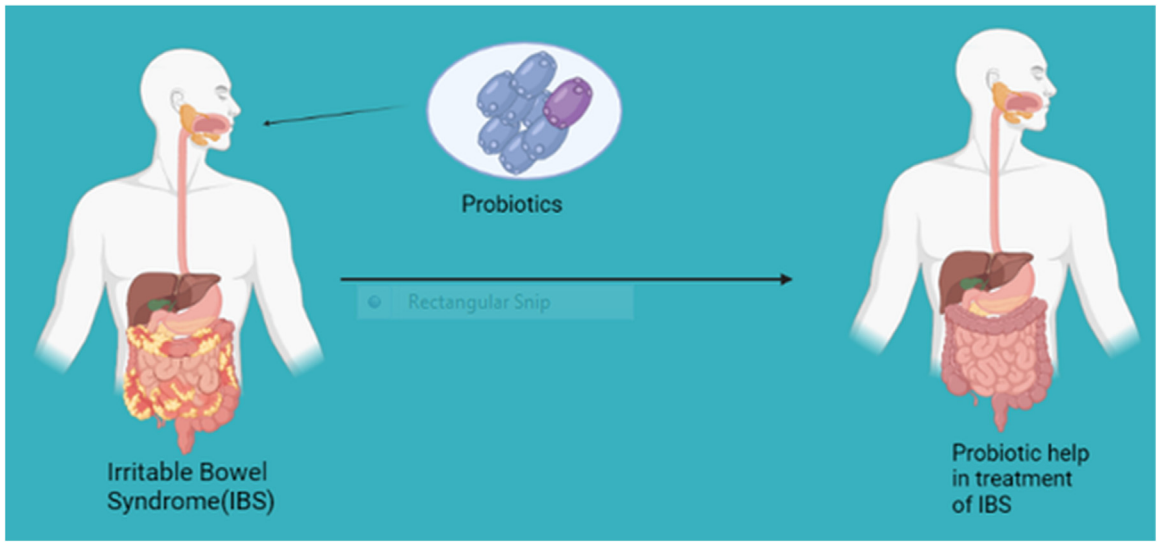

Figure 4. Estimated effects of probiotics on irritable bowel syndrome (IBS).

genetics play a role. Gut microbiota manipulation involves alterations in the composition of the microbiota as well as changes in the habitat of the gut microbiota, including modifications in short-chain fatty acids and endocrine cell densities. Adhering to a low-FODMAP diet for an extended period may improve the gut microbiota.[30] Probiotics have the potential to modulate the gut microbiota by enhancing gut barrier function, inhibiting pathogenic bacterial growth, and exerting positive effects on neurotransmitters.[31] Manipulation of gut microbiota has been shown to reduce IBS-related symptoms.[12]

Probiotics

Probiotics are live microorganisms consumed as part of the diet that can modify the composition of the gut microbiota. The availability of probiotics in the market is continuously increasing. Generally considered safe, probiotics may have adverse effects in immunocompromised individuals. These microorganisms confer health benefits to those who consume them, with daily doses ranging from 10^6 to 10^{10} CFU. It is important to note that not all probiotics are identical; they may vary in composition and influence.[32] The efficacy of probiotics depends on the specific strain and conditions for which they are utilized. Probiotics have been shown to aid in the treatment of IBS (Figure 4).

Different strains of probiotics

Patients with IBS can take probiotics safely and effectively, especially when administered for a shorter period of time; i.e., <8 weeks. Compared with many other current therapeutic choices, the side effects of probiotics have been determined to be less dangerous. Stool consistency, gut transit time, and total stool frequency have all been shown to improve with the use of probiotics. Kefir, yogurt, and a few other fermented foods are common sources of probiotics. All of these bacteria may promote improved gut health. Among these sources, *Lactobacillus delbrueckii* subsp, *Bifidobacterium* strains, *Streptococcus thermophiles, Lactobacillus bulgaricus*, and *Lactobacillus* strains are the most commonly utilized microorganisms. Studies have shown that they improve gut health and have anti-inflammatory effects and responses. Probiotic products frequently contain bacteria from *Enterococcus* and *Streptococcus* species in addition to the regular *Lactobacillus* and *Bifidobacterium* species. Various probiotic product formulations are available, offering a range of feasible options.[33] These formulations encompass different microorganisms, such as *Bacillus* species, yeasts, such as *Saccharomyces cerevisiae* and *S boulardii*, and even the filamentous fungus *Aspergillus oryzae*. These probiotics can be conveniently administered through capsules, tablets, powders, sprays, or pastes, thus providing flexibility and diverse delivery methods. Probiotic use is a more natural method and has fewer adverse effects than pharmacotherapeutic medications.[34]

A two-stage computerized randomization approach was employed to evaluate the efficacy of probiotics in patients with IBS, a prevalent gastrointestinal condition in numerous countries. Employing a randomized, double-blind, placebo-controlled approach, the investigation included 152 patients with IBS. The objective of this study was to evaluate the effects of probiotics on IBS by allocating patients to receive either probiotics or a placebo over 12 weeks. The results revealed that probiotics constituted a safe and efficient remedy for IBS because improvements in symptoms were observed among patients administered multistrain probiotics.[1,35]

The objective of this investigation was to scrutinize the influence of multistrain probiotics on patients with IBS patients with diarrhea. This study assessed the effects of probiotics on epithelial barriers and intestinal permeability using radionuclide tracers. The subjects ingested two capsules of multistrain probiotics, and intestinal permeability was persistently evaluated using the Bristol stool scale. A decrease in intestinal permeability, concomitant with alleviated abdominal discomfort and improved stool consistency, was observed in patients receiving multistrain probiotics. The study included 40 patients with diarrhea-predominant IBS, of whom 60% were women and 40% were men. Multistrain probiotics were administered for 30 days, and 81.5% of patients demonstrated improvement in intestinal permeability after the 30-day treatment period.[8,36]

Microinflammation and elevated high-sensitivity C-reactive protein levels are crucial factors to consider in the pathogenesis of IBS with diarrhea. A placebo-controlled, double-blind study examined the effects of a probiotic mixture (containing various strains) on inflammatory markers in women diagnosed with IBS and diarrhea.[37] The study included 160 patients, of whom 107 received a probiotic mixture as treatment, whereas the others were administered a placebo. Both the probiotic and placebo capsules were administered for 8 weeks. Stool consistency and symptoms were monitored using the Bristol stool scale and visual analog scale, and high-sensitivity C-reactive protein levels were measured at base-

line and between 4 and 8 weeks. Symptoms improved in women in both the probiotic and placebo groups; however, no superiority was demonstrated by the use of probiotics on symptoms and high-sensitivity C-reactive protein levels. An 8-week treatment with a probiotic mixture did not yield any significant difference compared with placebo.[38,39]

In a study investigating the effects of a multistrain probiotic containing dietary fiber on IBS, the Rome III criteria and randomization method were employed to evaluate 142 patients with IBS. Multistrain probiotic fermented milk was utilized as a treatment for these patients, demonstrating beneficial effects on IBS. A decrease in the frequency of daily stools and improvement in stool consistency were observed.[14] The efficacy of probiotics depends on the specific strain and the conditions under which they are employed. Probiotics containing *S boulardii* have exhibited preventive effects in the treatment of IBS recurrence. A study examining yeast (*S boulardii*) as a probiotic for IBS treatment utilized the PubMed and Medline databases for its methodology. The application of a probiotic containing *S boulardii* resulted in no adverse effects or a decrease in the number of daily stools.[13,35,40]

In another study assessing the effects of probiotics containing *S boulardii* on IBS, 5029 patients were considered. Randomized clinical trials were conducted, and the treatment administered for IBS was *S boulardii* probiotics. The study duration ranged from 7 weeks to 6 months, and *S boulardii* probiotic was found to be beneficial for IBS recovery.[41,42] A study focusing on cytokine levels and clinical response to a probiotic containing *S boulardii* involved 72 patients. A randomized, double-blind, placebo-controlled method was employed, with patients receiving either 750 mg/day *S boulardii* or placebo for 6 weeks. Following the 6-week period, a significant reduction in proinflammatory cytokines, including interleukin 8 and tumor necrosis factor-alpha, was observed along with an increase in the levels of anti-inflammatory cytokines, such as interleukin 10.[35] This study investigated the effects of a probiotic containing *S boulardii* on the levels of both anti-inflammatory and proinflammatory cytokines in patients diagnosed with IBS. This study revealed that the probiotic yielded a favorable outcome with respect to the levels of both types of cytokines. Notably, whereas IBS symptoms improved in both the placebo and probiotic groups, only those who received the probiotic *S boulardii* enhanced their quality of life (QOL).[43,44]

To examine the efficacy of *S boulardii* probiotics on IBS, a randomized approach was utilized to administer either a probiotic or placebo to patients with IBS. The study spanned 4 weeks and involved 34 patients receiving the probiotic and 33 receiving the placebo.[45,46] This study aimed to measure the influence of *S boulardii* on QOL of patients using the IBS-QOL scale both before and after treatment. The findings revealed that all patients experienced symptom improvement, including those receiving the placebo. However, whereas the probiotic group showed improvements in all domains of IBS and QOL, the placebo group only displayed an enhancement in dysphagia. In summary, the *S boulardii* probiotic improved IBS-QOL by 15.4% and offered health benefits, symptom reduction, and improved QOL in patients with IBS.[9]

This study aimed to identify the most efficient probiotics for the treatment of IBS by employing 2 methods: the Preferred Reporting Items for Systematic Reviews and Meta-Analyses technique for systematic examination of clinical trials on IBS conducted between 2011 and 2021 and the Multi-criteria Decision Making Analysis approach.[47] This study administered probiotics as a form of treatment for patients with IBS and discovered that strains such as *L rhamnosus, Bifidobacterium animalis,* and *L acidophilus* had a positive influence on IBS symptoms. It was ascertained that the use of diverse probiotic strains in combination was more effective in treating IBS than a single-strain probiotic.[48,49]

Challenges and Perspectives

Although probiotics have shown potential for treating IBS, the precise mechanisms underlying their effectiveness are not yet fully understood. Some hypothesized mechanisms of action include suppressing harmful microorganism growth and regulating the activity of neurotransmitters, such as serotonin and norepinephrine, which have an influence on the gut–brain axis. However, additional research is required to gain a deeper understanding of the intricate connections between these mechanisms and how they contribute to the therapeutic effects of probiotics in IBS.

Another critical consideration is the potential risks associated with long-term use of probiotics for IBS management. Despite being generally safe, there have been reports of adverse effects such as infections, sepsis, and allergic reactions, especially in individuals with compromised immune systems. Therefore, it is essential to carefully select the appropriate probiotic strains and dosing regimens for each patient and monitor them for any adverse effects. In addition to probiotics, a comprehensive approach integrating a low-FODMAP diet and cognitive behavioral therapy has demonstrated efficacy in managing IBS symptoms. Future research should strive to further unravel the interactions between these therapeutic modalities and determine optimal treatment strategies for individual patients based on their particular symptoms and underlying mechanisms.

Numerous clinical trials are currently underway to evaluate the effectiveness of probiotics in managing IBS. The Probiotics on Irritable Bowel Syndrome trial is one such study that examined the efficacy of a multispecies probiotic preparation in reducing IBS symptoms. Another clinical trial tested the effectiveness of probiotics in conjunction with a low-FODMAP diet to alleviate the severity of IBS symptoms. Staying up to date with the outcomes of these ongoing clinical trials may offer valuable insights into the potential of probiotics in managing IBS.

IBS is a common gastrointestinal condition that affects approximately 10% to 20% of the population. IBS development has been associated with the gut microbiota and psychological stress. *Blastocystis* has been linked to IBS accompanied by diarrhea, whereas probiotics such as *S boulardii* have demonstrated potential in treating IBS. Machine learning methods have been used to study the relationship between gut microbiota and IBS, revealing significant links between gut microbiota and various diseases including IBS, IBD, and *C difficile* infection.

Lifestyle modifications, such as a low-FODMAP diet, probiotics, and cognitive behavioral therapy, have been found to alleviate IBS symptoms. The gut–brain axis, which is the biochemical signaling process between the central nervous system and gastrointestinal tract, has also been implicated in IBS. The effectiveness of probiotics in treating IBS depends on the specific strain and conditions for which they are used. Although gut microbiota manipulation and probiotics have shown promise in treating IBS, further research is necessary to identify the optimal probiotic strain and dosing regimen for IBS treatment, and to determine precisely how probiotics exert their influence on IBS.

Conclusions

Probiotics have demonstrated potential as viable therapeutic options for managing IBS. However, there are still unanswered questions regarding their mechanisms of action and potential risks associated with prolonged use. Therefore, careful selection of probiotic strains and dosing regimens, in conjunction with other therapeutic approaches, may be necessary to achieve optimal treatment outcomes while minimizing potential risks.

Declaration of Competing Interest

The authors have indicated that they have no conflicts of interest regarding the content of this article.

Acknowledgments

Geetika M. Ahlawat performed the literature survey and drafted the first draft; Prabhat K. Singh reviewed, revised, and finalized the draft.

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