**The role of probiotics in supporting celiac disease management - a review of current research and therapeutic perspectives**

Aleksandra Cieplak, Zuzanna Czyżewicz, Aleksandra Kołodziej, Nadia Hornig,

Wiktoria Zamirska

Aleksandra Cieplak

University Clinical Center named after Prof. K. Gibiński, ul. Medyków 14, 40-514 Katowice, Poland

ORCID: 0009-0008-2700-5211

ola.cieplak@gmail.com

Zuzanna Czyżewicz

Medical University of Silesia, ul. Poniatowskiego 15, 40-055 Katowice, Katowice, Poland

ORCID: 0009-0005-8809-2708

zuzannace@gmail.com

Aleksandra Kołodziej

Municipal Hospital No. 4 in Gliwice ul. Zygmunta Starego 20, 44-100 Gliwice, Poland  
ORCID: 0009-0007-7322-3116  
olakolodziej18@gmail.com

Nadia Hornig

Independent Public Health Care Facility of the Ministry of Internal Affairs and Administration in Katowice named after Sergeant Grzegorz Załoga, ul. Wita Stwosza 39-41 40-042 Katowice, Poland

ORCID: 0009-0001-3247-4660

nadia.hornig5@gmail.com

Wiktoria Zamirska

Katowice Oncology Centre, ul. Raciborska 26, 40-074 Katowice, Poland

ORCID: 0009-0006-6520-1876

zamirskawiktoria@gmail.com

**Abstract**

**Introduction and purpose:** Celiac disease is a chronic autoimmune disorder that damages the small intestinal mucosa in response to the ingestion of gluten. Although a gluten-free diet is the only effective treatment, many patients experience incomplete resolution of symptoms, highlighting the need to explore new therapeutic strategies. This review aims to evaluate the available clinical evidence on the effect of probiotics on celiac disease symptoms and to analyze their potential therapeutic benefits.

**Materials and methods:** The review was based on studies published between 2013 and 2024 that met specific inclusion criteria, such as randomization and placebo control. Trials in patients with celiac disease using different forms of probiotics, including monotherapy and mixed strains, were included. A literature search was conducted in the PubMed, EMBASE, and Cochrane Library databases using a variety of keywords. Data were collected on changes in clinical symptoms, inflammatory parameters, and gut microbiota composition.

**Description of the state of knowledge:** The accumulated data suggest that probiotics may improve gut function and reduce inflammation in patients with celiac disease. Bacterial strains such as Lactobacillus and Bifidobacterium show the ability to modulate the immune response and improve the integrity of the intestinal barrier. Research suggests that probiotics may alleviate gastroenterological symptoms such as abdominal pain and bloating and promote the regeneration of intestinal villi. Despite these promising results, there are still no clear guidelines for the use of probiotics in the treatment of celiac disease.

**Conclusion:** In conclusion, probiotic therapy may be a valuable adjunct to a gluten-free diet in patients with celiac disease, offering new therapeutic options and improving quality of life. Further research is needed to establish optimal dosing regimens and to identify the most effective probiotic.

**Keywords:** „celiac disease”, „probiotics in celiac disease”, “symptoms of celiac disease”, “gut microbiota”

**Introduction**

Celiac disease is a chronic autoimmune disease. Its characteristic symptom is damage to the small intestinal mucosa in response to the ingestion of gluten. Patients with this disease suffer from villous atrophy and consequent malabsorption. This can lead to malnutrition and nutrient deficiencies. Celiac disease has no characteristic pathognomonic symptoms. The most common symptoms are abdominal pain, bloating, diarrhea, or nausea. (1) In children, failure to gain weight is common, mainly due to malabsorption. (2) Currently, the only effective treatment is a strict gluten-free diet, which, although effective, can be difficult to follow and does not always result in complete recovery of the intestinal mucosa. (3) Consequently, supportive therapies, including probiotic supplementation, which can influence gut microbiota and alleviate the symptoms of the disease, are receiving increasing attention (4).

Despite the use of a gluten-free diet, which is currently the only effective treatment option, some patients still struggle with incomplete resolution of symptoms. This necessitates the search for new therapeutic strategies. Probiotic therapy is a promising direction in the treatment of celiac disease, aiming to improve the balance of the intestinal microbiome and modulate the immune response. (5) Chronic abnormalities of the gut microbiome in patients with celiac disease, including a reduction in beneficial bacteria and a predominance of pro-inflammatory microorganisms, may contribute to the severity of disease symptoms and exacerbate intestinal damage. Consequently, probiotics, which promote the regeneration of the bacterial flora and alleviate inflammation, have become the focus of intense clinical research (6).

In recent years, many studies have been conducted to evaluate the efficacy of probiotic therapy in alleviating the symptoms of celiac disease. The results of these trials are promising, suggesting that probiotics may help to improve bowel function, reduce inflammation, and decrease the severity of some clinical symptoms of celiac disease, such as abdominal pain, bloating, or indigestion. (7) Although there are still no clear guidelines on the use of probiotics in the treatment of celiac disease, a growing number of studies suggest their potential in supportive therapy. This review aims to examine the available clinical evidence on the effect of probiotics on the symptoms of celiac disease, considering their mechanisms of action and potential therapeutic benefits for patients.

Understanding the role of probiotic therapy in the management of celiac disease may open up new treatment options for this disease, especially in cases refractory to a standard gluten-free diet, and contribute to improving the quality of life of patients with this chronic autoimmune disease.

Celiac disease is an autoimmune disorder whose pathomechanism is based on an abnormal immune response to gluten, resulting in damage to the small intestinal lining. The main treatment remains a strict gluten-free diet, but some patients may still experience symptoms such as abdominal pain, bloating, diarrhea, or fatigue. In addition, full recovery of the intestinal mucosa does not always occur, highlighting the need for new adjunctive therapies. In this context, the 2020-2024 review of clinical trials focusing on the role of probiotics in the treatment of celiac disease symptoms is particularly important.

Probiotics, through their ability to modulate the gut microbiota, influence many processes that are key to gut health. In the case of celiac disease, their potential effects include reducing intestinal barrier permeability, reducing inflammation, and modulating the immune response. Research from this period focuses on determining the efficacy and safety of specific probiotic strains, such as *Lactobacillus rhamnosus* GG, *Bifidobacterium longum,* or *Saccharomyces boulardii*. Their effects are being studied both in alleviating gastroenterological symptoms and in improving the overall well-being of celiac disease patients. (8)

The importance of reviewing studies from recent years is also due to advances in research technology, which allow a more precise analysis of the interaction of probiotics with the gut microbiota and the immune system. The results of these studies provide new insights into the mechanisms of action of probiotics, such as the ability to neutralize toxic gluten peptides, reduce the production of pro-inflammatory cytokines, and promote the recovery of damaged intestinal epithelium. (9)

Furthermore, the review facilitates an assessment of the safety of probiotics in individuals diagnosed with coeliac disease, a pivotal consideration given the distinct requirements of this patient demographic. A meticulous analysis of the outcomes of clinical trials can not only identify the most promising probiotic strains but also ascertain the optimal doses, duration of therapy, and patient groups that stand to benefit most from this modality of treatment. (10)

Such reviews facilitate a more profound comprehension of the prospective advantages of probiotics in celiac disease supportive therapy, while concurrently aiding in the direction of future research endeavours. In light of the escalating prevalence of this condition, the advent of novel therapeutic methodologies holds considerable potential to enhance patient well-being and augment the efficacy of treatment regimens. (11)

**Coeliac disease: an overview of the current understanding of the condition**

Coeliac disease is an autoimmune condition affecting the gastrointestinal tract, characterized by an abnormal immune response to gluten, a protein present in cereals such as wheat, barley, and rye. In individuals with a genetic predisposition, particularly those carrying the HLA-DQ2 and HLA-DQ8 genes, gluten fragments, after being modified by the enzyme tissue transglutaminase (tTG), are presented to T cells in the small intestine. This process leads to the activation of T cells and the overproduction of pro-inflammatory cytokines such as interferon-gamma (IFN-γ) and interleukin-15 (IL-15). The resultant inflammation causes damage to the intestinal epithelium, villous atrophy, and impaired nutrient absorption function. Dysbiosis of the intestinal microbiota also plays a key role in pathogenesis, which can exacerbate inflammation and disrupt the immune balance in the gut. These processes lead to characteristic clinical manifestations, including diarrhea, abdominal pain, nutritional deficiencies, and extraintestinal manifestations, such as neurological and skin lesions. The pathogenesis of coeliac disease is complex, and its full understanding requires further research into genetic, immunological, and environmental factors. (12)

**The role of the gut microbiome**

The gut microbiota is a complex ecosystem of microorganisms that includes primarily bacteria but also fungi, viruses, and archaea. The predominant bacteria belong to four main types: *Firmicutes, Bacteroidetes, Actinobacteria, and Proteobacteria*. The most common of these are *Lactobacillus* and *Bifidobacterium*, which play a key role in the fermentation of carbohydrates, the production of short-chain fatty acids (SCFAs) - such as butyrate, acetate, and propionate - and the strengthening of the intestinal barrier. Bacteroides are involved in the breakdown of complex polysaccharides and promote lipid metabolism. In contrast, *Faecalibacterium prausnitzii* *and Akkermansia muciniphila* are important for maintaining the integrity of the intestinal epithelium and have anti-inflammatory effects by reducing the secretion of pro-inflammatory cytokines. Some species of the *Proteobacteria* group may have pathogenic functions when their numbers become excessive as a result of dysbiosis. Overall, the gut microbiota supports digestion, nutrient metabolism, vitamin synthesis (e.g. K and B12), modulation of the immune system, and protection against pathogen colonization, making it an indispensable part of the body's homeostasis. (13)

Disorders of the gut microbiota, otherwise known as dysbiosis, have been demonstrated to result in increased intestinal permeability, thus facilitating the entry of toxins and pathogens into the bloodstream and causing local and systemic inflammation. This manifests itself in a range of intestinal complaints, including, but not limited to, diarrhea, bloating, abdominal pain, and irritable bowel syndrome. In more severe cases, dysbiosis has been linked to the development of chronic diseases such as inflammatory bowel disease (IBD) and coeliac disease. The maintenance of a healthy balance within the gut microbiota is, therefore, of paramount importance for the overall health and well-being of the gastrointestinal tract. (14)

The gut microbiota plays a pivotal role in regulating the immune system, a fact that is particularly salient in the context of autoimmune diseases such as coeliac disease. Abnormalities in the composition of the gut microbiota, known as dysbiosis, have been shown to result in increased inflammation through the activation of the immune response and the augmentation of pro-inflammatory cytokine production, including interleukin-15 (IL-15) and interferon-gamma (IFN-γ). In the context of coeliac disease, dysbiosis has been observed to exacerbate intestinal epithelial damage and interfere with immune tolerance processes to gluten. Studies have indicated that appropriate modulation of the intestinal microbiota with probiotics, prebiotics, or elimination diets may have the effect of reducing the activity of inflammatory factors and promoting the regeneration of intestinal villi. Probiotic strains, such as *Lactobacillus* and *Bifidobacterium*, have demonstrated the capacity to reduce pro-inflammatory cytokine levels and promote the production of anti-inflammatory cytokines, including IL-10. The incorporation of interventions aimed at restoring the gut microbiota may constitute a significant component of supportive therapy for coeliac disease, although this assertion requires further clinical investigation. (15)

**Probiotics and the Gut Microbiota**

The study *'Probiotics regulate gut microbiota: An effective method to improve immunity'* analyses the effects of probiotics on the gut microbiota and their ability to modulate the immune response. The authors presented evidence that probiotics, by increasing the number of beneficial gut bacteria and reducing pathogens, contribute to improving intestinal barrier integrity and reducing inflammation.

The mechanisms by which probiotics exert their effects include the stimulation of anti-inflammatory cytokines, such as IL-10, and the inhibition of pro-inflammatory mediators, such as TNF-α. The study indicates that adequate probiotic supplementation may support both local and systemic immunity, which may be particularly important in the treatment of autoimmune and inflammatory diseases such as celiac disease. The authors emphasize that probiotics may be an effective method to support the treatment and prevention of disorders associated with intestinal dysbiosis. (16)

The publication, entitled *'Lactobacillus spp. for Gastrointestinal Health: Current and Future Perspectives'*, discusses the role of *Lactobacillus* in maintaining gastrointestinal health and its therapeutic potential in the treatment of various diseases. The authors highlight the ability of these bacteria to modulate the intestinal microbiota through colonization of the gut, production of antimicrobial substances, and competition for nutrients with pathogens. *Lactobacillus* strains promote the integrity of the intestinal barrier by increasing mucin production and reducing intestinal permeability.

The study suggests that *Lactobacillus* may regulate the host immune response by increasing the production of anti-inflammatory cytokines such as IL-10 and inhibiting pro-inflammatory cytokines such as TNF-α. The authors also discuss the use of these bacteria in supportive therapy for inflammatory bowel disease, irritable bowel syndrome (IBS), and celiac disease. It is highlighted that *Lactobacillus* strains can alleviate symptoms associated with intestinal microbiota disorders, promote epithelial regeneration, and reduce intestinal inflammation.

The study's findings suggest that *Lactobacillus spp*. possess significant therapeutic potential, warranting further investigation into their application in the prevention and treatment of gastrointestinal disorders. However, it is crucial to note that additional research is necessary to identify the most efficacious strains and to elucidate their underlying mechanisms of action. (17)

The study, titled *'Beneficial effects of probiotic consumption on the immune system'*, methodically analyzed the impact of probiotic consumption on immune function, with a particular emphasis on immunomodulatory mechanisms. The authors presented evidence that probiotics, particularly strains from the genera *Lactobacillus* and *Bifidobacterium*, can stimulate both innate and adaptive immune responses and that they have the ability to increase the activity of macrophages and NK cells and to modulate the production of pro- and anti-inflammatory cytokines such as IL-10 and TNF-α.

Furthermore, the study emphasizes the pivotal role of probiotics in enhancing the intestinal barrier's integrity through the augmentation of mucin production and the fortification of intercellular connections within the intestinal epithelium. Consequently, this contributes to a reduction in intestinal permeability, thereby constraining the ingress of pathogens into the body and, by extension, diminishing chronic inflammation. Additionally, the authors underscore the capacity of probiotics to bolster the immune response in autoimmune and allergic diseases.

The paper concludes that regular consumption of probiotics has the potential to support immune system homeostasis, thereby reducing inflammation and enhancing overall health. However, further research is required to elucidate the specific mechanisms of action of individual strains and their effects on various disease states. (18)

**A discussion of probiotic strain selection and the variation in clinical effects**

Probiotics, defined as live micro-organisms that, when administered in adequate amounts, exert a beneficial effect on the health of the host, represent a significant component of therapeutic and preventative measures in numerous diseases. However, the judicious selection of probiotic strains is paramount, as different strains of the same species may demonstrate varying biological and clinical properties. Consequently, their utilization should be informed by scientific evidence that delineates the specific actions of individual strains in specific health conditions. (19)

For instance, the *Lactobacillus rhamnosus GG* strain is extensively employed in the management of infectious diarrhea in children and the mitigation of post-antibiotic diarrhea. The probiotic yeast *Saccharomyces boulardii* is notably efficacious in the treatment of diarrhea associated with *Clostridioides difficile* infection and in travelers’ diarrhea. Other probiotic strains, including *Bifidobacterium longum* and *Bifidobacterium breve*, have been employed in the treatment of irritable bowel syndrome (IBS) and to support intestinal barrier function. *Lactobacillus plantarum* has been shown to possess anti-inflammatory properties, making it a potential treatment for inflammatory bowel diseases such as ulcerative colitis. (20)

The differential impact of probiotic strains on the human gut is attributable to their distinct mechanisms of action, including their capacity to colonize the gastrointestinal tract, modulate the immune system, and produce antibacterial substances or metabolites with anti-inflammatory properties. Consequently, the selection of probiotics should be tailored to individual patients, considering their specific needs and therapeutic objectives. Advances in the field of microbiota and probiotic research are creating new opportunities for their use in clinical practice while emphasizing the necessity for further research to achieve a more comprehensive understanding of the diversity of their actions. (21)

Table.1 Selected probiotic strains, use, and effects on the gut microbiome

|  |  |  |
| --- | --- | --- |
| **Probiotic Strain** | **Application** | **Effect on Gut Microbiome** |
| **Lactobacillus rhamnosus GG** | Alleviating celiac disease symptoms, supporting the immune system | Increases beneficial bacteria count, reduces inflammation, improves gut barrier integrity |
| **Bifidobacterium longum** | Improving gut function, modulating immune response | Supports fiber metabolism, increases production of short-chain fatty acids (SCFA), decreases gut permeability |
| **Saccharomyces boulardii** | Treating diarrhea, supporting celiac therapy | Stabilizes gut microbiota, inhibits pathogen growth, supports intestinal epithelium regeneration |
| **Lactobacillus casei** | Supporting gastrointestinal health | Increases mucin and SCFA production, supports microbiota balance |
| **Bifidobacterium breve** | Alleviating dysbiosis symptoms | Reduces inflammation, improves nutrient absorption |
| **Lactobacillus plantarum** | Supporting treatment of irritable bowel syndrome (IBS) | Increases microbiota diversity, reduces dyspeptic symptoms |
| **Faecalibacterium prausnitzii** | Anti-inflammatory action | Supports intestinal epithelium integrity, reduces pro-inflammatory cytokine secretion |

(19)(20)(21)

**A review of studies on the impact of probiotic therapy in the support of celiac disease symptom control**

The extant research on probiotic therapy in the treatment of coeliac disease shows promising results, although the topic remains the focus of intensive investigation. Probiotics, defined as live micro-organisms that, when administered in adequate amounts, show beneficial effects on the health of the host, have the capacity to affect the gut microbiome, a condition which is disrupted in celiac disease patients. Changes in the composition of the gut microbiota, such as a reduction in probiotic bacteria and an increase in pro-inflammatory microorganisms, are commonly observed in people with this disease. (22) Studies suggest that probiotics may improve the balance of the gut microbiome, which may result in reduced inflammation and improved recovery of the intestinal mucosa. (23)

The paper *'Interaction between Gut Microbiota and Celiac Disease: From Pathogenesis to Treatment'* examines the complex relationship between gut microbiota and celiac disease, considering its role in the pathogenesis of the disease and potential therapeutic options. The authors highlight that intestinal dysbiosis plays a key role in enhancing the immune response to gluten in genetically predisposed individuals. The study further elucidates that a shift in the composition of beneficial bacteria, such as *Lactobacillus* and *Bifidobacterium*, and an elevated prevalence of potentially harmful microorganisms, including *Proteobacteria*, can potentially lead to an increase in intestinal permeability and heightened inflammatory responses. The paper also delves into the mechanisms by which the microbiota modulates the immune system, encompassing the production of cytokines and the impact on T lymphocytes. The authors emphasize the significance of microbial interventions, such as probiotics, prebiotics, and postbiotics, which have the capacity to restore equilibrium to the microbiota, to reduce inflammation, and to promote the regeneration of intestinal villi. The study suggests that modification of the gut microbiota may represent a promising approach for the adjunctive treatment of coeliac disease. (24)

A systematic review and meta-analysis of randomized controlled trials was conducted as a study entitled *Probiotics for Celiac Disease: A Systematic Review and Meta-Analysis of Randomized Controlled Trials*. This study included six randomized clinical trials involving 5,279 patients with celiac disease. The study aimed to determine whether probiotics could support the therapy of this disease, particularly in alleviating gastrointestinal symptoms and improving patients' quality of life. The results demonstrated that probiotics, particularly those derived from the genera *Lactobacillus* and *Bifidobacterium*, can modulate the composition of the gut microbiota, reduce inflammation, and alleviate symptoms such as abdominal pain, bloating, and diarrhea. However, the authors underscore that the current evidence is not yet sufficient to formulate clinical guidelines, as variations in probiotic strains employed, doses, and duration of therapy may influence outcomes. Further research is required to ascertain the most effective strategies for probiotic utilization in coeliac disease. (25)

A further analysis concentrated on studies evaluating the effect of probiotics on gastrointestinal symptoms and gut microbiota composition in people with coeliac disease, incorporating ten clinical trials with a total of 489 participants. The results suggest that probiotic supplementation may lead to a reduction in symptoms such as diarrhea, abdominal pain, and bloating, and in some studies, a reduction in inflammatory markers such as IL-6 and TNF-α was also observed. The beneficial effects on the intestinal microbiota consisted of an increase in beneficial bacteria, such as *Lactobacillus* and *Bifidobacterium*, and a reduction in pathogenic bacteria. Despite the positive results, the authors highlight the limitations associated with the heterogeneity of the methodology and the need for further, more homogeneous studies. (26)

A subsequent randomized controlled trial, the results of which were published in 2020, involved 45 patients with celiac disease. Patients received either VSL#3 or a placebo for 12 weeks. The study aimed to evaluate the effect of the probiotic on the composition of the gut microbiota and the safety and tolerability of its use. The results showed that VSL#3 supplementation was well tolerated and did not cause any adverse effects. However, no statistically significant changes in gut microbiota composition were observed between the probiotic and placebo groups. The authors suggest that probiotics may be more effective when used as part of a personalized therapy that takes into account individual differences in patients' microbiomes. This study highlights the need for further trials on a larger scale and with more precise selection criteria. (27)

The present study, entitled *'Effects of Lactiplantibacillus plantarum and Lacticaseibacillus paracasei supplementation on the single-cell fecal parasitome in children with celiac disease autoimmunity: a randomized, double-blind, placebo-controlled trial'*, analyses the effects of probiotic supplementation on the gut microbiota of children with coeliac disease autoimmunity. Controlled clinical trial' analyzed the effect of supplementation with selected probiotic strains (*Lactiplantibacillus plantarum* and *Lacticaseibacillus paracasei*) on the composition of the gut microbiota of children with celiac disease autoimmunity.

The study was conducted in a randomized, double-blind design with a placebo control group. A total of 60 children with antibodies specific to celiac disease autoimmunity participated in the study. Participants were randomly assigned to either a group receiving probiotics or a placebo for 12 weeks. Changes in the composition of the intestinal microbiota were analyzed, particularly for the presence and diversity of intestinal parasites in the stool sample, using advanced single-cell sequencing methods.

The results of the study demonstrated that probiotic supplementation resulted in a reduction in intestinal parasite burden and beneficial alterations in the composition of the microbiota, including an increase in the number of probiotic bacteria and a decrease in potentially harmful microorganisms. Improvements in biomarkers associated with intestinal inflammation were also observed in the probiotic group, suggesting a potential protective effect of probiotics in children with a genetic predisposition to coeliac disease.

The authors accentuate that these results suggest the possibility of using *Lactiplantibacillus plantarum* and *Lacticaseibacillus paracasei* as adjunctive therapy to prevent disease progression in children with autoimmune celiac disease risk. However, further studies are needed to confirm the long-term benefits and safety of probiotics in this population. (28)

In the research paper entitled *'Probiotics, prebiotics and other dietary supplements for gut microbiota modulation in celiac disease patients'*, the authors conducted a review of studies examining the effects of probiotics, prebiotics, and other dietary supplements on the gut microbiota of patients with celiac disease. The objective of the study was to ascertain the potential of dietary interventions, particularly those related to probiotics and prebiotics, to enhance celiac disease treatment and alleviate symptoms by modulating the gut microbiome. A growing body of research has demonstrated the pivotal function of probiotics in restoring the equilibrium of the gut microbiota, a disruption that is the hallmark of individuals afflicted with coeliac disease. The utilization of probiotics has been shown to enhance the diversity of the microbiome by fostering the proliferation of beneficial bacteria, such as *Lactobacillus* and *Bifidobacterium*, which possess the capacity to assist in the reconstruction of the compromised intestinal mucosa. Additionally, probiotics have been shown to possess anti-inflammatory properties, which may contribute to a reduction in inflammatory markers such as C-reactive protein and pro-inflammatory cytokine levels, which are frequently elevated in individuals with coeliac disease.

The authors of the study also highlighted the role of prebiotics, which act by stimulating the growth and activity of beneficial gut bacteria. Prebiotics may support probiotic activities, improving the effectiveness of dietary interventions, especially in the context of restoring the gut microbiota and improving its function. Prebiotics may also contribute to the alleviation of symptoms associated with coeliac disease, such as bloating, abdominal pain, or diarrhea. Furthermore, research suggests that adequate prebiotic supplementation can support intestinal regeneration processes and reduce chronic inflammation, which is crucial for the long-term management of coeliac disease.

The study also examined the potential of other dietary supplements in the management of coeliac disease, noting that certain ingredients, including omega-3 fatty acids, vitamins D and A, and minerals, may influence the gut microbiota and, by extension, alleviate celiac disease symptoms. However, the authors emphasized that the evidence supporting the effectiveness of these supplements remains inconclusive and necessitates further clinical trials to substantiate their claims.

A primary conclusion of the study is that probiotic interventions and the use of prebiotics may be a valuable addition to the treatment of coeliac disease, particularly in terms of modifying the gut microbiota and reducing inflammation. However, despite the encouraging results, the authors highlight the necessity for further, more advanced studies with a larger sample of patients to determine more precisely which probiotic strains, doses, and duration of therapy are most effective. Furthermore, it is imperative to conduct studies that consider the genetic and environmental diversity of patients to personalize interventions and optimize treatment efficacy. The findings of the study suggest that probiotics and prebiotics may be promising adjunctive therapies; however, further exploration and confirmation of their role in the treatment of coeliac disease is required. (29)

The study *'Probiotic Use in Celiac Disease: Results from a National Survey'*, conducted by Andrew Joelson and colleagues, aims to investigate the use of probiotics among patients with coeliac disease, using data collected from the iCureCeliac® registry. Coeliac disease is a chronic autoimmune disorder that occurs in genetically predisposed individuals and leads to damage to the small intestinal mucosa as a result of gluten ingestion. While a strict gluten-free diet is the only proven treatment for the disease, many patients are seeking additional methods of symptom relief, which has led to an increased interest in probiotics. The study involved 1,160 patients with coeliac disease, of whom approximately one-third reported using probiotics as a form of health support. It is important to note that despite the growing popularity of probiotics and their potential benefits in the context of gut health, there is a limited number of clinical trials that support their efficacy in the management of celiac disease symptoms. The results of the study reveal an interesting relationship: Patients who were diagnosed at a later age and those who experienced persistent symptoms despite following a gluten-free diet were twice as likely to use probiotics. The authors of the study emphasize the importance of further research to better understand the role of probiotics in the management of coeliac disease and their impact on patients' quality of life. The authors also underscore the necessity for education, both for patients and healthcare professionals, regarding the potential benefits and limitations of probiotic use. This study offers valuable insights into celiac disease management practices and may serve as a foundation for future research on the efficacy of probiotics in this patient population. (30)

**Conclusions**

As a chronic autoimmune disease, coeliac disease necessitates the implementation of effective therapeutic strategies that can assist patients in managing their symptoms. A review of studies on the use of probiotics in the treatment of coeliac disease demonstrates their promising potential in alleviating symptoms and enhancing patients' quality of life. Studies conducted between 2013 and 2024 have demonstrated that probiotics, such as *Lactobacillus* and *Bifidobacterium strains*, can influence the composition of the gut microbiota, which is pivotal in modulating the immune response and reducing inflammation. Probiotics have been shown to enhance the integrity of the intestinal barrier, which may result in a reduction in intestinal permeability and the prevention of further mucosal damage. (31)

The findings of the studies conducted indicate that the utilization of probiotics has the potential to result in a substantial decrease in gastroenterological symptoms, including abdominal discomfort, flatulence, and diarrhea. Moreover, probiotic interventions have been observed to stimulate the regeneration of intestinal villi and enhance inflammatory parameters, a development of particular relevance to patients with coeliac disease who fail to attain complete remission despite adhering to a gluten-free diet. The effectiveness of probiotic therapy is contingent on the type of strains utilized and their dosage, underscoring the necessity for further research in this domain. (32)

The analysis of existing data underscores the necessity for the establishment of standard guidelines for the implementation of probiotics in the management of coeliac disease. The integration of probiotic therapy with conventional dietary interventions has the potential to unveil novel therapeutic avenues and substantially enhance the quality of life for individuals afflicted with coeliac disease. (33) As the corpus of studies substantiating the benefits of probiotic therapy expands, it becomes evident that their function within a holistic approach to celiac disease treatment merits further investigation and development.

**Disclosure:**

**Authors’ contribution:**Conceptualization: Aleksandra Cieplak  
Methodology: Aleksandra Kołodziej, Zuzanna Czyżewicz  
Software: Nadia Hornig  
Check: Aleksandra Cieplak, Zuzanna Czyżewicz  
Formal analysis: Wiktoria Zamirska, Nadia Hornig

Investigation: Nadia Hornig  
Resources: Aleksandra Kołodziej, Wiktoria Zamirska  
Data curation: Zuzanna Czyżewicz  
Writing -rough preparation: Aleksandra Cieplak  
Writing -review and editing: Aleksandra Kołodziej, Nadia Hornig  
Supervision: Wiktoria Zamirska  
Project administration: Aleksandra Cieplak

All authors have read and agreed with the published version of the manuscript

**Funding Statement:**  
The study did not receive special funding.

**Institutional Review Board Statement:**  
Not applicable.   
  
**Informed Consent Statement:**  
Not applicable.  
  
**Data Availability Statement:**  
Not applicable.  
  
**Acknowledgments:**  
Not applicable.  
  
**Conflict of Interest Statement:**   
The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article

**References**

1. Butterworth J, Los L. Coeliac disease. Vol. 52, Medicine (United Kingdom). 2024.

2. Sahin Y. Celiac disease in children: A review of the literature. Vol. 10, World Journal of Clinical Pediatrics. 2021.

3. Aljada B, Zohni A, El-Matary W. The gluten-free diet for celiac disease and beyond. Vol. 13, Nutrients. 2021.

4. Rueda GH, Pinto-Sánchez MI. Probiotics in celiac disease: Are we ready for their use in clinical practice? Vol. 51, Acta Gastroenterologica Latinoamericana. 2021.

5. Pecora F, Persico F, Gismondi P, Fornaroli F, Iuliano S, de’Angelis GL, et al. Gut Microbiota in Celiac Disease: Is There Any Role for Probiotics? Vol. 11, Frontiers in Immunology. 2020.

6. Cristofori F, Indrio F, Miniello VL, De Angelis M, Francavilla R. Probiotics in celiac disease. Vol. 10, Nutrients. 2018.

7. Ali B, Khan AR. Efficacy of Probiotics in Management of Celiac Disease. Cureus. 2022;

8. Wieërs G, Belkhir L, Enaud R, Leclercq S, Philippart de Foy JM, Dequenne I, et al. How Probiotics Affect the Microbiota. Vol. 9, Frontiers in Cellular and Infection Microbiology. 2020.

9. Wacklin P, Kaukinen K, Tuovinen E, Collin P, Lindfors K, Partanen J, et al. The duodenal microbiota composition of adult celiac disease patients is associated with the clinical manifestation of the disease. Inflamm Bowel Dis. 2013;19(5).

10. Jedwab CF, de Mattos Boccalini Roston BC, de Souza Toge ABF, Echeverria IF, Tavares GOG, Alvares MA, et al. The role of probiotics in the immune response and intestinal microbiota of children with celiac disease: A systematic review. Vol. 40, Revista Paulista de Pediatria. 2022.

11. Constante M, Libertucci J, Galipeau HJ, Szamosi JC, Rueda G, Miranda PM, et al. Biogeographic Variation and Functional Pathways of the Gut Microbiota in Celiac Disease. Gastroenterology. 2022;163(5).

12. Iversen R, Sollid LM. The Immunobiology and Pathogenesis of Celiac Disease. Vol. 18, Annual Review of Pathology: Mechanisms of Disease. 2023.

13. Belkaid Y, Hand TW. Role of the microbiota in immunity and inflammation. Vol. 157, Cell. 2014.

14. Afzaal M, Saeed F, Shah YA, Hussain M, Rabail R, Socol CT, et al. Human gut microbiota in health and disease: Unveiling the relationship. Vol. 13, Frontiers in Microbiology. 2022.

15. Barone MV, Auricchio R, Nanayakkara M, Greco L, Troncone R, Auricchio S. Pivotal Role of Inflammation in Celiac Disease. Vol. 23, International Journal of Molecular Sciences. 2022.

16. Wang X, Zhang P, Zhang X. Probiotics regulate gut microbiota: An effective method to improve immunity. Vol. 26, Molecules. 2021.

17. Dempsey E, Corr SC. Lactobacillus spp. for Gastrointestinal Health: Current and Future Perspectives. Vol. 13, Frontiers in Immunology. 2022.

18. Maldonado Galdeano C, Cazorla SI, Lemme Dumit JM, Vélez E, Perdigón G. Beneficial effects of probiotic consumption on the immune system. Ann Nutr Metab. 2019;74(2).

19. McFarland L V., Evans CT, Goldstein EJC. Strain-specificity and disease-specificity of probiotic efficacy: A systematic review and meta-analysis. Vol. 5, Frontiers in Medicine. 2018.

20. Sniffen JC, McFarland L V., Evans CT, Goldstein EJC. Choosing an appropriate probiotic product for your patient: An evidence-based practical guide. PLoS One. 2018;13(12).

21. Draper K, Ley C, Parsonnet J. A survey of probiotic use practices among patients at a tertiary medical centre. Benef Microbes. 2017;8(3).

22. Chibbar R, Dieleman LA. The gut microbiota in celiac disease and probiotics. Vol. 11, Nutrients. 2019.

23. Nylund L, Kaukinen K, Lindfors K. The microbiota as a component of the celiac disease and non-celiac gluten sensitivity. Clin Nutr Exp. 2016;6.

24. Rossi RE, Dispinzieri G, Elvevi A, Massironi S. Interaction between Gut Microbiota and Celiac Disease: From Pathogenesis to Treatment. Cells. 2023;12(6).

25. Seiler CL, Kiflen M, Stefanolo JP, Bai JC, Bercik P, Kelly CP, et al. Probiotics for Celiac Disease: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Vol. 115, American Journal of Gastroenterology. 2020.

26. Mozafarybazargany M, Khonsari M, Sokoty L, Ejtahed HS, Qorbani M. The effects of probiotics on gastrointestinal symptoms and microbiota in patients with celiac disease: a systematic review and meta-analysis on clinical trials. Clin Exp Med. 2023;23(6).

27. Harnett J, Myers SP, Rolfe M. Probiotics and the Microbiome in Celiac Disease: A Randomised Controlled Trial. Evidence-based Complementary and Alternative Medicine. 2016;2016.

28. Hurych J, Oscarsson E, Håkanson Å, Jirků-Pomajbíková K, Jirků M, Aronson CA, et al. Effects of Lactiplantibacillus plantarum and Lacticaseibacillus paracasei supplementation on the single-cell fecal parasitome in children with celiac disease autoimmunity: a randomized, double-blind placebo-controlled clinical trial. Parasit Vectors. 2023;16(1).

29. Marasco G, Cirota GG, Rossini B, Lungaro L, Di Biase AR, Colecchia A, et al. Probiotics, prebiotics and other dietary supplements for gut microbiota modulation in celiac disease patients. Vol. 12, Nutrients. 2020.

30. Joelson AM, Choy AM, Blackett JW, Molinsky RL, Geller MG, Green PH, et al. Probiotic Use in Celiac Disease: Results from a National Survey. Journal of Gastrointestinal and Liver Diseases. 2021;30(4).

31. Khavkin AI, Yablokova EA, Shapovalova NS, Erokhina MI. Gut microbiota and prospects for probiotics in paediatric celiac disease. Archives of Pediatrics and Pediatric Surgery. 2024;1(2).

32. Saviano A, Petruzziello C, Brigida M, Morabito Loprete MR, Savioli G, Migneco A, et al. Gut Microbiota Alteration and Its Modulation with Probiotics in Celiac Disease. Vol. 11, Biomedicines. 2023.

33. Soheilian Khorzoghi M, Rostami-Nejad M, Yadegar A, Dabiri H, Hadadi A, Rodrigo L. Impact of probiotics on gut microbiota composition and clinical symptoms of coeliac disease patients following gluten-free diet. Contemp Clin Trials Commun. 2023;35.