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The Use of Probiotics in Mental Health

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ABSTRACT

This review focuses on the potential health benefits of probiotics and live microorganisms as therapeutic agents for mental and emotional disorders. Through mechanisms, including modulation of immune responses, control of the hypothalamic-pituitary-adrenal (HPA) axis, maintenance of the gut barrier, and synthesis of important neurotransmitters, we examined their effects on anxiety, depression, stress-related disorders, cognitive function, and emotional well-being. Some clinical trials have shown positive results, and the generalizability of these findings is limited due to inconsistencies in probiotic strains, dosages, and research methods, although several studies have reported beneficial results. Ultimately, this study highlights the potential of tailored probiotics to fill these gaps in our understanding of the relationship between humans and probiotics.

1. INTRODUCTION

In recent years, there has been a growing association between gut bacteria, emotions, and cognition, and The World Health Organization reported that rates of depression and anxiety around the world increased by approximately 25% during the COVID-19 pandemic. This indicates that there is a pressing need for helpful and easy-to-reach solutions. [1]. Probiotics in the field of mental health have gained great interest because of scientific advances that have contributed to the discovery of probiotics; thus, it has become very important to study probiotics from the perspective of immunity and digestion, as well as from the perspective of improving the quality of life and preventing chronic diseases [2]. An increasing number of studies have examined the role of probiotics in reducing symptoms of depression, anxiety, and stress-related illnesses. It appears that all probiotic strains, dosages, and study designs influenced the outcomes. Numerous studies and clinical trials have shown significant benefits in controlling emotions and cognition following probiotic administration. Several strains, such as *Lactobacillus* and *Bifidobacterium*, have demonstrated excellent benefits, and other studies have found little or no significant effects, which warrant further research and comprehensive investigation. According to the World Health Organization, probiotics are tiny living organisms that can make you healthier when you take enough of them. This review will mainly discuss live

probiotics from the *Lactobacillus* and *Bifidobacterium* groups. Other similar things, such as postbiotics and synbiotics, are also being researched, but this paper will mainly focus on live probiotics. [3]. Scientific research has shown a strong link between gut health and mental wellbeing. Therefore, probiotics have been found to have potential therapeutic effects on cognitive and mood disorders. The gut-brain axis consists of endocrine and neurotransmitter circuits that shape mental states, and this review examines how probiotics could be used together with other treatments, such as medicine or therapy, to help with mental health. [4]. Researchers have suggested that probiotic strains, such as *Lactobacillus* and *Bifidobacterium*, can alter bacteria in the gut and interact with emotion-associated neurochemical pathways [5]. Analyzing working methods, evaluating the effectiveness of treatment for some mental illnesses, and understanding the limitations of current research helps us understand the impact of probiotics on mental health [2]. In this review, we discuss mental health issues such as feeling sad, worried, stressed, and having trouble thinking clearly. Serious mental illnesses such as schizophrenia or bipolar disorder are not included in this review, but we might study how they are related to bacteria in the gut in the future.

2. LITERATURE REVIEW

2.1. Mechanisms of Action

This literature review evaluates current data on the role of probiotics in mental health treatment and offers evidence-based solutions that complement traditional psychotherapy [6].

The positive effects of probiotics on mental health are mostly ascribed to their ability to alter the gut-brain axis, a bidirectional communication pathway that connects the gut microbiota to the central nervous system (CNS). Multiple routes underlie this interaction, including changes in intestinal permeability, immune system control, synthesis of neurotransmitters, and modulation of the hypothalamic-pituitary-adrenal (HPA) axis [4]. Determining how probiotics can help prevent and cure mental health problems, such as anxiety, depression, and stress-related illnesses, depends on the awareness of these systems.

Probiotics mostly affect mental health through the production of neurotransmitters. In particular, some probiotic bacteria of the *Lactobacillus* and *Bifidobacterium* genera have been shown to generate neurotransmitters such as gamma-aminobutyric acid (GABA), serotonin, and dopamine [5]. Promoting relaxation and lowering neural excitability critically depend on GABA, the primary inhibitory neurotransmitter in the brain. Anxiety disorders and depression have been related to dysregulation of GABAergic signaling; hence, probiotics that boost GABA synthesis may have anxiolytic and antidepressant effects [6]. Likewise, serotonin, a fundamental neurotransmitter linked to mood control, is mostly produced in the gut; enterochromaffin cells in the intestinal lining account for approximately 90% of the total synthesis of serotonin in the body [7]. *Lactobacillus reuteri* and *Bifidobacterium infantis* are probiotic strains that have been shown to boost serotonin availability, which may reduce symptoms of depression and improve emotional resilience [8].

The ability of probiotics to control the immune system function is another important way to influence mental health. With increased levels of pro-inflammatory cytokines, including interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and C-reactive protein (CRP), observed in people with mood disorders, chronic low-grade inflammation has been linked to the pathophysiology of depression and anxiety [9]. By lowering systemic inflammation, boosting the production of anti-inflammatory cytokines, including interleukin-10 (IL-10), and strengthening the intestinal barrier to stop the translocation of bacterial endotoxins into the bloodstream, probiotics help maintain immune homeostasis [10]. For instance, *Lactobacillus rhamnosus* and *Bifidobacterium breve* have been shown to lower pro-inflammatory cytokine levels and thus reduce neuroinflammation, possibly lowering depressive symptoms [11].

Probiotics also affect the hypothalamic pituitary (HPA) axis, which fundamentally controls the body's stress response. The main stress hormone, cortisol, is released under regulation by the HPA axis; when it is continuously high, it causes anxiety, depression, and cognitive impairment [6]. Probiotic supplements have been shown to help control the HPA axis activity and reduce cortisol levels, thereby minimizing physiological and psychological stress reactions. A randomized controlled study found that subjects who ate a mix of *Lactobacillus helveticus* and *Bifidobacterium longum* for four weeks showed lower cortisol levels and

experienced less psychological anxiety [12]. These results suggest that by adjusting HPA axis activity and improving resistance to environmental stress, probiotics have stress-protective benefits.

Moreover, probiotics are important in preserving the integrity of the gut barrier, which greatly affects mental health. Often referred to as a "leaky gut," increased intestinal permeability allows microbial metabolites such as lipopolysaccharides (LPS) to enter circulation and set off systemic inflammation and neuroinflammation [7]. Depression and cognitive impairment are associated with higher levels of LPS. Tight junction proteins in the intestinal epithelium have been shown to be reinforced by probiotic strains, such as *Lactobacillus plantarum* and *Bifidobacterium bifidum*, thereby lowering permeability and stopping the leakage of inflammatory bacterial components into the circulation [13]. Probiotics enhance general brain health by restoring the gut barrier function and reducing neuroinflammation.

Another crucial relationship between the gut flora and mental health is the synthesis of short-chain fatty acids (SCFAs) by probiotic bacteria. Key regulators of brain activity, SCFAs, include acetate, propionate, and butyrate, which are fermentation byproducts of dietary fiber breakdown by the gut bacteria. These metabolites control neurotransmitter production, affect neuroinflammation, and provide energy to intestinal epithelial cells [14]. Butyrate improves brain function, particularly in relation to brain-derived neurotrophic factor (BDNF), a protein vital for neuroplasticity, learning, and memory. Depression and neurological diseases have been linked to low BDNF levels; hence, probiotics that increase SCFA synthesis may have neuroprotective properties [15]. Butyrate helps control the expression of genes by inhibiting histone deacetylases (HDACs), which can change how genes related to inflammation, brain function, and coping with stress are turned on or off. This shows that butyrate may be helpful in treating mood and brain disorders.

Taken together, these studies demonstrate that probiotics can affect mental health. Probiotics provide a potential path for promoting mental health through neurotransmitter synthesis, immunological modulation, hypothalamic pituitary-adrenal (HPA) axis control, gut barrier maintenance, and SCFA synthesis. However, the major determinants of treatment results include differences in the composition of individual gut microbiota, probiotic strain specificity, and dose. Further studies are required to maximize probiotic treatments and provide uniform procedures for their application in mental healthcare.

2.2. Probiotics and Mental Health Disorders

The ability of probiotics to control mental health problems has recently attracted considerable interest. Research indicates that gut microbiota dysbiosis, that is, an imbalance in gut microbial composition, may be responsible for the pathogenesis of several mental diseases, including depression, anxiety, and stress-related illnesses [6]. As a new therapeutic approach to change the gut-brain axis, probiotic supplements influence neurochemical pathways, immunological responses, and stress management systems [5]. Evidence in favor of the use of probiotics in common mental health disorders is reviewed in this section, stressing both the encouraging results and the current constraints.

2.3. Depression and Probiotics

One of the most common mental health illnesses worldwide is depression, which involves biological, psychological, and environmental factors that help to start and worsen. With some bacterial species linked to either protective or negative effects on mood control, increasing evidence points to changes in gut flora that cause depressive symptoms [10]. Many studies have investigated the use of probiotics as complementary treatments for depression, yielding encouraging but conflicting results.

Particularly, in individuals with mild to moderate depression, a meta-analysis examined randomized controlled trials (RCTs) evaluating the effects of probiotics on depressive symptoms and found that probiotic supplementation was linked to a notable decline in depression intensity [11]. These processes include enhanced intestinal barrier integrity, reduced inflammation and increased serotonin availability. In patients with irritable bowel syndrome (IBS), another study observed that *Bifidobacterium longum* NCC3001 treatment changed brain activity and reduced depressive symptoms, thereby implying a possible gut-brain link

in mood control [16].

However, other studies have reported conflicting results. For example, a large-scale experiment revealed that although probiotics changed the makeup of gut flora, they did not significantly lower depressive symptoms compared with placebo [17]. Variations in research design, probiotic strains, doses, and participant traits accounted for these differences. Furthermore, although probiotics show promise, they could be more useful in the entire therapeutic plan than as a standalone intervention for depression [18].

2.4. Probiotics and Anxiety Disorders

Anxiety disorders, including social anxiety, panic, and generalized anxiety disorder (GAD), are among the most common mental disorders worldwide. Through interactions with the hypothalamic-pituitary-adrenal (HPA) axis, neurotransmitter generation, and immunological signaling [6], the gut microbiota has been linked to anxiety control, and the vagus nerve is a key pathway for communication between the gut and brain. Probiotics can help regulate the activity of the vagus nerve, which can affect emotions and thinking by using substances such as GABA and inflammatory molecules. Studies on animals have revealed that cutting the vagus nerve can prevent the positive effects of specific probiotics on behavior. Probiotics have been investigated for their ability to alter these pathways and reduce anxiety symptoms.

Several clinical studies have shown the beneficial effects of probiotics. Combining *Lactobacillus helveticus* R0052 with *Bifidobacterium longum* R0175 greatly lowered psychological stress and cortisol levels in healthy people, according to a study [12]. Likewise, individuals with GAD who underwent eight weeks of probiotic treatment exhibited notably lower anxiety levels than those who received placebo [7].

Despite these encouraging results, some contradictions remained. Although probiotics enhance gut microbiome diversity, certain studies have shown that they do not regularly translate into clinically significant decreases in anxiety symptoms [19]. Furthermore, the degree of anxiety, co-occurring diseases, and personal variations in gut microbiota makeup may influence the effectiveness of probiotics. Standardized treatment strategies and the most successful probiotic strains for anxiety control require further investigation.

2.5. Probiotics and Stress-Related Disorders

Among several mental disorders, including depression, anxiety, and post-traumatic stress disorder (PTSD), chronic stress is the main risk factor. With probiotics showing promise in altering the HPA axis and lowering physiological signs of stress [5], the gut microbiota is clearly important in controlling the body's stress response.

Studies have shown that probiotics can affect the resilience to stress. *Lactobacillus casei* Shirota strain supplementation lowers subjective stress levels and enhances cognitive function in individuals under acute stress, according to a double-blind placebo-controlled experiment [13]. Similarly, another study found that probiotic supplements enhance emotional resilience in individuals under demanding circumstances and reduce stress-induced cortisol output [2].

Animal studies offer further understanding of the processes underlying these effects. For instance, mice treated with *Lactobacillus rhamnosus* showed lower anxiety-like behavior and altered GABA receptor expression in brain areas linked to stress control [3]. These results imply that, although human studies are required to validate these effects, probiotics may affect the brain circuits involved in stress adaptation.

Despite these encouraging results, it is difficult to conduct preclinical research for clinical use. The effects of probiotics on stress-related diseases might be strain-specific, dose-dependent, or affected by personal variations in microbiota makeup [19]. Personalized methods for probiotic supplementation should be investigated in future studies considering diet, lifestyle, and baseline microbiome diversity.

2.6. Probiotics and Cognitive Function

Beyond mood and stress control, new studies have indicated that probiotics have neuroprotective properties and improve cognitive performance. Gut microbiome changes, neuroinflammation, and oxidative

stress, all of which can be affected by probiotic supplementation, contribute to cognitive decline [15].

Probiotic treatment notably increases Mini-Mental State Examination (MMSE) scores compared to placebo, according to a study on the impact of probiotics on cognitive function in patients with Alzheimer's disease [1]. The suggested mechanisms include reduced systemic inflammation, improved glucose metabolism, and increased expression of neurotrophic factors. Likewise, another study discovered that over time, older people who ate fermented dairy products high in probiotics showed improved cognitive ability and memory recall [20].

However, determining the long-term effects of probiotics on cognitive health remains a challenge. While some studies show favorable results, others reveal either very little or no change in cognitive ability [13]. Further studies are required to identify individual probiotic strains and intervention techniques that maximize cognitive ability in various groups, especially in aging and neurodegenerative diseases.

3. DISCUSSION OF PREVIOUS STUDIES

Analysis and Critique of Previous Research

Current studies on probiotics and mental health have provided valuable insights into the potential role of gut microbiota in mental disorders. Several randomized controlled trials (RCTs), meta-analyses, and experimental studies have suggested that probiotics may influence cognitive function, emotional regulation, and stress resilience [11]. However, many of these studies have methodological limitations, such as small sample sizes, inconsistent formulations, and varying study designs. These factors reduce the generalizability and clinical relevance of the findings.

A notable strength of recent research is the growing reliance on human RCTs, which produce more reliable data than preclinical animal models do. Studies such as [12] have reported reductions in anxiety and stress biomarkers following probiotic supplementation, supporting the hypothesis that modulation of the gut microbiome can positively affect mental health. Moreover, meta-analyses, such as those in [11], have aggregated data from multiple trials, thereby increasing the statistical power and reinforcing the potential benefits of probiotics for anxiety and depression.

However, despite these promising findings, several significant challenges remain. A major issue is the lack of standardization across studies in terms of the probiotic strains and dosages. While some trials reported improvements using combinations, such as *Lactobacillus helveticus* and *Bifidobacterium longum* [10], others utilized different strains with inconsistent results. This heterogeneity complicates the formulation of consistent, evidence-based treatment protocols. Additionally, many studies have used multi-strain supplements without isolating the specific effects of each strain, further obscuring conclusions regarding strain-specific efficacy. When studying probiotics for mental health, we need to consider the placebo effect. In research, about 30% of people might feel better simply because they believe they are taking helpful treatment, even if it is just a sugar pill. This can make it difficult to understand whether probiotics really make a difference. In the future, scientists should plan studies to distinguish the real effects of probiotics from the placebo effect. [16]. Reference 17 points out a key problem: even though probiotic treatment changed the gut bacteria, it did not really help with feeling less depressed. This shows how important it is to select the right probiotic and the right person to obtain the best results.

Another key limitation is the widespread use of subjective psychological assessment. Most studies rely on self-reported questionnaires to evaluate mood, stress, and anxiety, which introduces potential bias and reduces the objectivity of the results [18]. While some researchers have incorporated biological measures, such as cortisol levels or neuroimaging data, these are still relatively rare. Incorporating more physiological and neurological markers in future studies could strengthen the evidence for probiotic effects on mental health [9].

Furthermore, the duration of probiotic interventions is often short, typically ranging from a few weeks to three months. As a result, the long-term effects of probiotic use on mental well-being remain largely unknown [13]. Without extended follow-up periods, it is difficult to determine whether the benefits of probiotics are sustained or diminished after discontinuation. Understanding the longevity of their impact on

gut microbiota and mental health is essential for developing therapeutic strategies. For probiotics to work well, they need to have strong strains, remain stable in the right amount, and be able to live in the gut. Some probiotics cannot survive stomach acid or become part of the gut bacteria, which might explain why they do not always help people in the same way.

4. GAPS IN THE LITERATURE AND FUTURE RESEARCH DIRECTIONS

Several gaps in the literature call for more research considering the strengths and shortcomings of earlier studies. One important shortcoming of this study was the absence of individualized probiotic treatments. Although individual gut microbiota composition varies greatly depending on genetic, nutritional, and environmental variables, current research usually uses a one-size-fits-all strategy [19]. Personalized microbiome profiling should be the focus of future research to identify which probiotic strains are more beneficial for certain people and mental health issues. A crucial study published in 2019 in Nature Microbiology showed that providing healthy gut bacteria from donors to people with depression can help improve mood and change the manner in which the gut communicates with the brain. This means that using different types of bacteria could be helpful in treating mental health issues. Precision probiotics designed to fit a person's gut flora greatly improve the effectiveness of therapy.

Furthermore, there is a lack of knowledge regarding probiotic interactions in the current psychiatric therapies. Most studies have examined probiotics alone, without examining their benefits when paired with antidepressants, anxiolytics, or cognitive-behavioral therapy [6]. Many people with depression and anxiety are currently undergoing pharmaceutical or psychological therapies. Hence, it is important to determine whether probiotics improve, complement, or conflict with the existing treatments. Probiotic supplements used alongside conventional psychiatric therapies in clinical studies may offer insight into their overall effectiveness.

However, the effects of food on probiotics remain largely unknown. Highly sensitive to dietary patterns, the gut flora may be enhanced or hampered by some foods in terms of probiotic colonization and activity [20]. Future studies should examine how diet affects probiotic efficacy and whether combining probiotics with prebiotic-rich foods such as fiber could maximize mental health outcomes. Although probiotics have shown promise in mood and anxiety disorders, their potential in other mental health conditions, such as schizophrenia, bipolar disorder, and neurodegenerative diseases remains under-investigated. Emerging studies have pointed to changes in the gut flora linked to disorders such as Parkinson's disease and Alzheimer's disease [15], thereby raising the issue of whether probiotics might help prevent or control cognitive decline. Expanding probiotic research in this field may open new therapeutic avenues for the treatment of difficult neurological and psychological conditions.

5. CONCLUSIONS

The study of probiotics in mental health provides convincing evidence of a significant relationship between mental health and gut bacteria. The gut-brain axis has become increasingly important in controlling mood, emotions, cognition, and reactions. Probiotics show positive results in reducing symptoms of depression, stress-related disorders, and anxiety, and recent studies indicate that the role of probiotics in cognitive improvement and neuroprotection makes this area a major focus for future neuropsychiatric treatments [5, 6, 12].

Despite the encouraging and impressive results, this study revealed significant gaps and difficulties in integrating probiotics into general mental health care [16]. This variation in probiotic strains and dosages has led to inconsistent results, limiting the ability to formulate conventional treatment recommendations [19]. Future studies should focus on bridging these gaps by developing probiotic solutions tailored to the specific microbiota patterns. Although probiotics offer promising and advanced prospects in mental health research, their therapeutic use is still in its infancy. Although current research indicates potential benefits in improving mental health, more comprehensive, long-term, and large-scale research is needed [20].

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

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