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Review Article

Probiotics and mental health: Exploring the gut-brain connection

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Abstract

Probiotics are termed as the living microbes that are beneficial to health if consumed in proper quantity. These are known as "friendly" or "good" bacteria, these microbes are essential to maintaining a balanced and healthy gut microbiota. Gut microbiota is closely linked to mental state as many mental illnesses are linked with disturbances in the gut microbiome. Probiotics that are beneficial in maintaining the mental health as well are termed as Psychobiotics. Probiotics appear to be an ideal therapeutic for gut health and have been explored to enhance mental health in past recent research studies. Disruptions in the delicate balance of the gut microbiota not only affect gut health but are also associated with various mental health disorders. This article represents a review study of the benefits of probiotics on mental health, where the potential of probiotics is used as adjunctive or preventive measures for mental health challenges.

Keywords: Gut-brain mechanism, Probiotics, Psychobiotics, Gut brain axis, Mental health

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Introduction

Probiotics and Gut Health

A positive health impact has been observed after consumption of probiotics in sufficient amount (Hill et al., 2014)[1]. These microorganisms are beneficial to our health, particularly our digestive system. They can be found in a range of foods, such as yogurt, kefir, and sauerkraut, or taken as supplements. Probiotics have been associated with improvement in the balance of the microbiome and reducing inflammation in the gut.

The gut microbiome holds the commands for many roles that include:

- Protection against infections
- Digestion of nutrients that is otherwise indigestible
- Regulation of new blood vessels formation too

Probiotics are known to improve or restore the gut flora (Jain et al., 2014) [2]. According to the concepts of Metchnikoff [3], probiotics play a very important function in the scientific community. The research documented an increased longevity of Bulgarians species after consumption of viable Lactobacilli containing milk. It concludes that microbes do communicate and play their part well. The beneficial aspects of probiotics have led to use as a dietary supplements or functional foods. In a study, role of probiotics was documented on mental status and in regulation of gut-brain axis (Thomas et al., 2010)[4]. Probiotics has also been introduced as beneficial in improving health of gastrointestinal tract and in quality and quantity improvement of pre-existing microbiota in human body. Intestinal immunity is seen enhanced as probiotics compete with gut microflora for nutrients (Toole and Cooney, 2008) [5].

Mechanism in the Brain

The HPA (Hypothalamic-Pituitary-Adrenal) axis is the first level communication between gastro intestinal tract and the brain. The axis helps in regulation of stress hormones such as cortisol and thus in turn affects the mental health. HPA axis is regulated by vagal nerve. By this means only, stress circuit of the body is activated. The HPA axis is

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also responsive to the other mental health status such as depression (Foster & Neufeld, 2013) [6].

Programming of the HPA axis in infancy and regulation of stress throughout life depends on gut microbiome. Gut microbiome is known to affect many important neurotransmitters like norepinephrine, serotonin etc. Gama amino butanoic acid (GABA) that is linked to emotions of mood and memory also gets affected through gut microflora. Incidences of anxiety and depression have been seen when GABA signals are deranged. The strains of Lactobacilli and Bifidobacteria and antidepressants acted in similar manner on the functioning of GABA. Both were uniformly effective in reducing anxiety. Thus emotions and sensory reactions are directly linked to gastrointestinal tract microbiota (Kane, L., & Kinzel, J., 2018) [7].

There are numerous probiotics supplements available in the market which not only used as gut health simplifier but also have potential to reduce activity of stress hormones released in the HPA axis.

The Gut-brain connection

There is a communication between the brain and microbiome and gut and the vice versa. **Gut impacts the brain**. According to a study published in Harvard Health [8], the enteric nervous system and central nervous system are connected together with biochemical signaling. Vagus nerve is the first level and longest connection between the gut and the brain. The gut is also known as the **"second brain"** as various neurotransmitters are produced by this, having direct role in regulation of mood.

A division of autonomic nervous system, which operates the automatic functions of internal organs, is called as **enteric nervous system.** The main link between both the systems is vagus nerve pathway. It is one of the twelve cranial nerves, which start in the skull and branch out as they move through the body. It transmits sensory data from the enteric nervous system to your brain on the conditions in your gut. It responds by sending motor impulses to your gut from your brain and thus helps in bidirectional

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communication. Many reflexes that function in your stomach in reaction to shifting circumstances, such as chemical shifts or the presence of food, are mediated by the vagus nerve, called as vagal reflexes. Reflexes are product of communication between the central nervous system and enteric nervous system (Fig. 1).

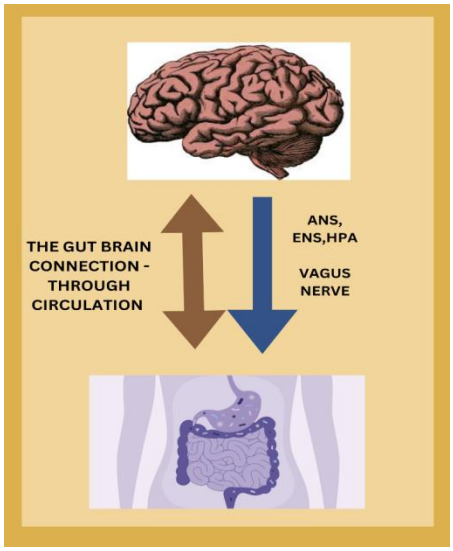

Figure1: The gut and the brain axis

A range of chemical and biological processes occur under complex gut brain system. This gut brain communication is triggered by trillions of microbiome. The microbiome produces a range of neurotransmitters and hormones that can influence our mood, behavior, and cognitive function. For example, the neurotransmitter serotonin, which is often referred to as the "feel-good" hormone, is produced in the gut and has been linked to depression and anxiety. Similarly, the hormone cortisol, which is released in response to stress, can also affect our mental health. Both brain and microbiome influence each other. Stress and anxiety, for example, can disrupt the balance of the microbiome, leading to gastrointestinal problems.

Main functions performed from Gut microbiota to Brain are:

- Secretion of essential neurotransmitters such as serotonin, GABA and neurotrophic factor such as (BDNF)
- Regulation of the mucosal immune response
- Protecting the intestinal barrier and maintaining the integrity of the tight junctions

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Main functions performed from Brain to Gut microbiota

- Changes in the mucous and biofilm production
- Changes in the motility and intestinal permeability
- Alterations in the immune system functioning

Objective

Mental health is a dynamic state that can be influenced by various factors, including biological, environmental, and genetic elements. Mental health conditions, such as anxiety, depression, and schizophrenia, are common and can affect anyone regardless of age, background, or socioeconomic status. Through the in-depth study of the researches and review papers, the aim of the current review is to study the gut brain connection and about the probiotics that will help to improve mental health. The review also emphasis and consolidate existing knowledge about the gut-brain connection and current state of knowledge regarding how probiotics such as lactobacillus and bifidobacterium species helps to improve mental health.

Review of Literature

The brain benefits (psychological benefits of probiotics) after the intake and use of probiotics are found to be significant in improving the mental health of the individual. Considering how common anxiety and depression are, probiotics present a viable substitute for antidepressants and other mental health drugs (Wallace & Milev, 2017) [9].

According to research conducted by Appleton et al. [10] in 2018, deranged gut microbiota led to mental health issues that led to dysbiosis. Impaired mental state is linked to poor quality of life that put extra burden on economy. A disturbance in the gut microbiota is thought to activate the well-known hypothalamic-pituitary-adrenal (HPA) axis. It is now well established that stress changes intestinal epithelial permeability, allowing LPS and bacterial antigens to enter the bloodstream and serve as humoral influencers with a variety of consequences. Acute stress affects the GI tract by altering colonocyte development and lowering the production of mRNA that code for tight junction proteins, according to in vivo studies.

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Smaga et al.[11] concluded about many health benefits of probiotics in their study in 2021, Some of these can be listed as anti-inflammatory, antioxidative, good for metabolism and improve cognitive function as well.

Researchers at the University of Virginia School of Medicine have shown that the bacterium Lactobacillus, which is present in yoghurt and fermented foods, helps the body cope with stress and may help avoid anxiety and depression.

A study published in the Journal of Psychiatric Research found that participants who took a probiotic supplement for four weeks had significantly reduced symptoms of depression and anxiety compared to those who took a placebo. The studies have also shown that administration of the probiotic strain particularly of Lactobacillus and Bifidobacterium species have improved the mental health condition scores such as stress, anxiety, depression etc.

There are many researches that have shown an improved cognitive performance and reduce levels of stress. However, there is a dire need of further researches to find out most effective species of probiotics which are more beneficial for the mental health.

Conclusion

The gut brain connection is one of the most crucial connections that can set your health on track. The diverse microflora presents in the gut health influence human body in many ways - it improves immunity, and has a role in various physiological functions, including influencing mental well-being. Emerging studies suggest that maintaining a healthy balance of gut bacteria through probiotic supplementation may have potential benefits for mental health This descriptive study concludes overview of probiotics and their role in gut health and the link between probiotics and mental health. Furthermore, human interventional studies are needed to get in-depth knowledge and exploring their role in management of mental health.

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