

**Probiotic : Mood Enhancer****Pallavi Shelar\*, Virendra Kumar\*, Manorama\* and Sarang Dilip Pophaly\*****Department of Dairy Microbiology, College of Dairy Science and Food Technology,  
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**ABSTRACT**

Mood is considered as an emotional state and may be defined as one's mental status of thinking and behavior in a healthy, normal individual. In the last few decades, an increasing number of role of probiotics in regulating mood, cognition and response to stress, via the bi-directional link between the brain and the gut microbiome. These probiotics showed efficacy in improving psychiatric disorder related behaviors including anxiety, depression and autism spectrum disorder (ASD), memory abilities, including spatial and non-spatial memory. Probiotics are living microorganisms that are known to confer health benefits to the host when ingested in adequate amounts. Certain strains of probiotics appear to influence the central nervous system (CNS) and behavior via the microbiota-gut-brain axis. In this competitive era most of the people are suffering from stress, regular consumption of probiotic foods have proved to be mood enhancers by getting desired neurotransmitter released in brain and also by stress relieving. Probiotic influence mood, personality traits and sleep may help to gain a better understanding of the relationship between the gut and the brain. Psychobiotic effects and mood, are demonstrate anxiolytic and antidepressive effects of probiotics.

## Mood

Human mood is actually a response of our nerves and brain to a set of complex chemicals released into blood as a result of several intrinsic and extrinsic factors, including food consumes. Moods are affective states that are diffuse and unfocused, that is, not directed towards a specific object. They are continually present (tonic) and shape the background of our moment to moment experience, but fluctuate over time. The cause of a mood may not always be easy to identify. People's mood is characterized by two important patterns i.e. directedness and time that distinguish moods: feeling happy vs. unhappy, feeling relaxed vs. tense and emotions: pride, anger or sadness (Lischetzke, 2014). In contrast to moods, emotions are affective states that are directed at a specific object (e.g., being proud of something) and are phasic (i.e., have a moment of onset and then dissipate)

Moods are classified to positive and negative emotions. Joy and gratitude are positive emotions, to express a favorable evaluation or feeling and anger or guilt is negative emotions they express the opposite. Tension, depression, anger, vigor, fatigue, and confusion are six distinct mood states. (Ekkekakis, 2012).

## What is a Probiotic

Probiotics recently have become a subject of great interest in the field of microbiology, especially their role in normal physiology and its impact on human health during infection. Probiotics, according to a consensus definition, are 'living micro-organisms, which upon ingestion in certain numbers, exert health benefits beyond inherent basic nutrition' (Cencic and Chingwaru, 2010). The main probiotic groups are *Lactobacillus*, *Bifidobacterium*, *Pediococcus*, *Lactococcus*, *Bacillus* and Yeasts strains which are used frequently and numerous probiotic microorganisms (e.g., *Lactobacillus rhamnosus* GG, *Lactobacillus reuteri*, Bifidobacteria and certain strains of *Lactobacillus casei*, the *Lactobacillus acidophilus* group, *Escherichia coli* strain Nissle 1917, certain Enterococci, especially *Enterococcus faecium* SF68, and the probiotic yeast *Saccharomyces boulardii*) are used in probiotic food, particularly fermented milk products, probiotic strains exhibit powerful activity in human health improvement. Regular utilization of food containing probiotic microorganisms is recommended to build a positive balance of the population of useful or beneficial microbes in the intestinal flora. Probiotic microorganisms have been reported to enhance GIT all over transit, produce vitamins and contribute vitamin availability to the human host. Probiotics have wider applications in food, feed, dairy and fermentation

industry. Numerous microbial species have been used as probiotics but most commonly, bacterial species are predominant (Table 1).

**Table 1. Species used as Probiotic**

Group of Microbes	List of Probiotic Species	References
Lactic acid producing bacteria	<i>Lactobacillus acidophilus</i> , <i>Lactobacillus bulgaricus</i> , <i>Lactobacillus casei</i> , <i>Lactobacillus fermentum</i> , <i>Lactobacillus lactis</i> , <i>Lactobacillus acidophilus</i> , <i>Lactobacillus paracasei</i> , <i>L. rhamnosus</i> , <i>L. delbrueckii</i> subsp. <i>bulgaricus</i> , <i>L. brevis</i> , <i>L. johnsonii</i> , <i>Lactobacillus plantarum</i> , <i>Lactobacillus salivarius</i> , <i>Lactobacillus fermentum</i> , <i>Lactobacillus kefir</i>	(Miriam et al., 2012; Taverniti et al., 2013; Mohammad-Kazim et al., 2017)
Non lactic acid producing bacteria	<i>Enterococcus faecalis</i> , <i>Enterococcus faecium</i> , <i>Escherichia coli</i> Nissle, <i>Streptococcus thermophiles</i> , <i>Propionibacterium</i>	
<i>Bifidobacterium</i> species	<i>Bifidobacterium adolescentis</i> , <i>Bifidobacterium bifidum</i> , <i>Bifidobacterium breve</i> , <i>Bifidobacterium lactis</i> , <i>Bifidobacterium longum</i> , <i>Bifidobacterium infantis</i> , <i>B. animalis</i> subsp <i>animalis</i> , <i>B. animalis</i> subsp <i>lactis</i> , <i>B. bifidum</i>	
Nonpathogenic yeast	<i>Saccharomyces boulardii</i>	
Non spore forming	<i>Coccobacillus</i> , <i>Lactobacillus</i> , <i>Streptococcus</i> , <i>Leuconostoc</i> , <i>Lactococcus lactis</i> subsp. <i>Lactis</i> , <i>Pediococcus</i> , <i>Propionibacterium</i> , <i>Enterococcus</i> , <i>Enterococcus durans</i> , <i>Bifidobacterium</i> , <i>Bacillus</i> , <i>Bacillus coagulans</i> , <i>Bacillus subtilis</i> , <i>Saccharomyces cerevisiae</i> , <i>Candida pintolopesii</i> , <i>Aspergillus niger</i> , <i>A.</i>	

	<i>oryzae</i> , <i>Bacillus lichenformis</i> , <i>B. cereus</i> var. <i>toyoi</i> , <i>B. clausii</i> , <i>B. coagulans</i> , <i>B. laterosporus</i> , <i>B. pumilus</i> , <i>B.</i> <i>racemilacticus</i> , <i>Streptococcus thermophiles</i>	
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### Health Effects of Probiotic

The majority of the microbiome lives in the gastrointestinal (GI) tract and is composed of 100 trillion microorganisms, containing 100 times as many genes as our genome (Wang *et al.*, 2016). The microbiota, the ecological community of commensal, symbiotic and pathogenic microorganisms literally sharing our body space, includes more than 10 times the number of host cells to human cells (Ley *et al.*, 2006). The microbiota is a dynamic ecosystem which is influenced by several factors including genetics, diet, metabolism, age, geography, antibiotic treatment, and stress (Hufeldt *et al.*, 2010; Cho *et al.*, 2012; Drago *et al.*, 2012).

Dairy strains of lactic acid bacteria (LAB) have a long history of utilization. Probiotics were used to influence human health through intestinal microbiota alterations. At present, probiotics and their effects on human health have been demonstrated both within different food matrices and as single or mixed microbial culture preparations. LAB, including diverse groups of *Lactobacillus* and *Enterococcus* species, that has been consumed daily since humans started to use fermented milk as a food.

Probiotics share unique roles in human nutrition, largely manipulation of populations or activities of the microbiota that colonize the human GI tract (Figure 1). Regular consumption of probiotics has health implications that include enhanced immune function, improved colonic integrity, improved digestion and elimination, regulating mood, cognition, response to stress, via the bi-directional link between the brain and gut microbiome (Dinan and Cryan, 2012).

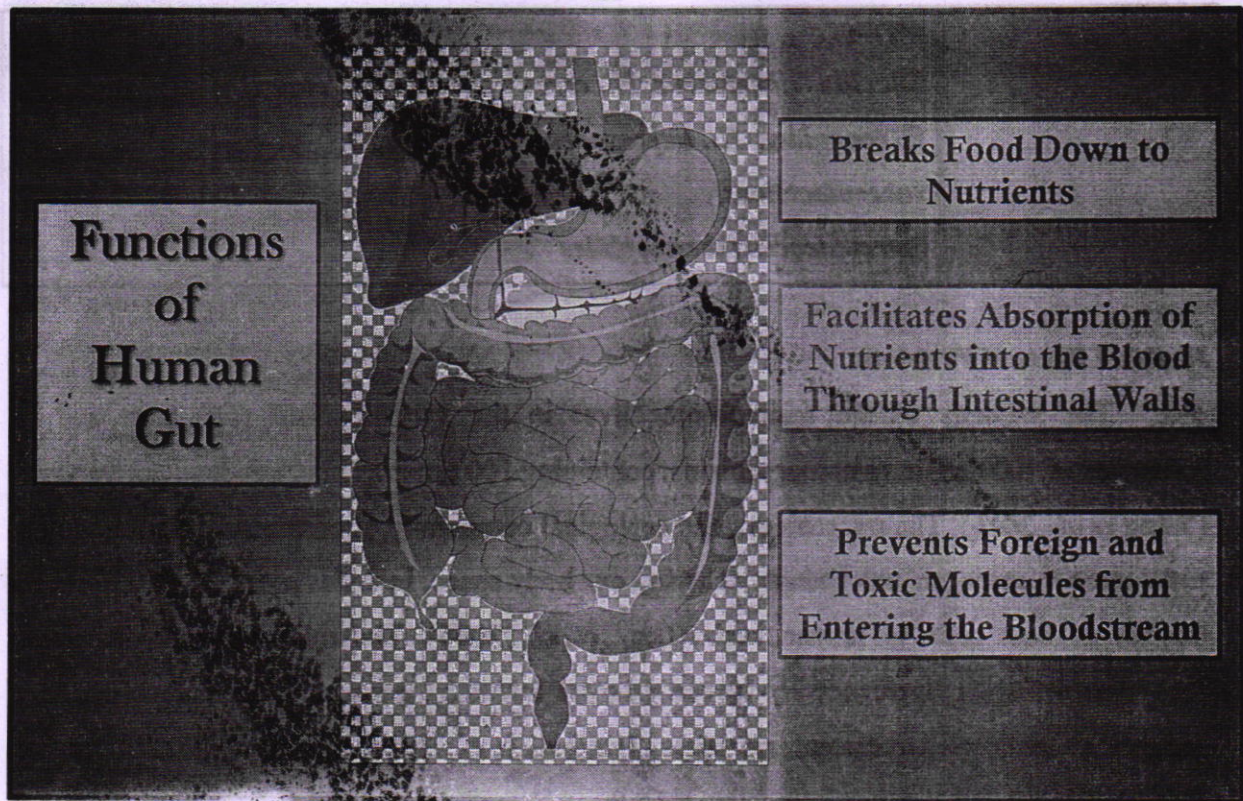
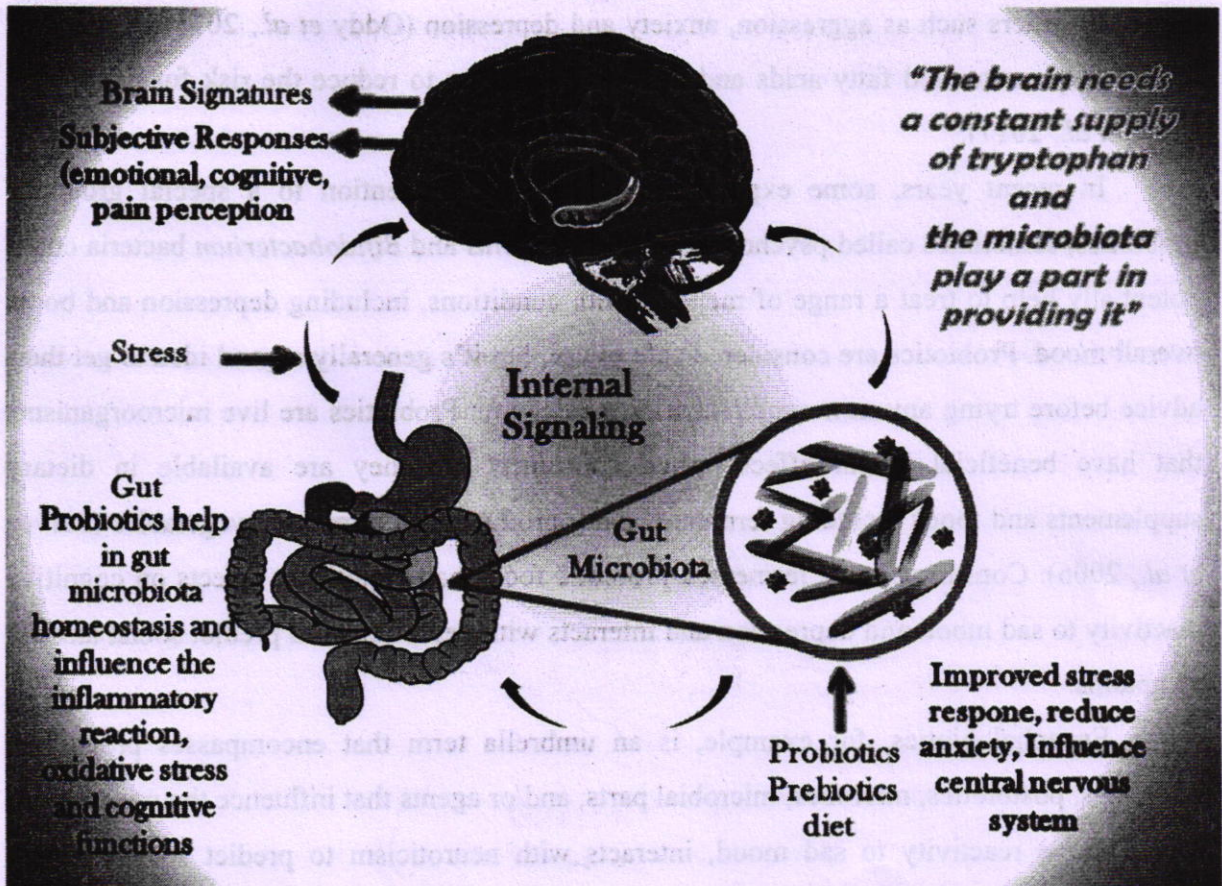


Figure 1. Effect of Gut Microbiome on Human Health

#### Probiotic as Mood Enhancer

The gut has been called a "second brain" because it produces many of the same neurotransmitters as the brain does, like serotonin, dopamine, and gamma-aminobutyric acid, all of which play a key role in regulating mood. Probiotic microorganism such as *Bifidobacterium animalis* subsp. *lactis* and *Lactococcus lactis* subsp. *lactis* are belongs here, it modulate brain activity and provide mental health, maintaining the functionality of the central nervous system through metabolic, neuroendocrine and immune pathways, contribute to the early development of normal social and cognitive behaviors (Figure 2). Useful strains having positive direct effect on central nervous system and also solve disorders (Abatenh *et al.*, 2018).



**Figure 2. Manipulation of Probiotic Effect in Gut Microbiota and Central Nervous System.**

## Depression

The World Health Organization (WHO) reports mental disorders will become the leading disease in 2020 and therefore they represent a major challenge in public health (WHO, 2013). Depression is one of the most common psychological disorders and >320 million people are currently diagnosed with the disorder worldwide (Kim and Shin, 2019). In most of the studies, the term 'depression' is poorly defined or not clarified (Wallace and Milev, 2017). Fully effective therapeutic strategies of depression treatment have yet to be developed because about one-third of patients do not respond to standard antidepressants. The gut microbiota, a community of bacteria colonizing the human gut, has a symbiotic (probiotic) relationship with humans. The gut microbiota interacts with the host central nervous system via the gut-brain axis.

## Effects of Probiotic to reduce the Depression

Diet and nutrition have increasing attention for their important roles in regulating mental health. Western diet with higher fat products is involved in the increased risk for

mental disorders such as aggression, anxiety and depression (Oddy *et al.*, 2018). A diet rich in  $\omega$ -3 polyunsaturated fatty acids and flavonoids appears to reduce the risk for depression (Opie *et al.*, 2017).

In recent years, some experts have turned their attention to a special group of probiotics, sometimes called psychobiotics. *Lactobacillus* and *Bifidobacterium* bacteria could potentially help to treat a range of mental health conditions, including depression and boost overall mood. Probiotics are considered safe to use, but it's generally a good idea to get their advice before trying any new supplement or medication. Probiotics are live microorganisms that have beneficial health effects when consumed and they are available in dietary supplements and foods including fermented dairy products and fermented vegetables (Parvez *et al.*, 2006). Consumption of fermented probiotic foods had significant effects on cognitive reactivity to sad mood and depression and interacts with neuroticism to predict social anxiety symptoms.

Encephalobiotics, for example, is an umbrella term that encompasses probiotics, prebiotics, postbiotics, microbes, microbial parts, and/or agents that influence the microbiome for cognitive reactivity to sad mood, interacts with neuroticism to predict social anxiety symptoms and brain health (Prescott and Logan, 2016). Psychobiotics on the other hand have been defined by Dinan and colleagues as live organisms that, when ingested in adequate amounts, produce a health benefit in patients suffering from psychiatric illness.

### Stress

In spite of the fact that today's consumers are increasingly attentive to food safety, quality and health-related issues, the maximum population is still fighting with the diseases of a modern age such as obesity, osteoporosis, cancer, diabetes, allergies, stress and dental problems. Recent evidence indicates a clear association between changes in the microbiota and cognitive behaviors (Gareau, 2014). 'Good' bacterium that could protect the brain against the harmful effects of stress. Probiotics generally, they have been shown to have strong effects in the domains of cognitive function, anxiety, and fear. Human body, especially digestive system, naturally contains probiotics, which are beneficial bacteria. There's a balance in human body between helpful bacteria, or probiotics and potentially harmful bacteria. The effects of probiotics on improving cognitive disorders are scarce (Bhattacharjee and Lukiw, 2013; Davari *et al.*, 2013).

Some complications such as cognitive disorders, oxidative stress, neuroinflammation, insulin resistance, and altered lipid metabolism, are identified to be influenced by the gut flora as well as probiotics (Akbari *et al.*, 2016).

### Beneficial Effects of Probiotic under Stress Condition

The immune system can be influenced by probiotics, limiting pro-inflammatory cytokine production and inflammation, which, in turn, can affect the endocrine and nervous systems (Desbonnet *et al.*, 2010). Probiotics manipulate GM by increasing microbiota diversity and beneficial bacteria compositions (Kwok *et al.*, 2014).

For stress regulation gut brain axis is crucial for the development of hypothalamic-pituitary-adrenal (HPA) axis through influencing, which turns in mood, emotions and brain derived neurotropic factor (BDNF) expression can modulate cognitive behaviors including learning and memory (Sudo *et al.*, 2004; Li *et al.*, 2009; Gareau *et al.*, 2011; Frohlich *et al.*, 2016; Papalini *et al.*, 2019). Probiotics might affect cognitive performance independent or dependent of the detrimental effects of stress (Gareau *et al.*, 2011; Messaoudi *et al.*, 2011; Ait-Belgnaoui *et al.*, 2014; Cowan *et al.*, 2016; Papalini *et al.*, 2019).

### Role of Probiotic in Brain Improvement

Disorders Types	Responsible Probiotic Strains	Probiotic Outcomes	Reference
Modulation of gut-brain axis	<i>Bifidobacterium animalis</i> subsp. <i>lactis</i> , <i>Lactococcus lactis</i> subsp. <i>lactis</i>	a.Modulation of brain activity and Provide mental health. b.Maintaining the functionality of the central nervous system through metabolic, neuroendocrine and immune pathways. c.Contribute to the early development of normal social and cognitive behaviors. d.Positive direct effect on central nervous system and also solve disorders.	(Tillisch <i>et al.</i> , 2013; Liu <i>et al.</i> , 2015)
Profile of mood states (POMS),	<i>Lactobacillus casei</i>	Consumption of probiotic-containing yogurt improved self-	(Benton <i>et al.</i> , 2007)



self related mood		reported mood of those whose mood was initially poor.	
Gamma-aminobutyric acid (GABA) and Serotonin	<i>Lactobacillus brevis</i> , <i>Bifidobacterium dentium</i> , <i>Lactobacillus plantarum</i>	Controlling the neural excitatory-inhibitory balance, mood, cognitive functions, learning and memory processes.	(Lu et al., 2008)
Attention deficit hyperactivity disorder (ADHD)	<i>Lactobacillus rhamnosus</i> GG, <i>Lactobacillus plantarum</i>	A reduced risk of developing ADHD, inattention, hyperactivity and impulsivity.	(Cheng et al., 2019)
Insomnia	<i>Lactobacillus brevis</i>	To induce depression, memory impairment and allergy	(Cohen et al., 2009)
Alzheimer's Disease	<i>Bifidobacterium breve</i>	Probiotics intervention could potentially modulate cognitive decline in Alzheimer's disease	(Wong et al., 2018)

### Conclusion

This review presents information on probiotics use in human clinical traits and their functional application in health areas all information are presented. The effect of probiotics products can have specific target function in the human alimentary tract. Probiotics are widely influence the central nervous system (CNS) and behavior via the microbiota-gut-brain axis. In this competitive era people are suffering from stress, the consumption of probiotics helps to lead a healthy life and healthy individual, excitory neurotransmitters enhance 'mood' and inhibitory neurotransmitters depress 'mood'. The consumptions of probiotics may also treat a range of mental health conditions, including depression and boost overall mood. The relationship between probiotics and mood are efficacy in improving psychiatric disorder related behaviors including anxiety, depression, and memory abilities, including spatial and non-spatial memory.

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