

Review Article

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Psychological Impact of Probiotics and Fermented Foods on Mental Health of Human in Integrated Healthy Lifestyle

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ABSTRACT

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Effect of probiotic gut microbiota on host health is very interesting for scientists as an example for active interactions among different living organisms. This article answers basic questions about this interaction, its effects on human mental health and its application in healthy and therapeutic nutrition of host. Mechanisms of gut microbiota affecting human mental health and limitations of probiotics in host gut were discussed. Probiotics application in healthy nutrition is only one factor in integrated healthy lifestyle for good physical and mental health of human.

Introduction

Attention has been almost concerned with the negative effects that microorganisms play in food, there is however a huge diversity of foods where microbial activity is an essential feature of their production in addition to benefits of these microorganisms for host health. Therefore, fermented foods and probiotic products can be used to enhance human general health and may be used to support recovery of some diseases under concept of therapeutic nutrition.

Probiotic gut microbiota have multi beneficial effects for host; improvement digestion and intestinal health, inhibition of pathogens in

intestinal tract, enhancement and induction of immune system response, anti-inflammatory activity, production of vitamins and cofactors, reduction of serum cholesterol, anti-oxidative activity, reduction of blood pressure, prevention of cancer and tumors, improvement of lactose metabolism in lactose intolerant persons and protective role against allergy (Santosa *et al.*, 2006; Figueroa-González *et al.*, 2011; Shinde, 2011; Nagpal *et al.*, 2012; Kechagia *et al.*, 2013; Turrone *et al.*, 2014; Amara and Shibl, 2015).

Availability of safe food - per se - can enhance human psychological health. Are some food types having positive effect on human mental health? Historically, fermented

foods provided good physical and physiological health of some peoples. It is known that, psychological health relates to physiological and physical health with bidirectional effect; one of both can affect the other. But what is the true value of fact that, probiotic fermented foods can enhance human behavior and mental health. Nowadays, this concept is used for production of specific fermented foods and probiotic supplements under terminology of Psychobiotics.

Effect of probiotic bacteria on host mental health

Several experimental studies reported that, supplementation with probiotic bacteria in food can influence nervous system function and mental health and provide beneficial neurochemicals and positive behavioral effects of animal or human host (Neufeld *et al.*, 2011; Desbonnet *et al.*, 2014; Nishihira *et al.*, 2014; Savignac *et al.*, 2014; Hilimire *et al.*, 2015; Steenbergen *et al.*, 2015; Akkasheh *et al.*, 2016; Cowan *et al.*, 2016). Furthermore, effect of probiotic gut microbiota on brain activity of healthy humans was demonstrated using functional magnetic resonance imaging (fMRI) (Tillisch *et al.*, 2013).

In preclinical study with rats and clinical study with volunteers, results deduced that daily consumption of probiotic strains (*Lactobacillus helveticus* and *Bifidobacterium longum*) for two weeks can significantly reduced anxiety-like behavior in rats and alleviated psychological distress in volunteers.

Which was evidence of gut microbiota role on central nervous system functions and suggests that oral intake of probiotics may have beneficial consequences on mood and psychological distress of host (Messaudi *et al.*, 2011).

Cross-sectional approach was applied with 710 young adults using completed self-report measures to determine interaction between consumption of natural fermented foods and neuroticism for predicting social anxiety symptoms. Results reported that higher frequency consumption of natural fermented foods that may contain probiotics was associated with fewer symptoms of social anxiety, which indicate that fermented foods have a protective effect against social anxiety symptoms (Hilimire *et al.*, 2015).

Forty patients in randomized, double-blind clinical trial with major depressive disorder (whose age between 20 and 55 years) were divided to two groups; one group received probiotic capsules contained *Lactobacillus acidophilus* (2×10^9 CFU/g), *Lactobacillus casei* (2×10^9 CFU/g), and *Bifidobacterium bifidum* (2×10^9 CFU/g) for 8 weeks, the other group received placebo capsules. Results reported that, probiotic supplement group has significantly decreased Beck Depression Inventory compared with the placebo group (Akkasheh *et al.*, 2016).

Seventy-five workers in a randomized, double-blind, placebo-controlled trial received yogurt and capsules for 6 weeks in 3 groups. Results indicated that consumption of probiotic yogurt (contained two strains; *Lactobacillus acidophilus* and *Bifidobacterium lactis*) or a multispecies probiotic capsule (contained seven probiotic bacteria species *Lactobacillus casei*, *L. acidophilus*, *L. rhamnosus*, *L. bulgaricus*, *Bifidobacterium breve*, *B. longum*, *Streptococcus thermophilus*) had significant beneficial effects on mental health parameters of workers (Mohammadi *et al.*, 2016).

Contrarily, in a double-blind, randomized, placebo controlled trial for 8 weeks; probiotic preparation (containing *Lactobacillus helveticus* and *Bifidobacterium longum*) failed

to reduce depression symptoms of seventy-nine participants, where the result indicated that no significant difference was found between the probiotic and placebo groups on any psychological outcome measures. Authors mentioned that this result may be due to the severity, chronicity or treatment resistance of the sample and acute symptoms of low mood of the participants, also using probiotics in future as an adjuvant treatment may be more effective (Romijn *et al.*, 2017).

Potential psychobiotic bacterial strain (*Lactobacillus rhamnosus* (JB-1)) could not improve stress-related behaviors, inflammatory response, cognitive performance of 29 healthy male volunteers after 8 weeks in randomized, placebo-controlled trial, where there is no significant effect of probiotic treatment over placebo (Kelly *et al.*, 2017).

Mechanisms of gut microbiota affecting host mental health

Multiple mechanisms are considered; probiotic bacteria able to influence the immune-related pathways (Desbonnet *et al.*, 2008), Probiotic gut microbiota can reduce pro-inflammatory cytokines (Lin *et al.*, 2008) and oxidative stress (Kullisaar *et al.*, 2003; Lopresti *et al.*, 2014) in host, which are associated with depression and mood disorders (Dowlati *et al.*, 2010; Stefanescu and Ciobica, 2012). Gut has a complex nervous system interfaces directly with the brain and allows bidirectional flow of information between gut microbiota and brain. There are multiple pathways of communication between gut microbiota and central nervous system including vagus nerve, immune and hypothalamic pituitary adrenal axis, which can modulate cognition, emotion and behavior of host as the microbiota-gut-brain axis (Foster and Neufeld, 2013; Tillisch, 2014).

Immunological, neurophysiological and microbiological systems in human body can interact to control and affect health and diseases such as mental health or emotional and mood disorders of host using neuroactive substances (neurotransmitters such as Serotonin, Dopamine, Acetylcholine, Norepinephrine, gamma-aminobutyric acid) which can be produced in the same identical structure by gut microbiota or human body cells itself (Lyte, 2004 & 2010; Komatsuzaki *et al.*, 2008; Reiff and Kelly, 2010; Jiang *et al.*, 2015), as a communication between bacterial cells in gut and human body cells.

The interaction acts in different directions, probiotic gut microbiota have the ability to both synthesize and respond to neuroactive compounds, which means that growth and colonization of probiotic gut microbiota in gastrointestinal tract can be affected by physical, physiological and mental health of host, it is a life interaction communication among all biotic and abiotic components of life ecosystems.

There is a symbiotic interaction between gut microbiota and host body. Gut microbiota can affect physical, physiological, immune and mental health of host. So, some scientists consider gut microbiota as an additional organ in our body.

Ability of probiotic gut microbiota to produce the neuroactive substances depends on presence of some substances in gut as substrates, which may be found in the probiotic food product or other foods.

For example, probiotic bacteria need glutamate as substrate and pyridoxal phosphate as enzyme co-factor for production of gamma-aminobutyric acid (Komatsuzaki *et al.*, 2008). Also, probiotic microbiota utilize tryptophan as a precursor for production of serotonin (O'Mahony *et al.*, 2015).

Limitations of probiotics in host gut

There are things that kill or inhibit and reduce count and colonization of our good friend bacteria (probiotics) in host gut; antibiotics therapy, drinking treated water with chlorine or fluoride, high-sugar and fat-diets consumption, exposure to toxic pollutants and social and psychological stresses (Bailey *et al.*, 2011; Dethlefsen and Relman, 2011; Bergin and Witzmann, 2013; Pérez-Cobas *et al.*, 2013; Shehata *et al.*, 2013; Liu *et al.*, 2014; Taggart and Bergstrom, 2014; Jiang *et al.*, 2015; Murphy *et al.*, 2015; Jena *et al.*, 2016). Therefore, fermented foods or probiotic supplemented products have to be eaten daily to support host health.

At the other side, eating of fresh and raw foods such as onion, garlic, leek, wheat, barley, oat, banana, apple, asparagus, Jicama, Jerusalem artichokes and chicory stimulates growth and activity of probiotic microbiota in host gut, because these foods contain prebiotic substances (such as; oligosaccharide fibers like inulin, fructooligosaccharides (fructans), galactooligosaccharides (galactans)) that can only be metabolized by the probiotic microbiota and non-digestible by host.

Sufficient amount of prebiotic foods must be eaten to generate a prebiotic effect, but not too lot to induce unfavorable or adverse effects such as non-selective utilization and excessive gas formation (Kleessen *et al.*, 2007; Roberfroid, 2007; Muir *et al.*, 2007; Macfarlane *et al.*, 2008; Slavin, 2013; Zhang *et al.*, 2013; Arena *et al.*, 2014; Kumar *et al.*, 2015; Valeur *et al.*, 2016; Gibson *et al.*, 2017).

Plant polyphenols, polyunsaturated fatty acids and conjugated linoleic acid may be considered as prebiotic substances (Gibson *et al.*, 2017).

Integrated healthy lifestyle

In a simple way, you can try the following for good general, physical, physiological and mental health of human as integrated healthy lifestyle:

Healthy nutrition depends on variation and moderation of human foods, eat your food with your all senses. Healthy habits and behaviors; anything wants to exit (something from your body, idea from your mind, word from your tongue, reaction from your sentiment, emotion from your psyche) get it out (without annoyance for others), do not keep it in.

Healthy life can be achieved by direct, active, positive and psychical interactions by all senses of human with all visible and invisible components of nature as a full ecosystem; biotic factors (humans, animals, plants, microorganisms) and abiotic factors (sun light, fresh air, fresh and marine water, land terrain, soil, elements).

Probiotic fermented foods and probiotic supplements products can enhance human behavior and mental health, it is an effective but not invasive treatment. It can be used as an important adjuvant factor for healthy nutrition or treatment of mental health disorders or other diseases. Probiotics application in healthy nutrition is only one factor in integrated healthy lifestyle for good physical and mental health of human.

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