

THE ROLE OF NUTRACEUTICALS IN MENTAL HEALTH

INTRODUCTION

The rapid pace of life in recent decades, characterized by busy schedules, limited time for exercise, and sedentary desk jobs, has heightened the importance of focusing on personalized nutrition to meet individual health needs.

In the modern era, issues such as obesity, diabetes, high blood pressure, stress, allergies, cardiovascular disease, and cancer are prevalent.

Mental well-being refers to a condition in which individuals can effectively manage stress, realize their potential, learn and work proficiently, and contribute positively to their communities. It is recognized as a fundamental human right and a vital component for personal, community, and socioeconomic advancement.

The human brain relies on carbohydrates, proteins, fats, vitamins, and minerals for optimal functioning. Despite accounting for only about 2% of total body weight, the brain consumes 20–30% of the daily energy intake, making it the most energy-demanding organ.[2]

The term "nutraceutical" refers to food or its components that offer health benefits beyond basic nutrition, often with potential medicinal properties. As people increasingly face chronic diseases linked to nutritional deficiencies, nutraceuticals are gaining interest as a way to bridge this gap.

"Nutraceuticals," a category of products combining food and medicine, have gained significant attention in recent years from both healthcare professionals and consumers seeking to improve their nutritional intake. Increasing evidence has shown that a diet rich in nutrients such as fibers, phytochemicals, and short-chain omega-3 fatty acids is associated with improved mental health and the prevention of neurodevelopmental disorders.

Numerous bioactive food constituents have been commercialized as pharmaceutical products, such as pills, capsules, solutions, gels, liquids, powders, and granules. Known as "nutraceuticals," these products enhance human health by offering physiological benefits, protecting against chronic diseases, improving overall well-being, and delaying the aging process.

There's a well-established link between good nutrition and diet, and positive outcomes in mental health, immune system function, and the composition of gut microbiota.

Keywords: Nutraceuticals, Healthcare professional, Mental health, Nutritional deficiencies.

THE SIGNIFICANCE OF NUTRACEUTICALS IN ADDRESSING NEUROLOGICAL DISORDERS.

Sr No	Diseases	MOA	Nutraceutical Role	Example
1	Neurodegenerative Disorders	Neurodegenerative disorders primarily develop due to protein misfolding.	Nutraceuticals primarily prevent protein misfolding by inhibiting the activation and synthesis of proinflammatory cytokines and their associated pathways.	Bacoside A, Bacoside B, brahmine, quercetin, kaempferol, withanine, somniferine, asiatic acid, bhilavanol A and B.
2	Alzheimer's Disease	AD is primarily linked to an increase in oxidative stress and free radicals.	Antioxidant-rich nutraceuticals are commonly used in the treatment of this condition.	Flavonoids (fruits, vegetables, tea, wine, coffee); carotenoids (lutein, zeaxanthin, lycopene, β -cryptoxanthin including α and β carotenes); anthocyanidins (cyanidin); flavones (luteolin, apigenin)
3	Parkinson's Disease	Uncontrolled oxidative stress and the presence of free radicals, along with abnormal protein misfolding, neuroinflammation, and impaired mitochondrial function, result in compromised cellular metabolism and energy production. This	Contributes to the development of neurodegenerative disorders such as PD.	Vitamin A, Omega-3 fatty acids, lycopene, vincamine, gallic acid, curcumin, Mito Q

		affects brain function.		
4	Depression	-	Nutraceuticals with properties that inhibit the reuptake of monoamines, along with anti-inflammatory and antioxidant properties, are well suited for treating depression.	Omega-3 fatty acids, folic acid, S-adenosyl methionine, zinc, N-acetyl cysteine, L-Tryptophan/5-HTP, Vitamin-D.
5	Psychosis	-	Nutraceuticals that enhance neurotransmission in dopaminergic and serotonergic neurons can be used in the treatment of psychosis.	All types of vitamins and omega 3 fatty acids

Table from: <https://pubmed.ncbi.nlm.nih.gov/32580329/>

NUTRACEUTICALS ROLES IN MENTAL HEALTH

The role of nutraceuticals in mental health has gained significant attention in recent research. The key nutraceuticals and their impact on mental health.

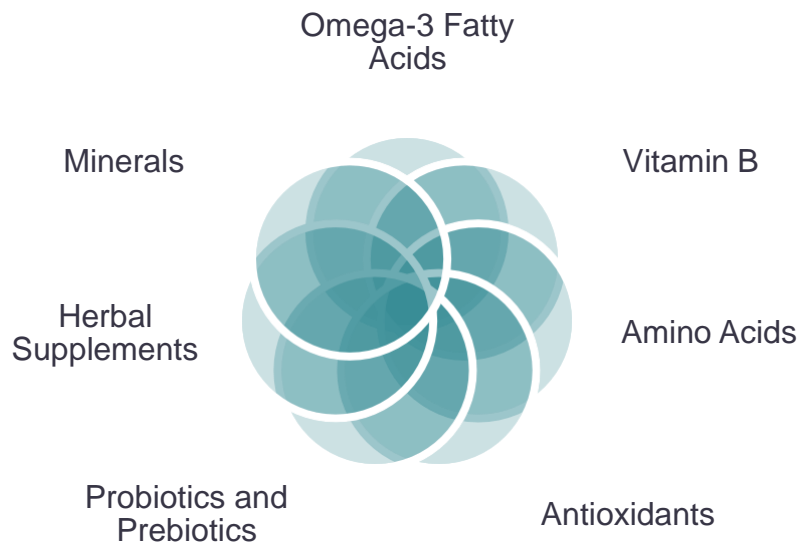


fig - Various nutraceutical products in use in mental health

- **Omega-3 Fatty Acids:**

The significance of omega-3 polyunsaturated fatty acids in physical health is firmly established, and their importance in mental well-being is increasingly recognized.



Sources:

Omega-3 polyunsaturated fatty acids, present in oily fish, flax seeds, walnuts, and oils like canola and walnut oils.

Deficiency:

Dietary deficiencies in omega-3 fatty acids are associated with a higher risk of developing psychiatric disorders such as depression, bipolar disorder, schizophrenia, dementia, attention-deficit/hyperactivity disorder (ADHD), and autism in humans. Specifically, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are crucial for maintaining mental health, and their insufficiencies are implicated in the pathophysiology of mental disorders. This effect may occur through the modulation of inflammatory processes and their direct impact on neuronal membrane fluidity and receptor function.

Roles:

Omega-3 supplements may effectively reduce symptoms of depression and anxiety in adults, especially when used alongside antidepressant medication.

Omega-3 fatty acids play integral roles in various physiological functions related to brain development, function, and aging, including neurogenesis, neurotransmission, and neuroinflammation.

- **Vitamin B:**

Vitamin B plays a crucial role in overall health, particularly mental health, and deficiencies may be associated with symptoms of psychiatric disorders. Vitamin B's (B1- thiamin, B2- riboflavin, B3- niacin, B5- pantothenic acid, B7- biotin, B6- pyridoxine, B9- folate/folic acid, B12- cobalamin)



Sources:

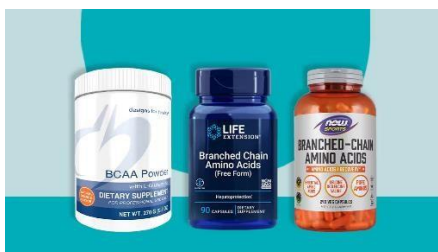
Whole grains, legumes, seeds, nuts, leafy greens, and animal products.

Vitamins B complex	Deficiency symptoms	Roles & Mechanisms
B1	Irritability, emotional disturbances, confusion, disturbed sleep, memory loss, Wernicke-Korsakoff syndrome	<ul style="list-style-type: none"> ➤ Thiamine is essential for brain function, serving as a coenzyme in the pentose phosphate pathway to help synthesize crucial compounds like fatty acids and neurotransmitters. ➤ It modulates the acetylcholine neurotransmitter system and maintains the structure and function of neuronal and neuroglial membranes.
B2	Fatigue, personality change, brain dysfunction	<ul style="list-style-type: none"> ➤ Derived from riboflavin, FMN and FAD serve as essential coenzymes in cellular functions, facilitating the synthesis of niacin, folate, vitamin B6, and heme proteins, as well as regulating thyroid hormones and assisting in essential fatty acid metabolism and iron absorption. ➤ Riboflavin deficiency may disrupt these processes, potentially affecting brain function. Moreover, riboflavin derivatives exhibit antioxidant properties, bolstering the body's antioxidant defenses via the glutathione redox cycle.
B3	Depression, anxiety, progressing to vertigo, memory loss, paranoia, psychotic symptoms, aggression	<ul style="list-style-type: none"> ➤ Processes and enzymes essential for the function of both peripheral and brain cells rely on niacin-derived nucleotides, specifically nicotinamide adenine dinucleotide (NAD) and NAD phosphate (NADP). These molecules serve various functions beyond energy production, including involvement in oxidative reactions, DNA metabolism and repair, antioxidant defense, and intracellular calcium signaling. ➤ Niacin interacts with two G protein receptors, NIACR1 and NIACR2, influencing processes like skin flushing and immune system regulation. ➤ In schizophrenia patients, there's a noted decrease in NIACR1 expression in the anterior cingulate cortex, while in Parkinson's disease patients, upregulation in the substantia nigra correlates with disrupted sleep patterns. Niacin supplementation has demonstrated potential in adjusting immune cell NIACR1 expression and improving sleep quality in Parkinson's disease.

B5	Encephalopathy, behaviour change, demyelination	<ul style="list-style-type: none"> ➤ Vitamin B5 serves as a substrate for the production of Coenzyme A (CoA), a vital component in various metabolic processes. ➤ CoA, apart from its role in oxidative metabolism, plays a significant part in shaping and sustaining brain cell structure and function. ➤ It participates in synthesizing essential compounds such as cholesterol, amino acids, phospholipids, and fatty acids. ➤ Pantothenic acid, through its contribution to CoA, also plays a role in the production of numerous neurotransmitters and steroid hormones.
B6	Irritability, impaired alertness, depression, cognitive decline, dementia, autonomic dysfunction, convulsions	<ul style="list-style-type: none"> ➤ Vitamin B6 is crucial for amino acid metabolism, acting as a rate-limiting cofactor in the synthesis of neurotransmitters like dopamine, serotonin, GABA, noradrenaline, and melatonin. ➤ Even mild vitamin B6 deficiency can reduce GABA and serotonin synthesis, leading to disrupted neural inhibition, sleep, behavior, cardiovascular function, and hormone regulation. ➤ Vitamin B6 also impacts immune function, gene expression, and brain glucose regulation. ➤ Pyridoxal-5'-phosphate (PLP) levels correlate with inflammation markers, often decreasing in more severe inflammation, possibly due to its role in tryptophan metabolism or one-carbon metabolism.
B7	Lethargy, hallucinations, seizures, neurological problems such as depression, cognitive decline, and autonomic dysfunction.	<ul style="list-style-type: none"> ➤ The brain's sensitivity to glucose delivery and metabolism makes biotin essential for these processes. ➤ Biotin is involved in hepatic glucose uptake, gluconeogenesis, insulin receptor transcription, and pancreatic β-cell function. ➤ Although severe biotin deficiency is uncommon, individuals with glucose regulatory issues, such as Type II diabetes, often exhibit lower biotin levels, with an inverse relationship observed between fasting plasma glucose and biotin levels.
B9 & B12	Affective disorders , behaviour changes, psychosis, cognitive impairment/decline, dementia (inc	<ul style="list-style-type: none"> ➤ Vitamins B12 and folate are intimately linked through their roles in the "folate" and "methionine" cycles. ➤ Both are essential for the synthesis and regeneration of tetrahydrobiopterin, which is

	Alzheimer's disease and vascular dementia)	required for converting amino acids into monoamine neurotransmitters and nitric oxide.
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- Amino Acids:**



Sr no	Amino Acids	Sources	Deficiency symptoms	Role in Neurotransmission	
1	Tryptophan	Foods of animal origin, soybeans and derivative, bananas, avocados, nuts, etc	Depression, anxiety, insomnia, and EDCs	Serotonin precursor	Emotional balance, sociability, lividity, and sleep (melatonin synthesis)
2	Histidine	Food of animal origin	Insomnia and anorgasmia	Histamine precursor	Sleep and sexual orgasm
3	Tyrosine	Food of animal origin, whole grains, and legumes	Mental energy, impulse control, motivation, alertness, memory, executive functions, & processing speed	Precursor of dopamine, adrenaline, & norepinephrine	Mental energy, impulse control, motivation, alertness, memory, executive functions, and processing speed

Table from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10418505/>

- Antioxidants:**



Sources:

Berries, nuts, dark chocolate, vegetables, and green tea.

Deficiency:

Oxidative stress and the continuous production of reactive oxygen and nitrogen species (ROS and RNS) are recognized for their harmful impact on cellular processes. Furthermore, mounting evidence suggests that oxidative free radicals play significant roles in the pathophysiology of several neuropsychiatric disorders, such as schizophrenia, bipolar disorder, and major depression.

Roles:

The antioxidant properties of nutraceuticals can significantly impact mental health by reducing oxidative stress, modulating inflammation, protecting neuronal cells, and enhancing neurotransmitter function.

Mechanism:

The brain is particularly susceptible to oxidative stress due to its high energy demand for sustaining neuronal synaptic activity, membrane potential, and neurotransmitter synthesis, among other essential functions.

- **Probiotics and Prebiotics**



Sources:

Omega-3 polyunsaturated fatty acids, present in oily fish, flax seeds, walnuts, and oils like canola and walnut oils.

Deficiency:

A deficiency in probiotics and prebiotics can negatively impact the gut microbiota and, consequently, mental health. This imbalance, often referred to as dysbiosis, can disrupt the gut-brain axis, leading to a range of physical and mental health issues. Here's an in-depth look at the effects of such deficiencies

- Altered Neurotransmitter Production
- Impaired Stress Response
- Cognitive Decline

Roles:

Probiotics and prebiotics, as nutraceuticals, have emerged as important players in mental health, primarily through their impact on the gut-brain axis. This axis refers to the bidirectional communication between the gastrointestinal (GI) tract and the central nervous system (CNS).

Probiotics and prebiotics play a significant role in mental health by modulating the gut-brain axis. Their ability to influence neurotransmitter production, reduce inflammation, improve gut barrier function, regulate stress responses, and produce

beneficial metabolites makes them valuable tools in managing mental health disorders.

- **Herbal Supplements**



Sources: St. John's Wort, Ginkgo Biloba, Rhodiola Rosea, Ashwagandha capsules or tinctures.

Deficiency:

Deficiency in herbal supplements can have significant impacts on mental health, the complex role these supplements play in supporting cognitive and emotional well-being.

Roles:

Herbal medicines commonly used for anxiety, depression, and insomnia.

- **Minerals**



Minerals	Sources	Deficiency	Roles
Magnesium	Spinach, prickly pear, salmon, pumpkin seeds, cereal, almonds, brazil nuts, beans	Magnesium deficiency can significantly impact mental health, leading to depression, anxiety, cognitive dysfunction, sleep disorders, and increased stress response.	Magnesium is a vital nutraceutical with significant benefits for mental health. Its may reduce in mood regulation, stress reduction, cognitive function, sleep improvement, anxiety management, neuroprotection, and behavioral stability makes it an essential component for

			maintaining mental well-being.
Potassium	Potatoes, sweet potatoes, banana, tomato sauce without addition of sugar and salt, tuna, low-fat dairy products, citrus juices, beans, leafy greens	Potassium deficiency can have significant negative effects on mental health, including impaired neurotransmitter function, electrolyte imbalance, fatigue, mood swings, cognitive impairment, increased stress response, and cardiovascular effects.	Potassium is a crucial nutraceutical with significant benefits for mental health. Its roles in neurotransmitter function, nervous system health stress reduction, and mood stability make it essential for maintaining mental well-being. May enhance brain function.
Zinc	Oysters, beans, nuts, red meat, certain types of seafood (crab and lobster), whole grains, fortified breakfast cereals, dairy products	Zinc deficiency can have profound effects on mental health, leading to mood disorders including depression and anxiety, cognitive decline, impaired neurotransmitter function, increased oxidative stress, and a heightened stress response.	Zinc is a vital nutraceutical with significant benefits for mental health. Its role in neurotransmitter regulation, neurogenesis, antioxidant defense, immune support, and stress reduction makes it an important element for maintaining and improving mental well-being.
Iron	Red meat, poultry, fish, beans, lentils, tofu, spinach, and fortified cereals	Iron deficiency can have significant negative effects on mental health, including cognitive impairment, mood disorders, fatigue, restless leg syndrome, impaired neurodevelopment, and decreased immune function.	Iron is a vital nutraceutical with significant benefits for mental health. Its role in oxygen transport, neurotransmitter synthesis, myelination, cognitive function, and behavioral health makes it essential for maintaining mental well-being.
Selenium	Seafood, bread, grains, meat, poultry, fish, eggs	Selenium deficiency can have significant negative effects on mental health, including increased risk of	Selenium is a vital nutraceutical with significant benefits for mental health. Its roles in antioxidant defense,

		depression, cognitive decline, anxiety, thyroid dysfunction, behavioral changes, and immune system weakness.	mood regulation, cognitive function, anxiety reduction, and neuroprotection make it essential for maintaining mental well-being.
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CONCLUSION

Overall, nutraceuticals constitute a valuable adjunctive approach to mental health care, complementing conventional treatments and lifestyle interventions. Incorporating nutrient-rich foods and targeted supplementation into one's diet can support brain health, emotional well-being, and resilience to mental health challenges, ultimately promoting a higher quality of life.

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