Nourishing the Mind: Role of Functional Foods in Stress Management

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ABSTRACT
Functional foods play a crucial role in stress management by providing essential nutrients that support brain function, regulate neurotransmitters, and reduce oxidative stress. Key mechanisms include neurotransmitter regulation (such as increasing serotonin and dopamine levels), cortisol modulation (reduction of stress hormones), antioxidant and anti-inflammatory action (protection of brain cells), and the gut-brain axis (better gut health promotes mood stability). The following foods are used in the treatment: adaptogenic herbs (ashwagandha, ginseng), omega-3 fatty acids (fish, walnuts), magnesium-rich foods (leafy greens, nuts), probiotics & prebiotics (yogurt, fiber-rich foods), and antioxidant-rich foods (green tea, berries, dark chocolate). Current drugs primarily focus on psychological or physical symptoms and often have side effects, including risks of overuse. A new approach is the use of functional foods, nutraceuticals, or products that are a combination of nutrition and therapy. These include dietary fiber, prebiotics, probiotics, antioxidants, and natural foods, which significantly affect stress management. These foods do more than simply provide basic nutrition; they have bioactive compounds that help maintain brain function, regulate hormones, and promote a general sense of well-being. This literature review looks into various types of functional foods, their health implications, mechanism of action and benefits that can provide a path to optimal use in promoting health and resilience in our increasingly stressful world. Although the present body of research is promising in showing the potential of functional foods in managing stress, there is a need for holistic studies that consider both psychological and physiological outcomes. Future human trials to study the efficacy of nutritional interventions to reduce acute responses to stress need to pay attention to several critical aspects of study design.

Introduction

Stress is the body's reaction to changes in its environment and how it responds to situations that disturb its balance. Anything from people to events can be a stressor. Stress is both a natural response to threats and a psychological way to manage that response, focusing on preparing the body for challenges. Growing awareness of the condition has yielded various explorations for methods of reducing stress both medically and non-medically. The term stress was introduced in healthcare by Canadian endocrinologist Hans Selye in 1949. Stress response is a complex physiological and neurological phenomenon which the human body requires for its survival. Different people react to stress in different ways, depending on their gene makeup, experiences, and social aspects. Stress hormones cause reactions that may be short-term or long-term reactions to stressful situations. Acute stress can be managed and resolved, but chronic stress leads to serious health problems (Asalak et al., 2022).

Stress Neurobiology

Stress activates the HPA axis, leading to higher levels of norepinephrine in the brain, which contributes to stress-related conditions. It is under the influence of CRF that the anterior pituitary secretes ACTH, which increases the production of glucocorticoids and alleviates stress in the body. Glucocorticoids could act in a way that temporarily degrades certain cognitive processes in humans upon stress occurrence. Neurotransmitter GABA is thought to be essential to the mechanisms of stress disorders; however, stress can disrupt the levels of GABA in such a way that it affects the behavior and physiology of an organism. Melatonin is produced in the pineal gland and is involved in the body responding to environmental stressors via the GABA pathway. In addition, dopamine is a neurotransmitter that regulates neuronal function and is expressed under stress, which modifies its various pathways. Norepinephrine is related to the central stress response, especially with regard to depression and immune functions. Stress is also associated with serotonin and psychological disorders; signaling from the brain is influenced by the stress response. Melatonin production could be fuzzy in its effect by stress, yet it could thus be used for stress-related problems and in enhancing vaccine responses. As stress

varies across brain areas, it also involves action of various glutamate receptors (Rice, 2012; Eugeny and Natalia, 2019).

Protective Role of Functional Foods against Oxidative Stress

Functional foods are also essential to combat oxidative stress that is induced by chronic tension. Oxidative stress can be defined as an imbalance of free radicals and antioxidants in the body, which induce cellular damage. Some antioxidant-rich foods, including berries, green tea, and dark chocolate, are rich in compounds like polyphenols, flavonoids, and catechins, which neutralize free radicals (Figure 1). Antioxidants are not only good at combating oxidative damage to the brain but also in reducing inflammation, which usually tends to increase with stress conditions. When one experiences stress, the body releases cortisol, a hormone that prepares us to deal with challenges but can cause harm if persistently elevated. Chronic stress also triggers oxidative stress, damaging cells and accelerating the aging process. In addition, neurotransmitter imbalances, such as lowering levels of serotonin and dopamine, worsen anxiety and depression conditions (Rajeshwari et al., 2014).

Regulation of the hormone cortisol is one of the most important ways functional foods can help in managing stress. This hormone is termed cortisol or the stress hormone and must be maintained at minimal amounts for regulating acute stress. Chronic stress however, high amounts of cortisol in the body will interfere with sleep, lowered cognitive ability, and will weaken the immune system. Cortisol regulation has some foods that contain magnesium, particularly spinach, almonds, and avocados. Magnesium helps to regulate the hypothalamic-pituitary-adrenal or HPA axis, thus suppressing the excessive production of cortisol and allowing relaxation (Jacka et al., 2009). Vitamin C-containing foods, including oranges, bell peppers, and strawberries, dampen the physiological effects of stress by reducing cortisol levels and enhancing immune health (Brody et al., 2002).

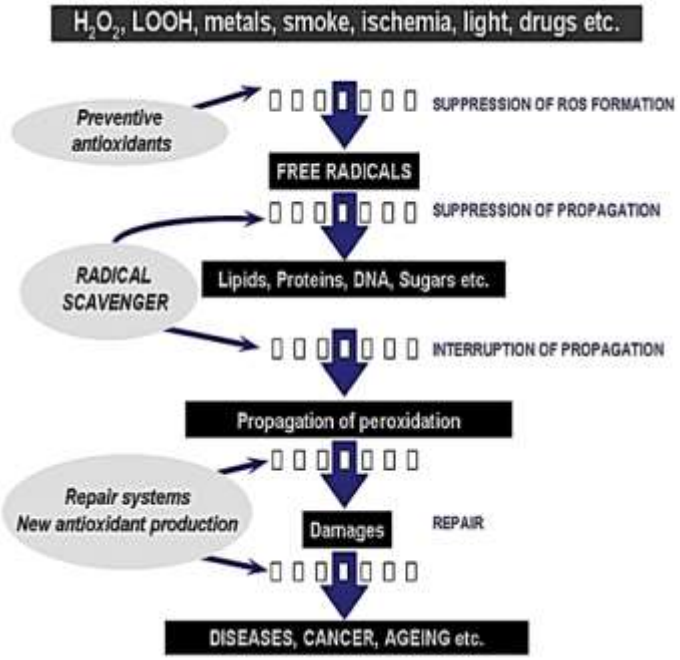

Figure 1. Mechanism of action of Nutraceuticals (Rajeshwari et al., 2014)

Role of Functional foods in Stress Management

Nutraceuticals are gaining significant attention for the safety and benefits of healthiness in supplements or processed foods; they prevent and help in managing diseases through containing beneficial natural source compounds of various chronic inflammatory diseases. Nutraceuticals include dietary supplements, value-added processed foods, and non-dietary supplements such as tablets, soft gels, and capsules containing bioactive ingredients. Nutraceuticals refer to the foods or dietary components that can prevent and treat the diseases. These contain protein, vitamins, minerals, and other compounds from the natural sources. As Nutraceuticals contain phytochemicals, these are beneficial to delay, prevent, and treat chronic inflammatory diseases (Sachdeva et al., 2020; Aslak et al., 2022).

The estimated suffering populations in terms of CVD will be 23.6 million and 40 million diabetics, and 215 million hypertensive populations by 2030. Affluence is one of the causes for lifestyle diseases, which the nutraceuticals and dietary supplements attend to. The consumption of foods such as oats, flaxseeds, soybean,

green tea, citrus fruits, tomatoes, garlic, and nuts, among others, including their corresponding physiologically active constituents, have been associated with mitigating the risk of diseases. People can maximize their health-promotional potential from their diet through the use of supplementation and the development or enrichment of the foods with health-promoting factors. Nutraceuticals and functional food are the vanguard of novel approaches to controlling lifestyle diseases. The health claims of functional foods have to be scientifically established through solid and credible data in the form of well-designed studies showing both safety and efficacy (Sangha, 2014; Khan et al., 2023). Functional foods refer to foods that may provide additional health benefits beyond basic nutrition.

These foods not only promote good health but also lower the risk of diseases, making them a key focus in modern nutrition and healthcare. Known by terms such as "nutraceuticals" and "designer food," functional foods have gained global popularity (Mellentin et al., 2014). Although these functional foods contain very small quantities of bioactive compounds, the health effects of these bioactive compounds were thoroughly studied in rodent models and in clinical settings. Recent epidemiological studies have supported that the consumption of some fruits, vegetables, as well as some animal products rich in bioactive compounds decreases the risk of metabolic disorders and cancer (Karasawa and Mohan, 2018). In 1989, Dr. Stephen De Felice coined the term nutraceutical by merging 'nutrition' and 'pharmaceutical'. He describes a nutraceutical as "any substance that is a food or a component of food that provides medical or health benefits, including disease prevention and treatment. " (Goldstein and Kopin, 2010; Chauhan et al., 2013).

Nutraceutical and Functional foods

According to Hippocrates, the father of modern medicine, "Let food be the medicine, and the medicine shall be the food." This has brought more attention to the health benefits specific foodstuffs may provide and how consumers and food and nutrition scientists have become keener on these benefits of foods (El Sohaimy, 2012). Sometimes, the terms nutraceutical and functional food are equated as being the same, but they are indeed different. Nutraceuticals derive from biologically active compounds that may provide health benefits, and are usually supplemented in addition to food, but functional foods provide their benefit only as food (Jalgaonkar et al., 2019).

Such foods that promote health and nutrition are classified as nutraceuticals or functional foods. Nutraceuticals are isolated, purified, and formulated products that are taken in the form of capsules or pills. Functional foods are a part of a regular diet, which provide physiological benefits beyond basic nutrition. Nutraceuticals are associated with medical claims and may prevent and cure diseases; these include dietary supplements and other specialized foods. Functional foods decrease the incidence of diseases but neither prevent nor treat them. Vitamins, proteins, fats, and carbohydrates are considered essential nutrients or functional foods that are essential for healthy survival. A functional food used in the prevention or treatment of diseases other than anemia is known as a nutraceutical. Nutraceuticals and functional foods play an important role in ensuring a good quality of life (Kalra, 2003).

Nutraceuticals and their therapeutic potential

Epidemiological studies indicate that phytochemicals, which are plant derived bioactive compounds, have a protective effect towards diseases such as cancer, heart disease, hypertension and stroke. It is well known that a number of key groups such as polyphenols and vitamins C and E are major contributors towards the antioxidant properties of plants. These phytochemicals that can manage or neutralize the reactive oxygen species are capable of combating the causes of degenerative diseases (Figure 1) (Rajeshwari et al, 2014). Though they appear naturally in the roots, flowers, leaves, vegetables, fruits and roots as integral parts of plants. Phytochemicals are broadly classified as primary components, these include sugars and proteins while the secondary components are alkaloids flavonoids, and tannins which are the main bioactive agents contributing to the disease prevention properties (Vighnesh et al., 2024).

Classification of Nutraceuticals

Nutraceuticals can be generally classified as products derived from natural sources (nature like) or synthesized (man-made), which supplement the normal diet and help to enhance nutritional quality and safety, besides disease prevention and treatment. Nutraceuticals are categorized as follows:

1. **Based on chemical constituents** (a) Nutrients: Chemical substances having definite nutritional function, namely vitamins, minerals, amino acids, and fatty acids. (b) Herbals: Herbs or botanical products as concentrates and extracts. (c) Dietary Supplement: Dietary supplements are products intended to be ingested by putting them in your mouth, that contain a dietary ingredient that is present in addition to what you normally eat. Examples include black cohosh for menopause symptoms, ginkgo biloba for memory loss, and

glucosamine/chondroitin for arthritis. They also provide specific purposes: sports nutrition, weight-loss supplements, and meal replacements. The ingredients of the supplement include the vitamins, minerals, herbs, or other botanicals, amino acids, enzymes, organ tissues, gland extracts, or other dietary substances. All these forms come in tablets, capsules, liquids, powders, extracts and concentrates (Williamson, 2001).

2. **Traditional and Non-Traditional nutraceuticals**

Nutraceutical foods are not just introduced on the market; there exists a vast assortment introduced that belongs to the genre of traditional food and non-traditional foods.

(a) **Traditional Nutraceuticals**: Under the conventional Nutraceuticals category come foods in which no alteration of the food is done; It is nothing but naturally occurring whole foods with new information about the potential health qualities. There has been no real change to the actual foods, other than the way the consumer perceives them. Many fruits, vegetables, grains, fish, dairy and meat products contain several natural components that deliver benefits beyond basic

Nutrients, be it lycopene in tomatoes, omega-3 fatty acids in salmon, or saponins in soy to even tea and chocolate, have all been touted to possess health benefits in one study or another. Tomatoes and salmon are just two such foods researchers have come across, containing benefits beyond plain, old nutrition: lycopene and omega-3s fatty acids, respectively.

(b) **Non-Traditional Nutraceuticals**: They are the product of agricultural breeding or added nutrients and/or ingredients like orange juice fortified with calcium, cereals with added

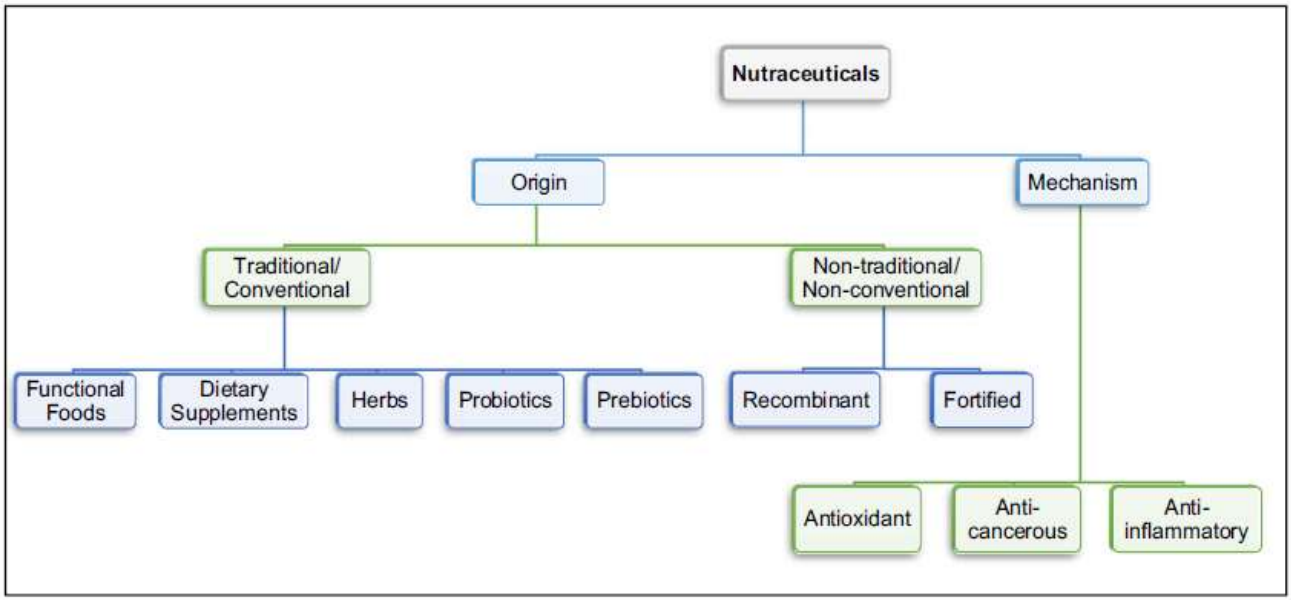

Figure 2. Nutraceuticals according to their origin and mechanism
(Anand and Bharadvaja, 2022)

vitamins or minerals and flour with added folic acid are nonconventional nutraceutical. Agricultural scientists successfully have come up with the techniques to boost the nutritional content of certain crops. Research currently is being conducted to improve the nutritional quality of many other crops (Figure 2) (Anand and Bharadvaja, 2022; Khan et al., 2023).

Protective foods as Functional food

Fruits and vegetables are very rich in nutraceuticals, which include vitamins and minerals, fibre, and phytochemicals. The primary phytochemicals include flavonoids of berries and carotenoids from carrots, apart from phenolic acids from citrus fruits. These have antioxidant and anti-inflammatory activity and provide cardio-protection. Dietary fibers in fruits belonging to the family of apples as well as in vegetables belonging to the family of broccoli improve the gut health and regulate blood sugar and cholesterol. Specific bioactive compounds, such as lycopene in tomatoes, anthocyanins in blueberries, and sulforaphane in cruciferous vegetables, have been found to inhibit chronic diseases related to the occurrence of cancer, cardiovascular disease, and diabetes. A lot of studies have been conducted to ascertain the role of these nutraceuticals in the prevention of diseases. For example, polyphenols found in apples and berries activate glucose metabolism, and nitrates found in leafy greens make it easier for blood pressure reduction. Sulforaphane in broccoli therefore

controls detoxification enzymes, inhibits tumorigenesis and therefore plays anti-cancer activities. Other antioxidants in fruits, berries and green vegetables give protection to neurons preventing neuro-degenerative disorders. The bioactive compounds therefore have a natural, effective support mechanism for showing interest in healthiness and ailment prevention through ingestion, thereby indispensable for any diet (Lobo et al., 2010).

Nuts as Functional food

Nuts are a good source of bioactive compounds, essential nutrients, and health-promoting properties. In addition, nuts are rich in proteins, dietary fibers, vitamins, such as vitamin E, B vitamins, and minerals, such as magnesium, potassium, and calcium, which will keep the metabolic functions, immunity, bones, and cognition working properly. In addition, bioactive compounds found in nuts include such things as omega-3 fatty acids in walnuts, supporting brain health and reducing inflammation and improving cognitive functions. Nuts are believed to manage weight since they are calorie-dense due to their satiating effect and regulating hunger. This is because of the overall healthy fats, fiber, and proteins contained in nuts that acts together to control appetite and decrease the overall intake of calories. Furthermore, studies have shown that regular nut consumption decreases oxidative stress, enhance blood sugar regulation, and is hence beneficial to those with or at risk of having type 2 diabetes. They contain healthy fats, mainly monounsaturated and polyunsaturated fatty acids, that help improve heart health by reducing bad cholesterol levels (LDL) and boosting good cholesterol (HDL). These Nuts, when consumed as part of a balanced diet, are a natural and effective way to improve overall health and prevent chronic conditions, making them functional foods with significant nutritional and therapeutic value (Basu et al., 2014).

Functional foods of Animal origin

Fish products are rich in polyunsaturated fatty acids, mainly eicosapentaenoic acid and docosahexaenoic acid (DHA). DHA is essential for the structure and function of brain and retinal cell membranes, and it plays a crucial role in the developmental needs of children. Extensive research showed that fatty acids such as DHA can contribute positively to inflammation diseases, among them arthritis, psoriasis, and more chronic diseases like cancer and heart attack. DHA may also potentially protect against the development of certain neurological disorders. Probiotics, which is a live bacteria, improves gastrointestinal health and, besides being anti-carcinogenic and anti-cholesterolemic, has demonstrated its ability in fighting intestinal pathogens. Often naturally occurring in milk and other processed foods, probiotics are crucial in the market of functional food. They will inhibit the pathogen growth mechanisms through several approaches, such as pH alteration and stimulation of immunity. There was a gut imbalance in autistic children, and in comparison, less Bifidobacterium and more Clostridium spp. have been found in them. Probiotics could help in this regard, potentially being useful in the treatment of conditions such as autism and Alzheimer's disease (Wergeland et al., 2012; Begum et al., 2017).

Herbs and Spices as Functional food

Herbs are an important constituent of the functional food category because of their bioactive compounds, which enhance health. Examples include rosemary, oregano, turmeric, and garlic, which contain a high level of phytochemicals like flavonoids and phenolic acids. Such compounds reduce oxidative stress and inflammation, contribute to heart health, and aid in the prevention of diseases. Herbs have specific benefits for different health areas (Shahidi and Ambigaipalan, 2023). Herbs and spices have been appreciated not only for their use in food preparation but also for health benefits, through bioactive compounds such as antioxidants and phytochemicals. Of the common herbs used are basil, rosemary, and oregano, and spices turmeric, ginger, cinnamon, and garlic, which have been associated with the prevention of chronic diseases. For instance, curcumin, in turmeric, is an anti-inflammatory and antioxidant, and gingerol, in ginger, has been proven to stimulate digestive processes. Cinnamon may actually enhance blood glucose regulation (Figure 3) and garlic exhibits cardiovascular effects on lowering blood pressure and cholesterol level. Such exogenous substances would also impact several biological activities underlying disease prevention while showing anti-inflammation, antimicrobial activity, and inhibiting cancer progress. H phenolics like rosemary and oregano have probably immense health benefits, may enhance their cognitive functioning, and act as a barrier against neurodegenerative diseases and thereby supporting their status as good functional foods that may provide general welfare (Rajeshwari et al., 2014; Bohn et al., 2015). Garlic lowers blood pressure and cholesterol, while ginger and peppermint give relief to digestive disorders by reducing nausea and indigestion. Immune-supportive herbs, like echinacea, decrease the severity of infections and enhance immune function. Such properties make herbs versatile ingredients in teas, supplements, and fortified foods that cater to diverse dietary and health needs (Sharma et al., 2023).

Health Benefits of Functional Foods and Nutraceuticals

The core content of functional foods for health benefits comes from natural bioactive molecules: curcumin, resveratrol, quercetin, sulforaphane, epigallocatechin, lycopene, and ellagic acid. Curcumin is a well-studied bioactive compound within the Curcuma longa, also known as turmeric. This compound possesses many antioxidant and anti-inflammatory effects (Sneharani, 2019). Resveratrol, present in grapes and pomegranates, exerts beneficial effects on vascular function, immunity, and gut microbiota modulation (Chaplin et al., 2018). The neuroprotective ability and the ability to avert neurodegenerative diseases have been attributed to quercetin, the most abundant flavonoid of apples (Elumalai and Lakshmi, 2016). Sulforaphane, a compound found in cruciferous vegetables like broccoli, cabbage, and kale, activates the Nrf2-ARE pathway, thereby maintaining redox balance and preventing oxidative stress. Sulforaphane also regulates xenobiotic-metabolizing enzymes that decrease the likelihood of carcinogen-induced DNA damage (Figure 4 and 5) (Juengel et al., 2017; Essa et al., 2024). *In vivo* experiments showed antioxidant role of coriander seeds as reflected by increased serum non-enzymatic and erythrocyte enzymatic antioxidants and very effectively reduced lipid peroxidation in erythrocytes and plasma in type 2 diabetes patients (Rajeshwari and Andallu, 2011). Aniseeds (*Pimpinella anisum*) (Rajeshwari et al., 2011) (5g/day) and mint leaves (*Mentha spicata*) were administered to two different groups of NIDDM patients for 60 days, encountered oxidative stress by significantly decreasing lipid peroxidation, protein oxidation and decreasing the activity of erythrocyte catalase (CAT), increasing serum beta- carotene, vitamin A, E and C in both the groups of diabetics. Besides, the treatments increased the activity of erythrocyte antioxidant enzyme, i.e. glutathione-S-transferase (GST) and reduced glutathione (GSH) content (Rajeshwari et al., 2012).

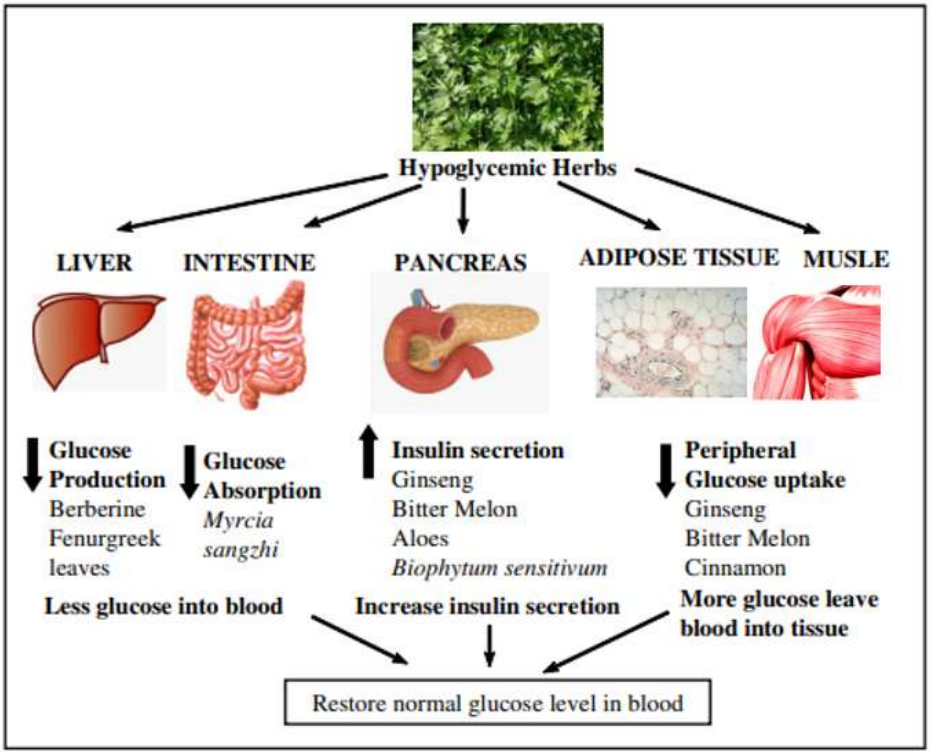

Figure 3. Action sites of herbs in diabetes treatment
(Hui et al., 2009; Rajeshwari et al., 2013)

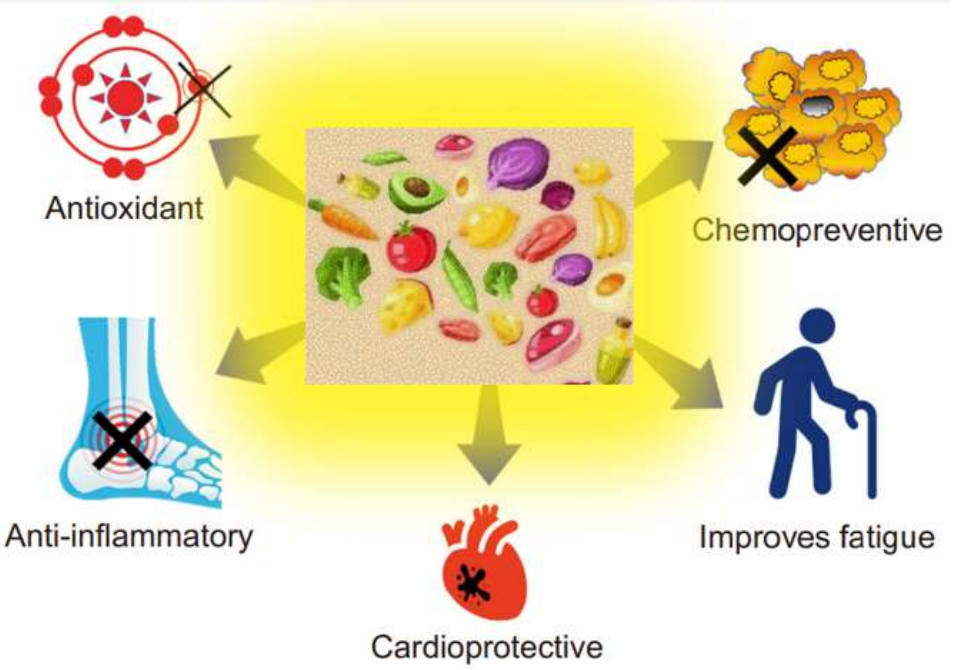

Figure 4. **Health benefits of Functional Foods** (Essa et al., 2024)

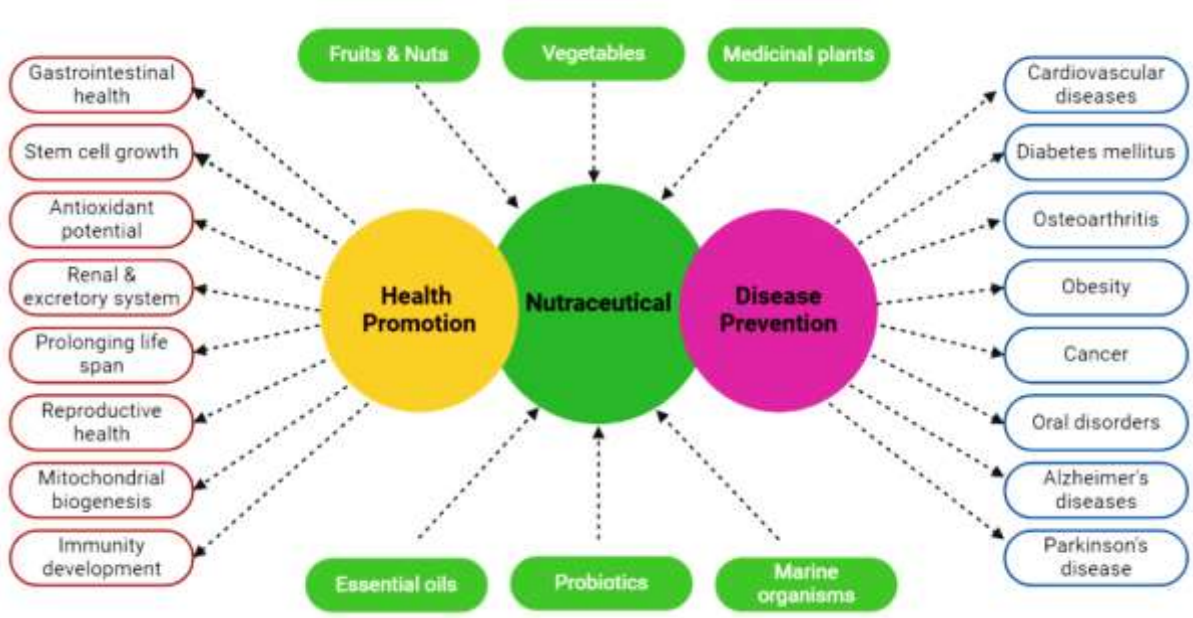

Figure 5. **Health benefits of various nutraceuticals in Functional Foods**
(Rajeshwari and Varsha, 2024; Vighnesh et al., 2024)

Role of Functional foods in Stress Management

Functional foods are important in stress management because they provide the body with necessary nutrients and bioactive compounds that help regulate the body's response to stress. Stress triggers the release of hormones such as cortisol and adrenaline, which, if sustained, can lead to adverse health effects like anxiety, depression, heart disease, and immune dysfunction. Some functional foods, including certain fruits, vegetables, nuts, seeds, and herbs, have therapeutic properties that help relax, reduce inflammation, and promote overall well-being. Key nutritional components in these foods, such as omega-3 fatty acids, magnesium, B vitamins, and antioxidants, are particularly effective in stress management. Omega-3 fatty acids, found in fatty fish and walnuts, can reduce inflammation and lower cortisol levels. Foods rich in magnesium, like dark leafy greens, are good for regulation of the nervous system and reduce muscle tension. B vitamins present in whole grains are important in the synthesis of neurotransmitters and influence mood. Additionally, berries and green tea contain antioxidants, which fight oxidative stress (Kris-Etherton et al., 2004).

Ashwagandha, chamomile, and lavender herbs further promote stress relief; thus, diet rich in such functional foods becomes vital for boosting resilience to the challenges of everyday life (Table 1) (Sharma et al., 2023). Another critical mechanism is the promotion of neurotransmitter balance, particularly serotonin and dopamine. Functional foods address the underlying causes of stress, including hormonal regulation, reduction of oxidative stress, and neurotransmitter balance, these foods handle short-term and long-term stress (Khan et al., 2023). These neurotransmitters are very important in mood regulation and emotional stability. Tryptophan is an amino acid found in turkey, eggs, and cheese, which serves as a precursor to serotonin synthesis. Tryptophan intake into the body elevates serotonin levels in the brain, making people feel calmer and reducing anxiety (Markus et al., 2000). Of course, omega-3 fatty acids also enhance neurotransmitter function by reducing neuroinflammation and enhancing dopamine signaling, an important mediator for motivation and pleasure (Hibbeln, 2002). Another important pathway through which functional foods influence stress is the gut-brain axis. The gut microbiome is a complex community that lives in the digestive tract. It communicates with the brain through neural, hormonal, and immune pathways. Foods high in probiotics, such as yogurt and kefir, bring good bacteria to the gut. Prebiotics in garlic and onions fuel these micro-organisms, while bananas are a good source. Good mood, reduced anxiety, and resilience to stress are linked with a healthy gut microbiome. This shows why functional foods that support gut health are important (Cryan and Dinan, 2012).
Adaptogenic herbs are pretty potent among the functional foods to enhance resilience in the body against stress. Examples of adaptogens include ashwagandha, ginseng, and *Rhodiola rosea*, which have been shown to modulate the HPA axis, stabilize cortisol levels, and enhance energy without overstimulating the system. It has diminished cortisol levels substantially in clinical research, in conjunction with enhanced levels of self reported stress levels to be effective at reducing natural avenues to alleviate it without traditional modes (Chandrasekhar et al., 2012). Functional food helps enhance quality sleep. Other than poor quality of sleep contributing to adding fuel to stress levels, most suffering from impairment sleep-wake cycle stress-relatedly. Tart cherry and walnut comprise rich sources of melatonin in diet. Melatonin is the hormone that controls the quality of sleep; therefore, foods with high contents of magnesium and tryptophan should be among the best. Better-quality sleep would help the body recover faster from stress-related impacts and balance its emotions (Pandi-Perumal et al., 2006; Rondanelli et al., 2013).

Table 1. Various nutraceuticals and their role in managing stress (Sharma et al., 2023)

S.No.	Phytochemicals	Mechanism of action
		Polyphenols
1.	Resveratrol	Activates the SIRT1 pathway, enhancing mitochondrial function and reducing oxidative stress.
2.	Epigallactocatechingallate	Modulates NF-κB pathway, reducing pro-inflammatory cytokine production and enhancing antioxidant enzyme expression through Nrf2 pathway activation.
		Flavonoids
3.	Quercitin	Scavenges ROS inhibits NF-κB pathway and enhances antioxidant defencesthrough Nrf2 pathway activation.
4.	Luteolin	Modulates NF-κB and MAPK pathways, inhibiting pro-inflammatory cytokine production and enhancing antioxidant defencesthrough Nrf2 pathway activation.
		Adaptogens
5.	*Rhodiola rosea*	Modulates cortisol levels, and enhances mood and cognitive function by HPA axis modulation.
6.	Ashwagandha	Modulates HPA axis, reduces cortisol levels, and bolsters antioxidant defences.
		Triterpenoid saponins
7.	*Ginkgo biloba*	Enhances cerebral blood flow, reduces oxidative stress, and improves cognitive function.
8.	Astragalus	Bolsters immune function, reduces inflammation, and supports stress resilience.
		Other nutraceuticals
9.	Omega-3 Fatty acids	Modulate neurotransmitter systems, reduce inflammation, and promote cognitive health.
10.	B-vitamins	Support cognitive health and alleviate stress by modulating neurotransmitter systems.

Practicality and enjoyment follow the incorporation of functional foods in diets. Spinach, yogurt, berries, and flaxseeds can be mixed for a smoothie at the start of the day, which fills the meal with nutrients, ensuring resilience under stress. Fatty fish, whole grains, and colorful vegetables constitute lunch and dinner, thereby ensuring sufficient intake of essential nutrients. Some of these munchies will be little handfuls of nuts or tiny pieces of dark chocolate. This will meet the sweet cravings and reduce tension levels. Other potential evening routines can include herbal teas like chamomile or green tea being drunk to lull the day into a state of calmness. Thus, functional foods could be considered a vital and scientifically proven approach towards the management of stress. They reduce the immediate impact of stress by attacking its physiological and biochemical underpinnings, thus building up resilience over time. As ongoing research continues to discover the complicated relationship between diet, the brain, and stress, functional foods form an important aspect of healthy and balanced lifestyle choices (Khan et al., 2023).

For example, omega-3 fatty acids, found in high quantities in fatty fish like salmon and mackerel, as well as plant-based sources like chia seeds and walnuts, play a vital role in maintaining brain health. Healthy fats reduce inflammation in the brain and promote proper neurotransmitter function, such as serotonin and dopamine, which are crucial for maintaining a positive mood. Studies have repeatedly demonstrated that habitual intake of omega-3-rich foods is associated with decreased symptoms of anxiety and depression (Logan, 2004; Hibbeln, 2002). Another interesting area where functional foods shine is the connection between gut health and mental well-being. Probiotic-rich foods like yogurt, kefir, and fermented vegetables like kimchi and sauerkraut introduce beneficial bacteria to the gut, while prebiotics, found in garlic, onions, and bananas, serve as food for these microbes. This dynamic duo improves gut health, which is closely tied to the brain through the gut-brain axis. Studies have shown that a healthy gut microbiome can decrease anxiety, improve mood, and enhance resilience to stress (Cryan and Dinan, 2012; Mayer et al., 2014).

Magnesium is, in fact a very important component of functional food and is, in fact a "stress-neutralizing mineral" as well. Dark chocolate, spinach, almonds, and avocado are rich magnesium sources that could help to smoothen off cortisol levels so that the body's nervous system is relaxed at all times. Magnesium is usually associated with stress and high anxiety, mainly because its deficiencies are linked with heightened feelings of stress and anxiety (Jacka et al., 2009). Foods rich in antioxidants-berries, nuts, and green tea-help to neutralize some of the oxidative stress chronic tension elicits in the body. Antioxidants are shown to reduce inflammation and support brain function. Adaptogenic herbs such as ashwagandha and Rhodiola rosea are therefore highly valuable herbs for those naturally seeking relaxation. These herbs have been used for centuries to help one's body adapt to stress, regulate cortisol, and optimize energy levels without causing overstimulation. According to clinical trials, ashwagandha supplementation significantly reduces cortisol levels and some symptoms of stress (Chandrasekhar et al., 2012).

The other important types of functional foods are those containing high amounts of vitamin C- containing foods: oranges, kiwi, bell peppers. It enhances the functioning of the immune system and even decreases cortisol to allow the body to recover more quickly from stress. Foods rich in tryptophan-a chemical found in turkey, eggs, and cheese-increase levels of serotonin, the "good feeling" neurotransmitter. This encourages a sense of rest, better quality sleep, and overall emotional control (Markus et al., 2000).

These functional foods can be easily incorporated into daily life and prove very rewarding. A smoothie of spinach, berries, yogurt, and flaxseeds is a nutrient-rich breakfast. A handful of nuts or a piece of dark chocolate always satisfies and does good. Meals that contain fatty fish, whole grains, and colourful vegetables will show how delicious it is to nourish the mind and body. A warm cup of herbal tea like chamomile or green tea at night can send one to sleep at the end of a long day (Khan et al., 2023). Scientific research further supports the determinant role diet plays in stress management. Other research demonstrates that fermented food decrease social anxiety (Hilimire et al., 2015), as well as omega-3s, and adaptogens, which lower cortisol levels within the body (Hibbeln, 2002; Chandrasekhar et al., 2012). This growing body of evidence underscores the profound influence of what we eat on our mental health.

Challenges

Although many functional foods show promise, their standardization of bioactive components still poses a challenge because cultivation, processing, and formulation vary. An appropriate dose can help ensure that health benefits are gained without certain adverse effects. Traditional knowledge justifies the efficacy of herbs, but science should come through in clinical trials to give a strong foundation to claims of good health. However, proper standardization and safety evaluation together with continued research are essential for the optimization of their use in functional food systems. Now, the research efforts of academic, government, and private research institutes around the world are being focused on identifying how functional foods and food ingredients might

be useful in preventing chronic diseases or optimizing health and thereby reducing healthcare costs and improving the quality of life for many consumers (Sharma et al., 2023).

Future prospects

Future foods, supplemented with other nutrient or non-nutrient components, could potentially prevent chronic diseases like heart disease, osteoporosis, or cancer. Functional foods are not just something to fill your belly; they are a means to fight against stress. If functional foods are integrated into a healthy and mindful diet, then building resilience, lifting mood, and achieving greater calm becomes achievable. Right nutrition is the foundation of a healthier, more balanced life in an overwhelming world. Now, people are more interested in a healthy diet so that they can prevent the onset of the disease through the food they intake rather than depending on medicines for treatment. With this belief and support from internet in terms of advantage of various nutraceutical, their demand has intensified over the last 20 years. Although self-medication turns fatal many times, with experts' help and detail information present on the internet; it is a trend now (Shahidi and Ambigaipalan, 2023). With this trend, along with drug development being costlier, it will be imperative for companies to switch to more novel and value-effective nutraceutical products for manufacturing.

Just like personalized medicine, nutrigenetics can be developed to analyze the difference in. This might be due to the difference between two genetically diverse individuals' responses to the administered nutraceutical to propose a customized nutraceutical. A greater domain of nutrigenomics could also be opened to recognize the nutraceutical's action on transcription and translation after genomics interaction for the best preventive measure. Much interest has lately been triggered about nutrigenomics as there had been statements and announcements stating that an almost complete rough draft of the human genome was available for general access and viewing. Nutrigenomics (a discipline concerned with the investigation of interactions between diet and development of diseases based on a person's genetic profile) will deeply impact future work in disease prevention, including the future of the functional foods industry (Falk et al, 2002). Meanwhile, increased government funding can be expected for quality and safety assurance of nutraceuticals and research to check their efficiency against life-threatening diseases. Biotechnology is the other technology that will change the future of functional foods.

Recent examples of biotechnology-derived crops, which hold enormous potential to improve the health of millions around the world, are golden rice and iron-enriched rice. These grains have been genetically engineered to provide elevated levels of iron and β-carotene that could potentially eradicate iron deficiency anaemia and vitamin A deficiency-related blindness worldwide. Further research will need to identify and establish critical bottlenecks in production systems and, for example, point out opportunities that will provide rural employment as well as a competitive advantage to small-scale farmers as producers of nutraceuticals (Williamson, 2001; Falk et al, 2002).

Conclusion

In conclusion, functional foods play a significant role in dealing with stress by providing the body with necessary nutrients and bioactive compounds, which aid in proper response to stress. With incorporated foods rich in omega-3 fatty acids, antioxidants, vitamins, and minerals, functional foods can help in modulating the effects of stress, reducing inflammation, and thus improving emotional well-being. However, while functional foods have great potential for improving public health, there are concerns over the scientific basis for their promotion. Health benefits should be based on rigorous safety and efficacy studies, including understanding interactions with other dietary components and pharmaceutical agents. Consumers should realize that functional foods are not a panacea for poor health habits; a holistic lifestyle approach to diet, exercise, and stress management is essential. Effective utilization of functional foods requires a concerted effort from academia, industry, government, and research institutions to fight lifestyle diseases through education and promotion of healthful eating practices.

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