

Functional Food Role in Health Promotion and Diseases Prevention

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ABSTRACT:

Research shows that socioeconomic status and health are related, with those with lower socioeconomic status being more likely to suffer from noncommunicable diseases. Diabetes and cardiovascular disease are two chronic diseases that can be prevented by diet, including plant-based foods. Polyphenols and other phenolic compounds reduce the risk of cholesterol and provide protection against neurodegenerative diseases. Antioxidants and functional foods can also help people lose weight. The primary nutrients in edible plants are proteins, fats and oils, minerals, vitamins, carbohydrates (which can be a mix of free sugars or starch), and organic acids. Antinutrients include cyanide, trypsin inhibitors, tannic acid/tannin, and phytic acids (phytate). Animal research suggests that a neurotoxin that causes Parkinson-like disease is competitively inhibited by a class of polyphenols called epigallocatechin gallate (EGCG). By triggering signaling pathways essential for cell survival, EGCG may also shield neurons. The widespread use of turmeric, which contains the polyphenol curcumin, has been suggested as a potential reason for India's low rate of Alzheimer's disease. Curry contains turmeric.

KEYWORDS:

Socioeconomic Status; Noncommunicable Diseases; Diabetes; Cardiovascular Disease; Plant-Based Foods; Polyphenols; Phenolic Compounds; Antioxidants; Functional Foods; Neurodegenerative Diseases; Epigallocatechin Gallate (EGCG); Curcumin; Turmeric; Antinutrients; Phytochemicals.

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INTRODUCTION

Pandemic, noncommunicable diseases (NCDs) were widespread and a significant public health issue, even in developing nations. In developing nations, the "epidemiologic transition" from infectious diseases to non-communicable diseases (NCDs) is linked to several risk factors, primarily related to economic development (Adogu et al., 2015). These include consuming foods high in saturated fats, salt, and sugars; consuming little fruit, vegetables, and fiber (Martins et al., 2024). The term "nutrition," which comes from the Latin word "nutrient," which means "to nourish," refers to the result of all the processes by which organisms obtain, process and use nutrients to support all functions of life. Food consumption, digestion, assimilation, biosynthesis, catabolism, and removal are all included (Thakur et al., 2019). Carbohydrates (which can be a combination of free sugars or starch), proteins, fats and oils, minerals, vitamins, and

organic acids are the main nutrients found in edible plants. Tannic acid/tannin, cyanide, trypsin inhibitors, and phytic acids or phytate are examples of antinutrients (Thakur et al., 2019). Frequent consumption of fruits, vegetables, and other plant-based foods may reduce the chance of many chronic diseases, such as diabetes, cardiovascular disease, and cancer. Many naturally occurring bioactive substances found in vegetables and fruit work well as agents to delay the onset of inflammation and oxidation. The advantages that each pure bioactive compound offers can be increased by combining them or by collecting them from food sources (Zhou et al., 2022). Researchers are focusing on preventive treatments for certain diseases because there are currently insufficient tools for early detection or appropriate treatments. Researchers are searching for remedies in this scenario by concentrating on dietary and nutritional models, like the Asian or Mediterranean diets. Dietary habits like

these could lower the risk of aging-related diseases brought on by shifting lifestyles (Trajkovska Petkoska et al., 2025). Plant sources such as fruits, vegetables, seeds, herbs, and legumes are the foundation of the plant-based Mediterranean and Asian diets, according to PubMed (Sam-Yellowe, 2024). These diets place an emphasis on leading a healthy life and highlight the prospective role of polyphenols, which are the naturally occurring components of plants that show their nutritional value, in preventing aging and disease (Obrenovich et al., 2010). Food contains a wide range of nutrients essential to life and many bioactive molecules or components that can promote health and prevent disease. The dietary guidelines recommend a healthy lifestyle consisting of high levels of plant-based food consumption, including the consumption of 400 g or higher levels of fruits and vegetables per day (Craig et al., 2021). There is no doubt that lifestyle factors have an impact on the development and course of some diseases. One of the most significant factors influencing health is nutrition and research indicates that diets rich in fruits and vegetables can help prevent a variety of illnesses (Liu, 2013). The presence of secondary metabolites, also known as phytochemicals, in fruits and vegetables may be essential, even though the mechanisms underlying these effects have not been fully understood (Poiroux-Gonord et al., 2010). A number of these phytochemicals have the capacity to disrupt cellular processes, modify the activation of transcription factors that control gene expression, and alter cellular metabolism in various ways. As a result, fruits and vegetables and their alleged health-promoting qualities have drawn more scientific attention during the last 20 years (Tomas-Barberan & Gil, 2008). Millions of plant, marine, and microorganism species contain phenolic compounds, a group of non-nutritional bioactive compounds that have been thoroughly investigated for their pharmacological and functional effects on humans over the past 20 years (El-Saadony et al., 2025). Most of the studies focus on optimization of extraction of these secondary metabolites, in addition to their in vitro antioxidant, antihypertensive, anti-inflammatory, antipyretic, anti-hemolytic effects on human erythrocytes, hypolipidemic and anti-proliferative effects which have been demonstrated by various in vitro and in vivo pharmacological studies (Srirangan & Sabina, 2025). It has been demonstrated how they contribute to the distinct sensory and organoleptic qualities of fruits, vegetables, and beverages, including their flavor, color, astringency, and taste (Kader, 2008).

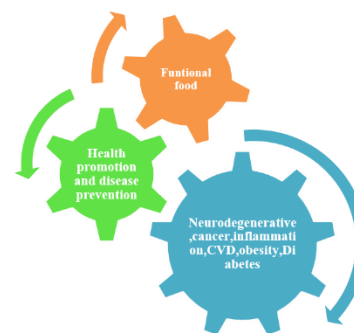


Figure 1: Health and Functional Foods

DISEASE PREVENTION BY FUNCTIONAL FOODS

Neurodegenerative Diseases

Some of the polyphenols can provide protection against neurodegenerative diseases as summarized in figure 1 like Huntington, Parkinson and Alzheimer disease. Resveratrol in 3-4 glasses of wine each day was found to be associated with an 80 percent decrease in the incidence of dementia and Alzheimer's disease in comparison to non-drinkers in a population-based prospective study in the Bordeaux region (Reale et al., 2020). Other epidemiologic studies have found that red wine that is taken weekly or monthly can reduce the risk of neurodegenerative diseases. Curcumin, resveratrol, and catechins (such as epigallocatechin gallate, or EGCG) could provide protection against dementia and Alzheimer-like diseases through antioxidant, immunomodulatory and scavenging effects that protect neurons and inhibit the neurotoxicity of the beta-amyloid protein, the accumulation of which is implicated in the development. The basic mechanism through which polyphenols inhibit neurotoxicity and exert a neuroprotective effect against neurodegenerative diseases, including Alzheimer disease, Parkinson disease, and Huntington disease is thought to be the iron-chelating activity of EGCG, curcumin, myricetin, ginsenosides and ginkgetin but not beer and spirits, the other alcoholic beverages studied (Li et al., 2024). Animal research shows that a group of polyphenols called epigallocatechin gallate (EGCG) competitively inhibited a neurotoxin that causes Parkinson-like disease. By triggering cell survival signaling pathways, EGCG may also shield neurons (Hor et al., 2020). Because of its widespread use, turmeric, that is present in curry and have the polyphenol curcumin, has been suggested to help explain India's low rate of Alzheimer's disease. The results of a study, older South Asian participants who regularly ate curry had better cognitive function than those who didn't (Reddy et al., 2018).

Cancer

Flavonoids that may neutralize free radicals and reduce the risk of cancer by stopping the growth of cells in tumors (Zahra et al., 2024). Polyphenols have been shown to have positive effects on certain cancer types, including breast, prostate, colon, endometrial, and epithelial cancers Origins, purposes, and the results of various functional foods in

preventing cancer as summarized in figure 1 & table 1(Maiuolo et al., 2021).

Inflammation

By reducing oxidative stress and modulating inflammatory responses by mitigating cytokine pathways, phenolic compounds can prevent localized and/or systemic inflammation (Liu et al., 2024). Engagement with the Gut Microbiota: Potential interactions between polyphenols and gut microbiota are a growing area of interest in the field. It is thought that polyphenol metabolites may inhibit invasive species while promoting beneficial gut bacteria, though the exact mechanisms are still unknown (Edwards et al., 2017). A drink made with blueberry extract has been shown in studies to increase the presence of good bifidobacteria, while green tea extract has been shown to modulate bacteria such as *Salmonella typhimurium*, *Escherichia coli*, and *Clostridium difficile* (Bao & Wu, 2024).

Cardiovascular health

In the US, over 68 years since 1918, cardiovascular disease (CVD) has been the major reason of death each year. The future of this crippling disease is also bleak as the twenty-first century looms over the horizon since CVD is the main cause of death compared to the 14 leading causes of death (Crisp, 2010). In 1997, over 960,000 people die of cardiovascular disease, which is the cause of one in every 2.4 and one death every 33 seconds. Luckily, people are starting to eat foods that lower cholesterol and, therefore, the risk of cardiovascular disease (CVD) as more people (1000) from PREVENTION magazine and the Food Marketing Institute said that they bought foods to reduce their cholesterol (Yu et al., 2018). Functional foods are foods which have health advantages beyond just nourishment because they contain physiologically active food ingredients as discussed in table 1.

Table 1: Effects and Functions of Functional Foods

Functional foods	Dietary Sources	Function	Effects
Alpha carotene	Yellow-orange and dark green vegetables	Antioxidant agent	Gap functional intercellular communication is improved with a moderate dose increase.
Beta carotene	Green leafy vegetables and orange and yellow fruits and vegetables	Antioxidant agent	Like α -Carotene
Lycopene	Tomatoes, watermelon, apricot, peaches	Antioxidant agent	Lycopene is more effective in suppressing cell proliferation of several human cancer cell lines than α and β -carotene.
Lutein	Dark green leafy vegetables	Antioxidant agent	Lutein also induces cell cycle and suppresses the growth of various types of cancer cells.
Beta Cryptoxanthin	Citrus fruits	Antioxidant agent	Anti-inflammatory effects; inhibit risks of various cancers
Astaxanthin	Green algae, salmon, trout	Antioxidant agent	Modifies the gap junction communications
Canthaxanthin	Salmon, crustacea	Antioxidant agent	radical Free scavengers and powerful quenchers of reactive oxygen species.
Fucoxanthin	Brown algae, heterokonts	Antioxidant agent	Anti-cancer and anti-inflammatory
Isothiocyanates	cauliflower, kale, Broccoli,	Antibacterial agent	Reducing risk of lung, breast, liver, esophagus, stomach, small bowel and colon cancer.

Research indicates that these interactions may also influence possible effects on the risk of chronic diseases, including enhanced insulin sensitivity and polyphenols' hepatoprotective and atheroprotective properties. The evidence is growing that phenolic compounds can enhance the beneficial effects of probiotics (Gasmi et al., 2022). The bioavailability of polyphenols and the possible interactions of related metabolites, either the phase II metabolites or those produced by the gut microbiota, with systemic tissues in both in vitro and in vivo models need further investigation (Mahdi et al., 2025).

The American Dietetic Association released the last position paper on functional foods which says nutrient enriched and fortified foods are examples of functional foods that have a potentially positive impact on health when eaten in a diverse diet on a frequent basis and at effective levels. It has been found in this review that recent research on the beneficial effects of ten functional foods in decreasing the risk of CVD has focused on clinical research: soybeans, oats, psyllium, flaxseed, garlic, tea, fish, grapes, nuts, and margarine fortified with stanol and sterol ester (Asgary et al., 2018). Functional foods are not only foods which simply fulfill a

basic nourishment role, but also those with health advantages like reducing the high blood levels of low-density lipoprotein (LDL) and total cholesterol (TC). A report by International Life Sciences Institute found that Foods high in flavonoids has been linked to several vascular health benefits including platelet less activity, enzyme regulation, anti-inflammatory action, heart health and lower blood pressure by preventing cholesterol oxidation (Vazhappilly et al., 2019).

Diabetes

Several polyphenolic compounds, anthocyanins being the most well-established are linked to the prevention and treatment of type 2 diabetes by shielding beta cells from the harmful effects of glucose, having anti-inflammatory and antioxidant properties, slowing the digestion of starches, and regulating and changing the transport of glucose to improve glycemic control (Cámara et al., 2022). Mellitus diabetes It is not clear whether increasing your intake of fruits and vegetables can put you at a higher risk of developing type 2 diabetes. It was found that three or more portions of fruits or vegetables per day did not significantly reduce the risk of type 2 diabetes but intake of antioxidants which were mainly vitamin E reduced the risk by 13 per cent. It is analyzed by 5 cohort studies of fruit and vegetable consumption and risk of developing type 2 diabetes in 167 128 study subjects and 4858 cases of type 2 diabetes occurrence with 13 years of mean follow-up. (Halvorsen et al., 2021). It was found that eating five or more servings of fruit and vegetables each day was associated with a 0.96 (95% CI, 0.79–1.17, $P = 0.96$), 1.01 (0.88–1.15, $P = 0.88$), and 0.97 (0.86–1.10, $P = 0.59$) relative risk of type 2 diabetes. Eight cohort studies on antioxidant intake and diabetes risk (139, 793 participants and 8,813 cases of incident type 2 diabetes with a mean of 13-year follow-up) reported the relative risk (highest versus the lowest antioxidant intake) of 0.87 (0.7930.98, $P = 0.0$). In a population-based prospective study 64,191 Chinese women with valid dietary data and no type 2 diabetes or other chronic illnesses at the time of study recruitment. It is discovered that fruit and vegetable intake is positively associated with the incidence of type 2 diabetes (T2D). All the vegetable groups were observed to contribute significantly and negatively correlated risk of T2D, but not the intake of fruits (Jiang et al., 2020).

Obesity

Anti-obesogenic polyphenols, including curcumin, resveratrol, catechins, could potentially enhance weight loss maintenance by decreasing inflammation, lipogenesis, adipocyte oxidation, and enhancing energy expenditure. By interacting with and blocking digestive enzymes, a variety of polyphenols have been demonstrated to have protein-binding qualities that can prevent the gastrointestinal tract from breaking down proteins, fats, and carbohydrates (Cirkovic Velickovic & Stanic-Vucinic, 2018). Many cellular, animal, and human studies have examined the effect of polyphenols on weight status. Because polyphenol-rich foods are energy-dense and thus nutrient-dense, they may

lead to lower total calorie consumption, making the association between obesity and polyphenol consumption complex in population-based research. Besides inhibiting inflammation and enhancing lipolysis, some polyphenolic compounds can also inhibit the creation, maturation, and multiplication of adipocytes, based on in vitro and randomized controlled studies. EGCG and other catechin polyphenols have been linked to anti-inflammatory, anti-mutagenic, and antioxidant properties (Rodríguez-Pérez et al., 2019). Even though there is evidence that the effect of green tea on fat oxidation could be attributed to the fact that caffeine is consumed together with it, catechins are believed to avoid weight gain by supporting energy expenditure and fat oxidation (60). In a meta-analysis of eleven randomized studies, participants randomly assigned to take green tea were more likely to preserve their weight loss compared to those not taking this tea beverage (Lin et al., 2020). In animal studies, blueberries, which are high in anthocyanins, prevent weight gain by reducing inflammation and modifying the pathways that lead to obesity. However, depending on the form of anthocyanin consumed, animal trials have shown varying effects in reducing weight gain (Azzini et al., 2017). Results from research on resveratrol's ability to prevent obesity in both humans and animals have been conflicting. In rats, resveratrol has been demonstrated to suppress adipocyte differentiation and lipogenesis. Supplementing with resveratrol did not affect blood triglyceride levels, according to a systematic review and meta-analysis of 282 human participants (Zhang et al., 2021). Standard levels of resveratrol intake are unlikely to have protective effects because it is consumed in small amounts (Weiskirchen & Weiskirchen, 2016). Finally, curcumin has been proposed to lower adiposity by promoting energy metabolism, decreasing inflammation, and inhibiting angiogenesis. Studies on animals have demonstrated that dietary curcumin supplementation increased fatty acid oxidation levels and decreased fatness in body and liver fatty acid synthesis (Shehzad et al., 2011).

SUMMARY

Research shows a direct relationship between socioeconomic characteristics and health status, with noncommunicable diseases (NCDs) primarily impacting people with the lowest socioeconomic level. Proteins, carbohydrates, fats, oils, minerals, vitamins and organic acids are all important in ensuring health. Plant-based foods (fruits, vegetables, seeds, herbs, and legumes) have the potential to reduce the risk of chronic diseases such as diabetes, cardiovascular disease, and cancer as shown in figure 2. Fruit and vegetables are recommended in dietary guidelines at 400g or more per day to live a healthy lifestyle. Phytochemicals, also known as secondary metabolites, which can be present in fruits and vegetables, may play a crucial role in health-promoting properties. Phenolic compounds are one type of non-nutritional bioactive compound that has been widely investigated due to their pharmacological and functional activity on human beings.

Polyphenols such as resveratrol, curcumin, and catechins can be used to prevent neurodegenerative diseases, such as Huntington disease, Parkinson disease and Alzheimer disease. Dementia and Alzheimer have been associated with a reduced number of people who drink red wine containing resveratrol. Polyphenols prevent neurotoxicity, and have a neuroprotective effect, lowering oxidative stress and regulating the action of inflammatory responses. They also contact gut microbiota, which may prevent invasive species and favor beneficial gut microbes. Phenolic compounds may enhance the positive effects of probiotics. Cardiovascular disease (CVD) is the leading cause of mortality in the US with more than 960,000 deaths in 1997. Individuals are embracing the use of foods that reduce cholesterol to reduce the chances of developing CVD. Soybeans, oats, psyllium, flax seed, garlic, tea, fish, grapes, nuts, and margarine fortified with stanol, and sterol ester are functional foods that provide health benefits over and above basic food as shown in image 2. Flavonoids and resveratrol could decrease the level of LDL and reduce the chances of cardiovascular diseases by inhibiting the oxidation of cholesterol. Vitamin E and other antioxidants have been associated with reduction of type 2 diabetes by 13%. Polyphenols such as curcumin, resveratrol, and catechins are anti-obesogenic and may help in losing weight by lowering inflammation, inhibiting lipogenesis and raising energy expenditure. Research indicates that these compounds can also decrease the genesis and proliferation of adipocytes. It is found that green tea, blueberries and resveratrol help to prevent weight gain yet their efficacy in humans and animals is unclear because of the low amounts of the elements.

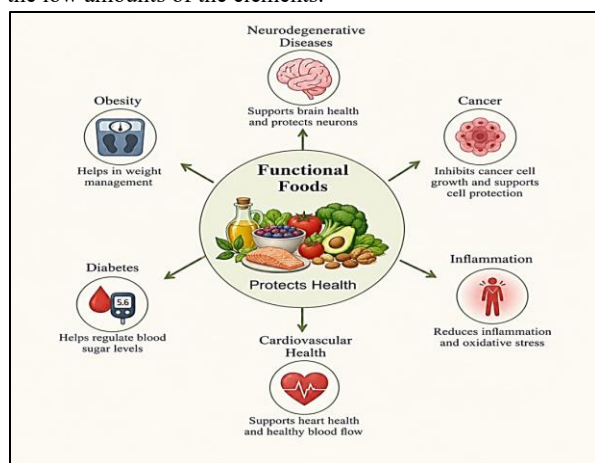


Figure 2: Functional foods and Wellness

CONCLUSION

Studies have shown that there is a correlation between socioeconomic status and health and that noncommunicable diseases impact individuals with lower socioeconomic status. Plant-based foods can be used to lower risk of chronic diseases, such as diabetes and cardiovascular disease. Phenolic compounds, including polyphenols, provide prevention against neurodegenerative diseases and reduce the risk of cholesterol. Functional foods and antioxidants can

also aid in weight loss. Plants that are edible contain mainly proteins, fats and oils, minerals, vitamins, carbohydrates (they may be a combination of free sugars or starch), and organic acids. Cyanide, trypsin inhibitors, phytic acids or phytate, and tannin are antinutrients. Animal experiments have indicated that a group of polyphenols (epigallocatechin gallate or EGCG) is able to inhibit a neurotoxin, which leads to Parkinson-like disease, in a competitive manner. EGCG can also safeguard neurons by stimulating cell survival signaling pathways. Turmeric, a widely used, polyphenol-containing herb, curcumin, has been suggested as a potential explanation for the decreased rate of Alzheimer's disease in India. Turmeric is found in curry. Resveratrol, curcumin, and catechins are polyphenols that shield against neurodegenerative diseases such as Alzheimer's, Parkinson's, and Huntington's diseases. They decrease oxidative stress, regulate inflammatory reactions, and act with gut microbiota, which may increase the effect of probiotics. Plant-based foods like vegetables and fruits can help decrease the chances of such chronic diseases as diabetes, cardiovascular disease and cancer. Bioactive compounds in vegetables and fruits delay inflammation and oxidation. Scientists are pursuing preventive therapy through dietary interventions such as Asian or Mediterranean diets, which have the potential of decreasing the number of diseases associated with aging, which are brought about by lifestyle changes.

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