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Bioactive Compounds in Health and Disease

Bioactive compounds in functional food and their role as therapeutics

Neelakanta Pillai Padmakumari Soumya[1]*, Saraswathy Mini[1], Shali Kochuvelickakathu Sivan[1], Sukanta Mondal[2]

[1]Department of Biochemistry, University of Kerala, Karyavattom Campus, Thiruvananthapuram, India- 695581; [2]ICAR- National Institute of Animal Nutrition and Physiology, Bengaluru, India-560030

***Corresponding author:** Dr. N.P. Soumya, MVSc, PhD, CCLAS, Department of Biochemistry, University of Kerala, Karyavattom Campus, Salem - Kochi - Kanyakumari Hwy, Karyavattom, Thiruvananthapuram, Kerala 695581, India

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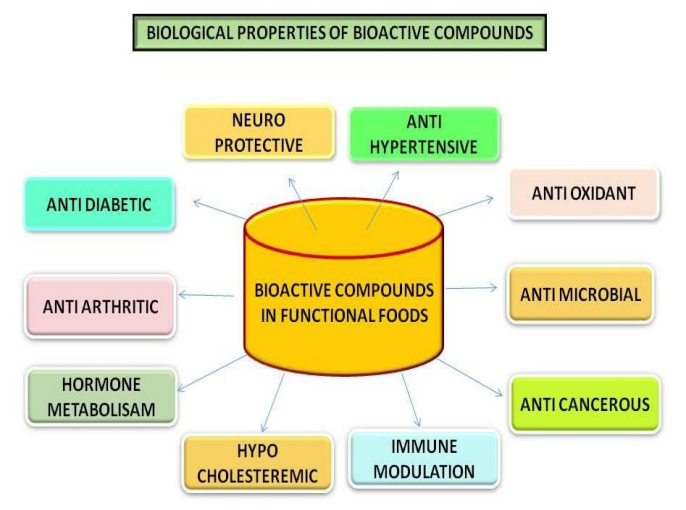
ABSTRACT



Bioactive food ingredients are non-essential substances found in foods that can modulate one or more metabolic processes, resulting in enhanced health. Functional diets have attracted more critical than ever as an alternative to conventional treatments of many diseases. The medicinal potential of functional foods and nutraceuticals are due to some unique functional groups produced due to food metabolism and their molecular variants. Phytochemicals are biologically active, naturally occurring chemical compounds in plants with various biological properties and therapeutic benefits. While functional foods and natural bioactive compounds have

been used as conventional medicines to treat chronic diseases for decades, recent scientific findings identify functional foods' health advantages and present the basic mechanisms of their behaviors. Phytochemicals have essential bioactive roles in the prevention and treatment of oxidative and inflammatory diseases. Plant-derived bioactive compounds can help suppress inflammation by inhibiting oxidative damage and communicating with the immune system. Many bioactive components are capable of binding to intestinal tract toxins or carcinogens. These bioactive peptides control diet-related medical conditions such as obesity, cardiovascular diseases, and other metabolic diseases. Various bioactive compounds in common food and their therapeutic role is discussed in this review.

Keywords: Functional food, phytochemicals, bioactive peptides, therapeutic effects.

INTRODUCTION

Bioactive compounds from food have been investigated to elucidate their biological activity in the human body systems, and functional foods have emerged as promising options for preventing and treating various diseases. Scientists estimated that unhealthy lifestyles and stress have a combined impact on the immune system, raising the risk of multiple cardiovascular disorders, cerebrovascular conditions, infections, and diseases like cancer. In response to the rising awareness of diet's influence on health, demand for functional foods and nutraceuticals has increased significantly. For their anti-microbial roles and humoral and cell-mediated immune functions, specific bioactive components have been integrated as additives in functional foods, nutraceuticals, and pharmaceuticals, where their biological activities can assist in disease control and prevention. Thus, some food ingredients' therapeutic potential has become a significant concern for physicians, food producers, researchers, and consumers. It seems that today's world is coming to clasps with the ancient excerpt, 'Let food be the medicine and medicine be the food' more than ever before.

Functional foods are any natural or refined food that has health benefits and disease prevention activities above its simple nutritional value. These different nutritional constituents in foods are the bioactive compounds that usually exist in limited concentrations. Nutraceuticals are foods and food supplements that contain bioactive compounds in a standardized form with therapeutic properties. The medicinal potential of functional foods and nutraceuticals are due to some unique functional groups produced due to food metabolism and their molecular variants. Components of functional foods are usually present in different forms, such as glycosylated, esterified, thiolylated, or hydroxylated forms. In particular, bioactive food ingredients are believed to be found mainly in plant foods, such as whole grains, fruits, and vegetables. Similarly, animal products such as milk, fermented milk products, and cold-water fish also contain bioactive components such as probiotics, conjugated linolenic acid, long-chain omega-3 polyunsaturated fatty acid, and

bioactive peptides. Bioactive nutritional factors often have several metabolic activities that cause beneficial effects on many diseases.

Bioactive food components from plant sources: Phytochemicals in plants are biologically active, naturally occurring chemical compounds with therapeutic benefits beyond those attributed to macronutrients and micronutrients. These compounds are considered secondary metabolites in plants with biological properties such as antioxidant activity, anti-microbial activity, enzyme detoxification regulation, immune system modulation, reduced platelet aggregation, hormone metabolism, and anticancer property [98].

Depending on their function in plant metabolism, phytochemicals are graded as primary or secondary constituents (Figure 1). More than 4,000 phytochemicals have been catalogued, and about 150 phytochemicals have been studied in detail [5]. The main primary elements include carbohydrates, amino acids, nucleic acid proteins, chlorophyll, purines, and pyrimidines. The other secondary constituents are alkaloids, terpenes, flavonoids, lignans, steroids, curcumin, saponin, flavonoids, glucosides, and phenolics [40, 98].

It is rare to find one class of bioactive food components within a plant singly. Instead, these are found in mixtures. Fruits, legumes, whole grains, nuts, seeds, mushrooms, herbs, and spices encompass a wide variety of dietary phytochemicals [73]. Likewise, broccoli, cabbage, onions, garlic, whole wheat bread, bananas, oranges, cherries, strawberries, raspberries, beans, legumes, and soy foods are also good sources of phytochemicals [78]. Differences in its level may vary from plant to plant depending on the variety, processing, cooking, and growing conditions [61].

Bioactive compounds such as omega-3 fatty acids (n-3 FA), plant sterol esters (PSE), and phenolic compounds (PHC) are natural molecules with great potential to reduce the atherosclerosis burden by

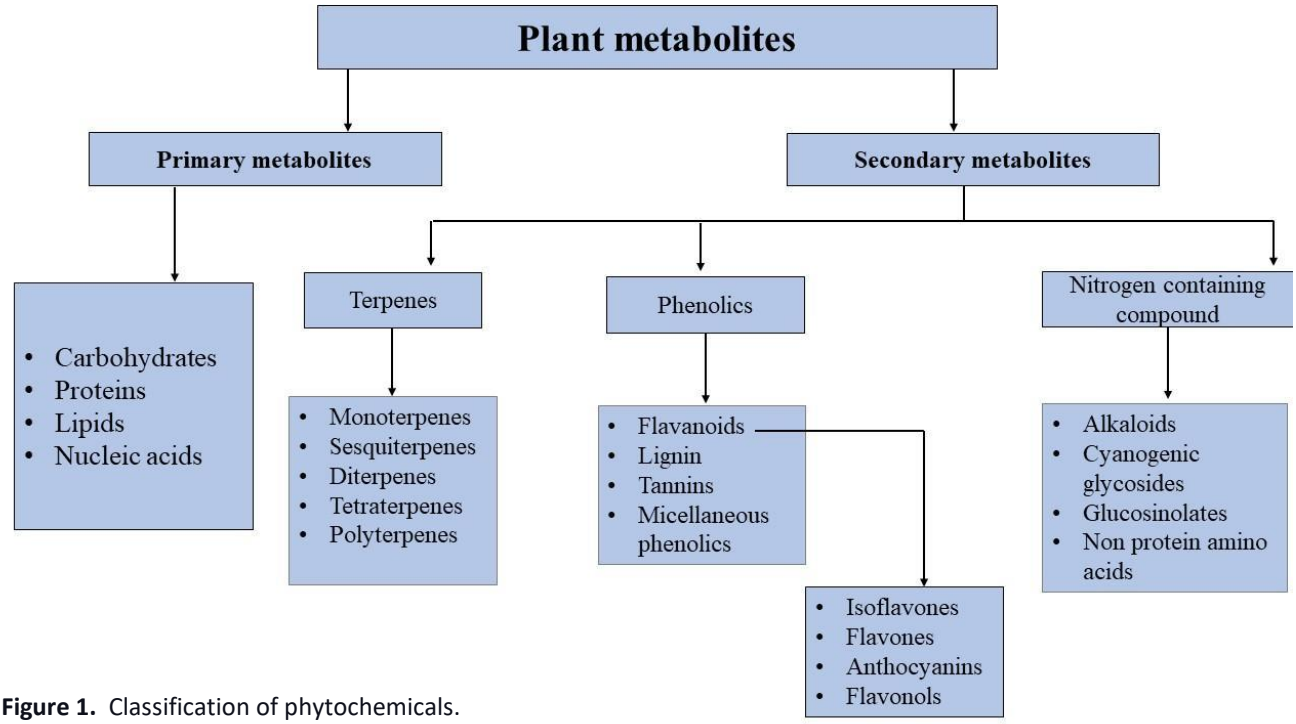


Figure 1. Classification of phytochemicals.

lowering inflammation, LDL cholesterol (LDL-C), and oxidative stress, respectively [100]. The most numerous and widely distributed category of bioactive molecules consists of polyphenols. Polyphenols are a complicated category of plant substances comprising one or more benzene rings and hydroxyl (OH), carbonyl (CO), and carboxylic acid (COOH) groups in varying amounts. These usually occur with one or more sugar residues attached (that is, conjugated). Flavonoids are the most common class of polyphenols. Catechins, thearubingens, theaflavines, isoflavones, and more than eight thousand others are other forms of polyphenols.

Fruits, cereals, legumes, vegetables, nuts, tea, wine, and other drinks made from berries, vegetables, and grains are dietary sources of polyphenols and flavonoids. The content of polyphenols can differ significantly between food sources and within foods of the same kind [15]. Organosulfur compounds are commonly found in broccoli, cauliflower, other cruciferous vegetables such as brussels sprouts, and in allium vegetables such as garlic and leeks onions. In a cyclic or noncyclic structure, organosulfur compounds contain sulfur atoms bound to a cyanate group or a carbon atom [45, 108]. The bioactive molecules of food products contain organosulfur compounds obtained once the vegetable has been damaged by cutting, chewing, or crushing. Through the action of myrosinase, different isothiocyanates are produced from glucosinolyates in cruciferous vegetables. In alliums, Allicin is formed from alliin and converted to diallyl sulfide/ diallyl disulfide/diallyl trisulfide by the action of enzyme alliinase. These hydrolytic breakdown products are the health-promoting bioactive food elements in both cruciferous and allium vegetables [63, 123].

In plants, phytosterols are the plant equivalents of cholesterol. Nevertheless, the structures are similar; the side-chain incorporates additional double bonds and methyl and ethyl groups in plant sterols. Campesterol, Beta-Sitosterol, and Stigmasterol are the most common bioactive phytosterols. Nuts, seeds, unrefined plant oils, and legumes are some of the best food sources. The saturated plant sterol derivatives are plant stanols, with sitostanol being the most common. Plant stanols occur naturally in soybean oil, wood pulp, and tall oil but are most commonly obtained in the diet by chemical hydrogenation of plant sterols. [87, 68].

Carotenoids are lipid-soluble plant pigments that contain approximately forty carbons and an extensive conjugated double bond system, both oxygenated or non-oxygenated hydrocarbons. The dominant non-polar bioactive carotenoids are beta-carotene, alpha-carotene, and lycopene. Lutein is the primary bioactive polar carotenoid. It is possible to find carotenoids esterified into fatty acids or unesterified in plant tissue. Good lutein sources are spinach, carrots, squash, sweet potato, and abundant in dark green leafy vegetables such as kale, spinach, mustard greens, and green beans. Lycopene is primarily present in tomatoes [110]. The whole fruit and vegetable carotenoid content varies with the age and storage condition of vegetables [91]. Tocopherols and tocotrienols are bioactive lipid-soluble compounds that contain a phenolic-chromanol ring connected to a saturated or unsaturated isoprenoid side chain [107]. Based on the number and location of methyl groups, mainly four primary forms of alpha, beta, gamma, and delta tocopherols and tocotrienols, are found in which the phenolic-chromanol ring varies. Furthermore, at positions 2, 4, and 8 of the

isoprenoid side chain, tocopherols have three asymmetrical carbons. Therefore, there are eight isomeric types of tocopherols, of which RRR-a-tocopherol has the most significant bioactivity in human blood and tissues and is also the most abundant Vegetable oils are familiar dietary sources of both tocopherol and tocotrienols, nuts and the germ part [16].

Biological Actions and role in Therapeutics: The exact biological mechanism of how plant-based bioactive food components impart health-promoting benefits significantly lacks understanding. Bioactive food components function at different or similar target sites simultaneously. It has been shown that bioactive food ingredients can reduce the risk of cancer, cardiovascular disease, osteoporosis, and infection [67]. In different phases of diseases, bioactive food components have health-promoting functions that are correlated with multiple progressive steps, from initiation to progress. For instance, in cardiovascular diseases, isoflavones can decrease circulating oxidized low-density plasma lipoproteins via binding cholesterol in the intestinal tract. Also, it decreases dietary cholesterol absorption, increases bile excretion, decreases endogenous cholesterol levels, and modulates arterial elasticity, thus improving blood vessel dilation and constriction responses [92, 102].

Inflammation is one of the foremost reasons for various acute or chronic pathological conditions. Epidemiological studies reveal that dietary patterns, foods, and bioactive compounds in spices and herbs can prevent inflammation, leading to carcinogenesis or cardiovascular diseases through their antioxidant and anti-inflammatory properties [58, 111]. Free radicals and reactive oxygen species are quenched by polyphenols, carotenoids, tocopherols, and allyl sulfides. Free radicals have a carbon or oxygen atom which is extremely unstable and has an unpaired electron. Anti-oxidants' primary activities include the regulation of the redox potential and the depletion of the potential carcinogenesis initiators. Redox modifications within a cell can cause different molecular responses, including apoptosis induction (cell death) and signal transduction activation. Therefore, in promoting health and disease prevention, redox and anti-oxidant control of physiological and pathological processes are essential. Many bioactive components are capable of binding to intestinal tract toxins or carcinogens, thus preventing transfer or absorption, like binding polyphenols in tea to N-nitroso compounds in the intestinal tract [117]. The dietary fiber and phytosterol/stanols have a lipid-lowering effect by sequestering cholesterol in the intestinal tract and reducing cholesterol absorption. Moreover, dietary fibers trap the harmful toxins and carcinogens in the tract [19].

Due to the structural similarity between some isoflavone and estradiol metabolites, the estrogen metabolite indicates the chance of similar biological activity to estrogen. However, isoflavones or phytoestrogens display estrogen's antagonistic activity, resulting in lower average sensitivity in premenopausal women to estrogen and reducing the risk of breast cancer [20, 106]. In postmenopausal women, hormone-sensitive surges in plasma cholesterol levels and bone loss can be reduced by incorporating phytoestrogen-rich diets [92, 102]. The multiple anti-oxidant potentials of polyphenols, tocopherols, carotenoids, isothiocyanates, and allyl

sulfides are the primary immune modulation mechanisms. These compounds can minimize the harmful effects of reactive oxygen species and free radicals, contributing to premature immune cell death [16]. It has also been shown that bioactive food components promote the phagocytic activity of macrophages and the development of many forms of immune cells, thus increasing disease resistance. Garlic, broccoli, onions, vegetable oils, almonds, walnuts, and others mentioned are among the foods that have been shown to have beneficial immunomodulatory effects (Table 1).

Table 1. Common Food Sources from plants with Their Bioactive Components and Biological Functions.

Food item	Bioactive Compound	Function	Reference
Broccoli, Cauliflower, Brussels Sprouts, Garlic, Onions	Glucosinolates, Diallyl Sulfides, Isothiocyanates.	Antimicrobial, Immunomodulator, Anticancer, Detoxification.	[47, 75]
Wheat	Wheat Gluten Derived Immunopeptides	Increased Natural Killer Cell Activity.	[44]
Whole Grains,Oats, Fresh Fruit With Skin	Dietary Fiber	Lipid-Lowering Action	[4]
Grapes, Red Wine, Tea, Fresh Fruits, and Vegetables	Isoflavonoids and Polyphenols.	Antioxidant, Lipid- Lowering, Immunomodulator, Antiosteoporotic, Anticancerous.	[9, 23, 128]
Soybean and Soybased Products, Flaxseed, Cabbage, Legumes, Tea	Phytoestrogens (Genistein, Daidzein).	Anticancerous Antiestrogen, Anti- Osteoporotic, Antiproliferative.	[49, 120]
Coconut	Trglyceridess Phytosterols	Antihelminthic, Anti-Inflammatory, Antinociceptive, Antioxidant, Antifungal, Antimicrobial, Antitumor, Analgesic, Antiarthritic, Antibacterial, Antipyretic,AntidiarrhealHypoglycemic. Cardioprotective, Antiseizure, cytotoxicity, Hepatoprotective, Vasodilation, Nephroprotective, and Anti-Osteoporosis Effects.	[7, 50, 54, 85]
Vegetable Oil, Nuts, Seeds	Tocopherols and Tocotrienols, Phytosterols	Antioxidant, Immunomodulator, Lipid Lowering	[101, 114]
Carrots, Corn, Squash, Green Leafy Vegetables, Oranges, Papaya, Red Palm Oil	Carotenoids	Antioxidant Immunomodulators.	[82]
Green Leafy Vegetables	Lutein	Reduction in Age-Related Macular Degeneration	[31]
Chlorella Vulgarian	Uncharacterized Peptides Of Molecular Weight 2e5 Kda	Stimulation Of Humoral Immune Functions, Haemopoiesis, Monocyte-Macrophage System Activation	[80]
Tomatoes	Lycopene	Antiproliferative, Anticancer	[86]
Garlic	Allicin, Ajoene	Antimicrobial, Anticancer Lowers bad Cholesterol; Antibiotic and Anti-Static Properties,	[6, 69]

Food item	Bioactive Compound	Function	Reference
Njavara Rice (Oryza Sativa Linn)	Alkaloids, phenolic compounds,essential oils, aromatic carbons, monounsaturated omega 9 fatty acids, fatty alcohol, polyterpenes,esters and volatile compounds	Hepato Protective Antispasmodic, AntiRheumatic, Anti Inflammatory, Hypocholesterolemic, Cancer Preventive, Nematicide, Antihistaminic,, Antiarthritic, Anticoronary, Antieczemic, Antiacne, 5-Alpha Reductase Inhibitor And Antiandrogenic Activities.	[14,76]
Turmeric	Curcuminoids	Anti-inflammatory, Antioxidant, Anticarcinogenic, Antimutagenic, Anticoagulant, Antifertility, Antidiabetic, Antibacterial, Antifungal, Antiprotozoal, Antiviral, Antifibrotic, Antivenom, Antiulcer, Hypotensive Hypocholesteremic	[21, 52]
Fenugreek	Vitexin, Isovitexin Apigenin, Kaempferol Caffeic acid Derivatives	Antioxidant, Hypoglycaemic, Lipid lowering activities	[56, 83]
Cinnamon	Cinnamaldehyde And Several Polyphenols, Predominantly Proanthocyanidin And Catechins	antifungal, antibacterial, anti-inflammatory	[41, 103]
Ginger	Gingerols and Shogaols	antioxidant, anti-inflammatory, antimicrobial, anticancer, neuroprotective, cardiovascular protective, respiratory protective, anti-obesity, antidiabetic, antinausea, and antiemetic activities.	[72, 105]
Black Pepper	Piperine and piperidines	Improves Digestibility. Antimicrobial Activity Used for Treatment of Vertigo, Asthma, Indigestion, Congestion, Fever, Diarrhoea.	[27, 79]
Lemon and Citrate Fruits	Flavanoids (Diosmin, Hesperidin, Limocitrin), Vitamin C	Antibacterial, Antifungal, Anti-Inflammatory, Anticancer, Hepatoregenerating, Cardioprotective	[36, 62]
Honey	Polyphenolic Gallic, Caffeic acid, Coumaric Acids, Flavonoids Pinocembrin, Chrysin, Quercetin, Luteolin, Apigenin, Abscisic Acid.	Anti-bacterial, Anti-inflammatory, Antifungal, Regenerative	[113]

Bioactive components from animal sources: Animals are abundant reservoirs of bioactive components that have a range of biological roles for human health. These bioactive molecules can be either vital to animals' survival or produced altogether to be more valuable to other organisms. Many natural animal origin compounds have been isolated, categorized, and used as nutritional or medicinal supplements to avoid, mitigate or cure different diseases and related symptoms [127]. These bioactive compounds promote various biological activities, such as anti-inflammatory, antioxidant, cholesterol-lowering, activity. Besides their ability to provide calories and amino acids, dietary proteins have also provided

health benefits in vivo and in vitro, either in an entire state or as hydrolysates. Food protein hydrolysates that cause beneficial biological functions are bioactive peptides. Bioactive peptides are generated through microbial fermentation, enzyme digestion, or enzyme proteolysis in vitro and may support major body systems' physiological activities [64]. These roles can include anti-oxidant, anti-microbial, anti-hypertensive, cytomodulatory, and immunomodulatory impact [42, 124].

Biological Actions and role in Therapeutics: Mammalian milk has various potent immunomodulatory peptides that influence immune function by suppressing or stimulating certain immune factors [32]. Bioactive peptides obtained from milk have possible additives in health-promoting functional foods. Bioactive peptides of whey proteins modulate both specific and non-specific immune responses [33]. Immunomodulatory peptides such as casein phosphopeptides and other casein-derived peptides are commercially available, stimulating immunoglobulin A (IgA) production in mice [30, 88] . Gastrointestinal digestion releases many bioactive peptides from casein and whey proteins, including anti-bacterial, immunomodulatory, anti-hypertensive, and opioid peptides [34, 35, 74]. Various biological effects of peptides extracted from cow buffalo, horse, pig, and camel milk include anti-microbial, immune-modulatory, anti-oxidant oxidant, enzyme inhibitory, anti-thrombotic, and antagonistic activity against a range of toxic agents [77]. These bioactive peptides control diet-related medical conditions such as obesity, cardiovascular diseases, and many other metabolic diseases.

Marine fishes are another diverse source of bioactive compounds with a wide variety of novel bioactive substances. Peptides, sugars, lipids, and a wide range of vitamins and minerals are abundant in marine fish, and omega-3 fatty acids from fish and fish oil are essential among these [57]. A significant source of high-quality proteins, lipids, and many vitamins and minerals and their derivatives have various pharmacological activities, rendering fish an outstanding therapeutic food. Marine fish-derived bioactive peptides may have various biological functions, including inhibition of angiotensin-I-converting enzyme (ACE), anti-oxidant, immunomodulatory, anti-microbial, and anticoagulant activities [28, 59]. New technologies have made it simple to study a fish-based diet's medicinal role in treating coronary disorders, neurodegenerative diseases, and radical-mediated diseases. The cheapest animal protein substitute available on the market is Fish Protein Concentrate. Teleost. Fishes such as anchovies and mola are widely consumed in Asian countries, especially in lower milk consuming populations. Microbial or viral inhibitory peptide- 5e10 kDa peptide hydrolysates have been reported from Pacific oysters (Crassostrea Gigas), and the peptides demonstrated inhibition of the development of herpes [126]. Moreover, the involvement of IL-2 dependent immune deficiency, including AIDS, can be avoided or postponed by oyster protein extract [1].

Similarly, meat and meat products are rich in bioactive substances such as vitamins, minerals, peptides, and fatty acids, many of which are beneficial to human health. Meat is undeniably an excellent source of well-balanced essential amino acids, especially sulfate ones, as it contains an

abundance of highly biologically essential proteins. Meat is a perfect source of nutrients, including minerals and vitamins [8, 81]. Egg comprises several bioactive ingredients with pro-and/or anti-inflammatory effects. The white fraction of eggs contains many bioactive proteins, including ovalbumin, ovotransferrin, ovomucin, lysozyme, and avidin [66]. These proteins have anti-bacterial and immunoprotective effects. Egg yolk-derived phosvitin has substantial bactericidal activity against E. coli [97]. When given orally, ovakinin, a biologically active peptide derivative of ovalbumin, has been shown to minimize blood pressure in spontaneously hypertensive rats. Some of the common Animals food Sources with their Bioactive Components and Functions are given in Table 2.

Table 2. Common Animals Food Sources with Their Bioactive Components and Functions.

Food Item	Bioactive Compound	Function	Reference
Milk	Whey Protein	Modulation of both specific and non-specific immune responses.	[33, 74]
Milk And Fermented Milk Products	Bioactive Peptides: Lactoferrin, Glycomacropeptide	Immune System Enhancing, Anti proliferative, Antimicrobial	[112]
Fermented Milk Products	Probiotics	Immunomodulators, Anticancer ,Antibacterial Anti-Oxidative Gastrointestinal Health Modulators	[32]
Pacific Oysters (Crassostrea Gigas)	Peptide Hydrolysate JCOE	Herpes Virus Growth Inhibition Properties	[1, 59, 126]
Egg	Phospholipids Ovalbumin Ovotransferrin, Ovomucin, Lysozyme, and Avidin	Antimicrobial, Immunomodulatory, Anti-Cancer, And Anti-Hypertensive Activities	[66, 97]
Meat	Vitamins, Minerals, Peptides, Fatty Acids, ACE-Inhibitory Peptides	Anti-Hypertensive, Anti Oxidant Activities	[81, 109]
Fish	Fatty Acids, Polysaccharides, Polyether, Peptides, Proteins, Enzymes And Lectins. Proteins	Antihypertension, Immunomodulatory, Antithrombotic, Antioxidant, Anticancer And Antimicrobial Activities	[60, 57, 129]

Therapeutic application of functional food: Bioactive compounds of food have a significant role in preventing and treating diseases since many of these compounds are involved in the pathophysiology of various disease developments. Several bioactive compounds are actively involved in the inflammation process, which is the cause of cancer, diabetes, and other inflammatory diseases. It has been reported that dietary habits, food ingredients, and bioactive compounds with anti-inflammatory properties are defensive. Thus, utilizing bioactive food compounds present in spices and herbs with anti-oxidant and anti-inflammatory properties may help prevent inflammation that can contribute to carcinogenesis or

cardiovascular diseases [111]. For instance, dietary improvements and functional diets are the two most promising non-pharmaceutical treatments for inflammatory bowel disease (IBD). Probiotics and non-starchy polysaccharide supplements in the diet have proven to be effective in the treatment of IBD. Plant-derived extracts, phytochemicals, vitamins, and omega-3 fatty acids are forms of bioactive compounds. These functional foods and dietary peptides have potent anti-inflammatory effects both in animal models and humans [2]. Functional foods can modulate inflammatory cytokines and engage with the immune system to create anti-inflammatory effects. Polyphenolic constituents from cotoneaster are reported to have anti-oxidative and anti-inflammatory activity, making it an ideal candidate for the preparation of nutraceuticals for inflammatory-related diseases [58]. Bioactive constituents from *Coriandrum sativum* are reported to have anti-hypertensive actions through their action mechanism as angiotensin-converting enzyme (ACE) inhibitors [48].

Phytochemicals from plants provide a promising new avenue for the development of diabetes mellitus therapeutics. Among these alkaloids, flavonoids, glycosides, terpenoids and steroids are more important [10]. Many fruits, vegetables, oil, legumes and nuts contain several potential phytochemicals with antidiabetic activities. These include mango, aloe vera, avocado, banana, bitter gourd, black tea, blueberry, coffee, cinnamon, garlic, ginger, grape, guava, jackfruit, olive oil, onion, papaya, pumpkin, pomegranate etc [11]. Dietary flavonoids mediate antidiabetic activity via modulating carbohydrate metabolism, beta-cell function, insulin sensitivity and functional availability of antioxidants [115].

Jackfruit (Artocarpus heterophyllus Lam) is a fruit crop that originated from South India well known for its medicinal properties. It contains various antioxidants that help prevent several chronic diseases, such as heart disease and diabetes. Jack fruit is reported to have a relatively low glycemic index (GI), preventing sudden hike in blood sugar level [29, 43]. It is also a good source of vitamin C, carotenoids, and flavones, contributing to its anti-inflammatory effect, reducing the risk of type 2 diabetes, hypertension, chronic heart diseases, and cancer [24, 51]. The phytonutrients from jack fruit possess antioxidant, antihypertensive, antiulcer, anticancer, and anti-aging properties [70, 39]. Similarly, supplementation of Banana inflorescence (*Musa paradisiaca)* is reported to downregulate oxidative stress, hyperglycemia and inflammation in streptozotocin induced diabetic rats. In contrast, bioflavonoid morin exerts its antidiabetic effect through its insulin-mimetic effect [90].

Several antitumor compounds also have been identified among dietary phytochemicals. Another research study conducted by Yang *et al*. (2018) looked at the antitumor function [125] and structural properties of water-soluble polysaccharides from *Kaempferia galanga* (aromatic ginger). Wattanathorn *et al.* [118] reported the strengthened bone mineral density in menopausal women by a polyphenol-rich herbal congee containing a combination extract of *Morus alba Polygonum odoratum* leaves.

Bioactive compounds are also reported to possess neuroprotective effects. Parkinson's disease (PD), Alzheimer's disorder (AD), Prion disease, multiple sclerosis (MS), experimental autoimmune encephalomyelitis (EAE), ischemic stroke, and neuropathic pain are several of the disorders that can

influence the brain. Many studies have suggested that the onset of Alzheimer's disease, age-related dementia, can be delayed or prevented by modifying lifestyle factors, including introducing an appropriate diet. Phenolic compounds, fat-soluble vitamins, isothiocyanates, omega-3 fatty acids, and carotenoids tend to be promising. These bioactive compounds act as anti-oxidants and anti-inflammatory agents, playing an active role in forming amyloid plaques and tau tangles [37]. C*aryocar Brasiliense* (Camb), a Caryocaraceae family member popularly known as "pequi," is a possible neuroprotective phytomedicine which possesses anti-oxidant and anti-cholinesterase activities as well as neuroprotective effects [25]. Bioactive components such as omega-3 fatty acids, plant sterol esters, and phenolic compounds can minimize the risk of atherosclerosis and cardiovascular diseases by decreasing inflammation, LDL cholesterol level and oxidative stress [100]. Thus, diets and functional foods will play a vital role in managing and preventing diseases.

CONCLUSION

Over the last decade, diets and functional foods have appeared as viable options for preventing and treating many diseases. Researchers are involved in bioactive peptides as a health-promoting functional food. In addition to meeting the body's nutritional needs, food proteins have been shown to have health benefits. Since patients' adherence to chronic drug prescriptions is notoriously low, minimizing drug doses or enhancing patient response to care is one choice that may effectively lead to early prevention. Bioactive components from food have been found to affect immune system parameters. Anti-hypertensive, anti-microbial, and immunomodulatory effects may be used to avoid or regulate lifestyle-related diseases, including hypertension, cancer, cardiovascular disease, diabetes, osteoporosis, stress, and obesity. This form of nutritional practice can be beneficial to both allergic and stable people who are affected. The use of bioactive substances in conjunction with medications tends to be a safe and successful way to delay cardiovascular diseases. However, information on bioactive food components' bioavailability and the appropriate dose necessary in humans is needed to maximize health benefits. Isolation and identification of these peptides and their pharmaco-dynamic parameters are required to transfer the powerful functional properties of food into clinical applications. Novel facilities such as innovative proteomics techniques, recombinant enzyme technology, and microbial fermentation have to be carried out to explore further.

List of abbreviations: n-3 FA: omega-3 fatty acids, PSE: plant sterol esters, PHC: phenolic compounds, LDL-C: LDL cholesterol, ACE: Angiotensin-I-converting enzyme , IBD:inflammatory bowel disease, PD: Parkinson's disease, AD: Alzheimer's disease, MS: multiple sclerosis, EAE: experimental autoimmune encephalomyelitis

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