Review Article

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Functional constituents of plant-based foods boost immunity against acute and chronic disorders

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Abstract: Plant-based foods are becoming an increasingly frequent topic of discussion, both scientific and social, due to the dissemination of information and exchange of experiences in the media. Plant-based diets are considered beneficial for human health due to the supply of many valuable nutrients, including health-promoting compounds. Replacing meat-based foods with plant-based products will provide many valuable compounds, including antioxidants, phenolic compounds, fibers, vitamins, minerals, and some ω3 fatty acids. Due to their high nutritional and functional composition, plant-based foods are beneficial in acute and chronic diseases. This article attempts to review the literature to present the most important data on nutrients of plant-based foods that can then help in the prevention of many diseases, such as different infections, such as coronavirus disease, pneumonia, common cold and flu, asthma, and bacterial diseases, such as bronchitis. A properly structured plant-based diet not only provides the necessary nutrients but also can help in the prevention of many diseases.

Keywords: acute diseases, antioxidants, chronic diseases, immunity booster, nutraceuticals, phenolic compounds, minerals, vitamins

1 Plant-based diets and foods

Plant-based diets are gaining more and more popularity, especially among adolescents and women. Reasons for changing eating habits are different perceptions of the earth’s resources and the environment, ethical issues related to animal care, the use of antibiotics and growth promoters in animal production, and the threat of zoonoses (especially in the light of the persistent SARS-CoV-2 epidemic), and possible health benefits resulting from the multitude of nutritional and health-promoting compounds present in plant-based foods [1–4]. Published research has shown that reducing the risk of serious chronic diseases, such as obesity, heart disease, and type 2 diabetes, is possible by replacing meat products with plant-based foods [5,6]. However, it should be highlighted that a poorly constructed plant-based diet can also cause many deficiencies of important nutrients that are not absorbed by human organism due to the elimination of animal products from the diet [3].
Plant-based foods include fruits, vegetables, nuts, seeds, whole grains, legumes, and beans [7]. These products contain bioactive secondary metabolites comprehensively distributed in plants and are predominantly manufactured by the shikimic acid pathway [8]. Legume phytochemicals are categorized into different groups and contain compounds, such as lignans, flavonoids, stilbenes, and phenolic acids [9,10]. Plants and their by-products contain phenolic acids, such as flavanols, condensed tannins, and anthocyanins, are the primary classes of polyphenols and are mainly present in legumes. Flavonoids, phenolic acids, and proanthocyanidins are the prevailing phenolic compounds present in peas, customary beans, and lentils [11]. The bioavailability and bio-accessibility of starch, lipids, proteins, and functional phytochemicals (carotene) are acknowledged as secondary indicators of the digestibility of plant-based food. Figure 1 shows the effects of different types of plant-based foods on the human body organ.

The functional components are produced from plant-based food (vitamins C, D, and E) or absorbed from the environment (i.e., zinc and magnesium) that aid in improving immunity against viral diseases [12]. Bioactive compounds, including polyphenols, ensure an authentic beneficial therapeutic potential as these are promoted within the direction of the inhibitor activities [13]. The ingestion of plant-based foods is considerably related to the lower risk of coronary artery diseases, cancer, diabetes, and Alzheimer’s disease (AD). The major types of plant-based food and their parts are listed in Table 1.

2 Natural components of plant-based foods as an immune booster

The immunity system is a complicated system of cells and proteins that protect the body from infection. The immunity system retains a history of each type of bacteria (microorganism) that has been destroyed, so if the microorganism enters the body again, it can quickly identify and destroy the microorganism [14]. The main components of the immunity system are white blood cells, antibodies, complement system, lymphatic or drainage system, organs, such as spleen, bone marrow, and gland-like thymus. The nutrients from fruits and vegetables (such as β-carotene, vitamin C, and vitamin E) can enhance immune function. Meanwhile, several vegetables, fruits, and some plant foods are also enriched in antioxidants, so they aid in alleviating oxidative strain [15]. Plant-derived natural components that aid in boosting immunity are shown in Figure 2.
Table 1: Selected plant-based food characteristics

| Plant food sources | Types                                      | Functional ingredient                                                                 | Part used                             | References              |
|-------------------|--------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------|-------------------------|
| Vegetable         | Green leafy: kale, spinach, and lettuce Root: radishes, potato, beets, sweet potato, garlic, and yam Cruciferous: cauliflower, broccoli, brussels sprouts, and cabbage Marrow: pumpkin, zucchini, and cucumber Plant stem (edible): celery and asparagus Allium: garlic, onion, and shallot | Fibers, antioxidants, polyphenols, vitamins, minerals, carotenoids, and fatty acids | Leaves, stems, root, pods, sprouting, axillary buds, flower, shoots, and fruits | [167–174]               |
| Fruit             | Citrus: limes, grape fruits, mandarins, and oranges Tropical and exotic: apples, pears, mangoes, avocados, bananas, and tomatoes Stone fruit: peaches, apricots, plums, and nectarines Berries: blueberries, raspberries, strawberries, kiwifruit, and passion fruit Melons: melons, honeydew melons, watermelons, and rockmelons Dry fruits: almond, hazelnuts, walnuts, pistachios, raisins, and cashew | Antioxidants, fatty acids, fibers, vitamins, minerals, polyphenols, and carotenoids | Peel, pulp, fruit, flower, and seed | [100,175–182]           |
| Cereal            | Wheat, oats, rye and barley, sorghum, rice, and maize | Phenolic acids, flavones, phytic acid, flavonoids, coumarins, and terpenes Ferulic acid, phytic acid, glutathione, and phytosterols Vitamins, minerals, and fibers | Grain, bran, endosperm, and germ | [183–187]               |
| Beans/legume      | Dried beans and peas: Red kidney beans, haricot beans, lentils, dry beans, snap beans, shell beans, and chickpeas Fresh beans and peas: Butter beans, green peas, broad beans, green beans, soybeans, and snow peas Types of legumes: Peanuts, black-eyed peas, chickpeas, and Lentils | Bioactive compounds (phytochemicals and antioxidants, isoflavones, lignans, protease inhibitors, trypsin and chymotrypsin inhibitors, saponins, alkaloids, phytoestrogens, and phytates) | Grain | [188–192]               |
2.1 Vitamins

2.1.1 Vitamin C

Vitamin C is an important micronutrient for human beings, and its multi-effect function is associated with its capacity to provide electrons. It is an effective antioxidant and cofactor for biosynthesis and gene regulation enzymes. It is an antioxidant that assists in destroying free radicals and regulating the body’s natural immune reaction. Vitamin C sources include red capsicum, tangerine, red strawberries, kiwi, green broccoli, mango, lime, citrus fruits, tomato juice, and potatoes [16,17].

Vitamin C promotes immune attack by assisting multiple cell functions of the innate and adaptive immune systems. It maintains the function of the epithelium and stimulates the action of removing oxidants from the skin so that it can resist environmental oxidative strain. Vitamin C collects in phagocytes, improving chemotaxis, phagocytosis, and eventually killing microorganisms. Numerous scientific studies and clinical trials describing potent immune-stimulating and antiviral effects have been published [18,19]. Vitamin C is required for apoptosis at the site of macrophage infection and removal of spent neutrophils; thereby, it reduces necrosis/endocytosis and possible tissue injury. However, it has been proven by various researchers that vitamin C can enhance the differentiation and multiplication of B cells and T cells [20,21], which may be due to its genetic regulation.

Vitamin C insufficiency can lead to declined immunity and increased chances of infections [22,23]. Then, due to the high rate of the inflammatory process and metabolic demands, infections can rigorously disturb vitamin C levels. The management of established infections needs considerably greater doses (grams) to be provided for the raised inflammatory reaction and metabolic demands [21].

2.1.2 Vitamin E

Vitamin E is a group of four tocopherols (α-, β-, γ-, and δ-tocopherols) and four tocotrienols (α-, β-, γ-, and δ-tocotrienols) present in food. These types possess antioxidant action but cannot be converted into each other. Only α-tocopherol can meet the requirements of human vitamin E [24]. The primary dietetic source of vitamin E is plant oils, such as soybean, sunflower, corn, and walnut [25,26]. Oils have greater vitamin E content (vitamin E/100 g oil is about 50 mg or more). The ratio of α-, β-, γ-, and δ-tocopherol differs according to the type of the oil. For example, safflower oil has a high content of α-tocopherol, soybean and corn oil have the highest content of γ-tocopherol, and the ratio of α- and γ-tocopherol in cottonseed oil is similar. Vitamin E is also found in vegetable oils, nuts, seeds, fruits, and vegetables, including kale, spinach, pumpkin, red pepper, mango, and avocado [27].

Vitamin E is an effective fat-soluble antioxidant. Compared with other cells in the blood, it has a higher concentration in immune cells and is one of the best active nutrients to regulate immune function. Its deficiency has been revealed to disturb the usual function of the immune system and can be improved by supplementing vitamin E through foods. Vitamin E insufficiency is uncommon, and its supplementation beyond the recommended amount can improve the functioning of the immune system, e.g., decreases the risk of infection, specifically in the elderly [28].

The role of vitamin E in the immune system is usually connected with α-tocopherol. However, evolving indication suggests that other forms of vitamin E, containing other tocopherols and tocotrienols, may also have active immunomodulatory functions [29].

Alternative research disclosed that vitamin E is a fat-soluble antioxidant that can protect polyunsaturated
fatty acids (PUFAs) in the membrane from oxidation, normalizing the manufacture of reactive oxygen species (ROS) and reactive nitrogen. Under normal and pathological conditions, the immunomodulatory effect of vitamin E has been found in both animal and human models. Due to the underestimation of the development, function, and regulation of dendritic cells, macrophages, natural killer (NK) cells, T cells, and B cells, recent research has focused on the role of vitamin E in specific immune cells. Vitamin E enhances cells to recognize the immune regulation mechanism [30].

In clinical, pre-clinical, and cell-based intervention studies, the mechanisms that cause vitamin E to affect the immune system and inflammation have been explored [29,31,32]. Vitamin E directly affects the integrity of T-cell membranes, signal transfer, and cell division and indirectly disturbs the inflammatory mediators produced by other immune cells, thus modifying the function of T cells. Vitamin E has medical importance in regulating immune function because it cannot only disturb the host’s vulnerability to infectious diseases (such as respiratory infections) that are susceptible to diseases (such as asthma) [33].

2.1.3 Vitamin A

Vitamin A is a micronutrient that maintains eyesight, promotes growth and development, and protects the reliability of the human epithelium and mucus. Due to its important role in enhancing immune function, it is known as an anti-inflammatory vitamin. This vitamin participates in the development of the immune system and plays a supervisory role in the cellular immune response and humoral immune process. Vitamin A has a proven therapeutic effect on various infectious diseases [34]. Plant sources that contain vitamin A include carrots, pumpkins, papaya, and mangoes. Its deficiency can disturb innate immunity by inhibiting the usual restoration of the mucosal barrier caused by infection and weakening the function of neutrophils, macrophages, and NK cells. Vitamin A is also essential for adaptive immunity and plays a role in the growth of T-type helper (Th) B cells, and its possible deficiency decreases the antibody-mediated response directed by Th2 cells. Th1-mediated immunity is also reduced. These alterations in mucosal epithelial redevelopment and immune function may be responsible for the greater death rate of infants, young children, and pregnant women who have vitamin A deficiency [35].

In the case of people with low vitamin A content in their diet, contagious diseases can aggravate vitamin A deficit by decreasing intake, absorption, and increasing excretion. Contagious diseases that induce acute-phase responses can also change the assessment of vitamin A status by temporarily decreasing the serum retinol concentration [36].

2.1.4 Vitamin B6

Vitamin B6 contains six pyridine derivatives [37] pyridoxal, pyridoxine, pyridoxamine, and their respective 5′-phosphates. It is a cofactor for certain enzymes, supporting them in performing their respective functions [38]. Plant-based foods, such as oats, bananas, wheat germ, soya beans, and peanuts, are good sources of B6 [39]. It helps control the isotype and the level of cytokine in the body. The human body needs B6 to absorb vitamin B12 and for the production of red blood cells and immune system cells [40]. Vitamin B6 can help the body produce a variety of neurotransmitters, such as serotonin, which transmit signals from one nerve cell to another. Serotonin is formed only from tryptophan. This transformation (tryptophan to serotonin) arises in the existence of pyridine phosphate, which is a derivative of vitamin B6 [41]. Vitamin B6 is essential for usual brain growth and function [42]. Pyridoxal 5′-phosphate is essential for the synthesis of the neurotransmitters serotonin, norepinephrine, epinephrine, and γ-aminobutyrate and, as such, is involved in both stimulating and inhibiting neurons [39,43]. It can help the body produce norepinephrine that affects mood and melatonin. Indications of severe deficit include muscular weakness, anxiety, irritability, sadness, failure to concentrate, and occasionally short-term memory loss. The recommended daily consumption of vitamin B6 for adults should be 1.3 mg [39]. Vitamin B6 aids in increasing the immune response to greater antibodies and aids the communication among cytokines and chemokines [44]. Its deficit decreases lymphocyte growth and multiplication, the production of antibodies, and the active cells of T [45].

2.1.5 Vitamin B9

Folate is the natural form of vitamin B9, water-soluble and naturally found in many foods. It is also added to foods and sold as a supplement in the form of folic acid; this form is better absorbed than that from food sources. Folate helps to form DNA and RNA and is involved in protein metabolism. Leafy vegetables (including romaine lettuce, turnip greens, asparagus, spinach, broccoli, and Brussels sprouts), peanuts, whole grains, beans, fresh fruits, and sunflower seeds are the sources of vitamin B9. Vitamin B9 can also boost immunity. It usually plays
a vital role in the biosynthesis of nucleic acids, proteins [46], RBCs, and nerve tissue [47]. Folic acid is important for the usual functioning of the brain and plays a main role in mental health. The lack of vitamin B₉ can cause depression, insomnia, fatigue, and anxiety [48].

2.2 Minerals

2.2.1 Zinc

Zinc (Zn) is an important trace mineral and plays a vital role in many physiological functions. Biologically active zinc is a bivalent cation mainly associated with enzymes and other proteins [49]. Rich plant-based food sources of Zn are legumes, including lentils and chickpeas, beans, nuts, and whole grains [50]. One of the significant functions of Zn is its effect on the immune system. It is essential for the growth and function of immune cells in the innate and adaptive immune system. Zn homeostasis is well controlled in cells, and any stress-free regulation will result in compromised normal function. Its insufficiency will adversely affect the hematopoietic function and affect the immune response at multiple molecular, cellular, and systemic levels. Zn contributes to the immune system and how alterations in intracellular zinc levels affect the immune response [51]. Zn affects numerous features of the immune system, from the skin barrier to the gene regulation of lymphocytes [52,53]. It is important for the usual growth and function of cells. Zn deficiency prevents overgrowth of lymphocytes and certain functions (such as stimulation, Th1 cytokine production, and B lymphocyte aid) from affecting the development of adaptive immunity, such as the development of B lymphocytes and antibody production, especially globulin G immunity damaged [54]. Macrophages are key cells in many immune functions and are undesirably affected by zinc deficiency. Zn insufficiency can disturb intracellular destruction, cytokine production, and phagocytosis. Zn is the immune mediator that stems from the several roles of zinc in basic cell roles (such as DNA replication, RNA transcription, and cell division). Its insufficiency increases cell apoptosis [55].

A previous study showed that zinc is also an antioxidant and has anti-inflammatory effects. The beneficial effects of Zn have been reported in patients with acute infantile diarrhea, inflammatory bowel disease, prevention of age-related macular degeneration, and treatment of colds with Zn. In HL-60 cells (promyelocytic leukemia cell line), Zn improves the upregulation of A20 mRNA and decreases the triggering of NF-κB through the TRAF pathway, causing reduced gene expression of tumor necrosis factor α, interleukin (IL)-1β, and IL-8. It is reported that the addition of zinc diminishes the formation of oxidative stress markers and inflammatory cytokines in young and elderly people [56]. Zn acts as a modulator of immune reaction through its accessibility. When this mechanism is disturbed, the utilization of Zn will reduce, thus altering the existence, multiplication, and variation of cells in various organs and systems, especially immune system cells [57].

2.2.2 Copper

Copper (Cu) is a trace mineral that plays an important role in humans [58]. Whole grains, beans, and nuts are good sources of Cu. Dark green leafy vegetables in the diet, plums, cocoa, black pepper, and dried fruits are also sources of Cu [59–61].

A link between Cu and innate immune function has been observed. Literature indicates that mild copper insufficiency in humans and animals is usually described as neutropenia [62]. This condition is partly linked to the reduction in the number of circulating neutrophils. Thus, it has been suggested that Cu is closely related to the differentiation, maturation, and proliferation of leukocytes [63]. Neutrophils are small and homogeneous cell populations, so they are probably to be an operational and valuable tool for evaluating human nutritional status [64]. As a result of Cu deficiency, isolated neutrophils showed declined phagocytic capability and/or decreased bactericidal action, but these factors were easily restored when Cu was added to the diet [65,66]. Some previous studies have shown that IL-2 Cu deficiency is reduced, which may be the mechanism of T-cell production. These outcomes indicate that even in the case of marginal deficiency, when the index total copper level is not affected by nutrition, proliferative response and the concentration of IL are decreased. In the case of severe Cu deficiency, the number of human peripheral blood neutrophils decreases, and as a consequence reduce their ability to produce superoxide anions and kill ingested microorganisms. When neutrophil-like HL-60 cells differentiate into more mature cell populations, they accumulate copper, and the increased activity of Cu/Zn superoxide dismutase or cytochrome C oxidase cannot reflect this accumulation. The identity of copper-binding proteins in these cell types can help understand new Cu functions.

2.2.3 Selenium

Selenium (Se) is a micronutrient that exists in the soil and enters the food chain by incorporating plant protein [67].
However, some areas of the world (including the United Kingdom, New Zealand, and Northeast China) have low or insufficient Se content in the soil, which is related to the insufficient Se content in the human body. Although evident Se deficiency is rare, it is common in most immunocompromised patients [68]. Globally, 1–5 billion people suffer from Se insufficiency [69]. Se deficit is often in most immunocompromised patients, which may describe the greater susceptibility of these patients to viral and bacterial infections [51]. Se plays a vital role in the function of the immune system. This antioxidant contributes to decreasing oxidative stress in the body, thereby decreasing inflammation and enhancing immunity [70]. Research has shown that improved levels of selenium in the blood are associated with boosting immune responses [71]. Sufficient levels of Se are important for initiating immunity. Moreover, Se plays a role in regulating immune responses and chronic inflammation. Indication of the role of several selenoproteins in inflammation regulation and immunity has emerged, providing insights into the mechanism by which selenium affects these processes. It is associated with improving oxidative stress, but in the absence of selenium, other functions in immune cells (such as protein folding and calcium flux) are also affected. Supplementing adequate levels of Se in the diet can also affect the function of immune cells. In some cases, certain types of susceptibility and immunity can mainly affect selenium levels and sexual dimorphism [72,73]. There is a lot of evidence that a relevant intake of micronutrients (including Se) through diet or supplements can benefit health and immunity.

Se is a basic component of the amino acid selenocysteine incorporated into selenoproteins. Glutathione peroxidase and thioredoxin reductase (TrxR) are examples of selenoproteins with antioxidant functions. These proteins affect oxidative stress and therefore play a main role in modifying the immune system [74]. Se is an effective antioxidant that exerts natural effects by incorporating it into selenoproteins, which play a relevant role in the regulation of ROS and redox states in practically all tissues. Thus, selenium intake from diet strongly affects susceptibility and immune responses [75–78].

Thus, the absorbed polyphenols interact with the intestinal immune system, leading to a protective response for the host [81]. Current evidence strongly suggests that polyphenols help avoid a variety of immune diseases, i.e., the polyphenols in red wine can considerably raise the level of IL-21 and decrease the release of IL-1β and IL-6 [82]. It is well known that many pathogens of human diseases are involved in immune function. This observation has led to extensive investigational research on immune mechanisms in many disease settings. Immune dysfunction has many unforeseen consequences. For instance, immune dysfunction of the intestinal mucosa can be the reason for the host’s diarrhea and may have an adverse impact on the balance of intestinal flora [83]. Hence, functional foods defined by providing specific nutrition or targeting multiple functional ingredients are considered a form of preventive medicine [84]. Polyphenols are biologically active substances that can stimulate intestinal health through several mechanisms, such as regulating immunity and mucosal inflammation. The innate immune system of the intestine holds three lines of defense: mucus layer, epithelium, and lamina propria. The mucus layer is the host’s first line of defense against foreign pathogens [85].

Flavonoids, including about 6,000 phenolic compounds, are the products of the secondary metabolism of plants. Flavonoids can be divided into flavonols (such as quercetin, kaempferol, and isoquercetin), flavones (such as luteolin, flavone glycosides, and apigenin), isoflavonoids (such as genistein and daidzein), flavanones (such as naringenin and hesperidin), flavanol (such as epicatechin, catechin, gallocatechin, and epigallocatechin), esters, and polymerized or condensed tannins and anthocyanins found in cocoa and tea (such as pelargonidin, anthocyanins, and malvidin found in red wine and berries) [86–88]. Flavonoids are often powerful plant pigments that protect free radical damage and support cells and cytokines that regulate immune responses [89]. Flavonoids play a crucial role in defending the immune system against respiratory infections [88,90]. The stability of polyphenols is different, particularly in the environment of intestinal digestion. For example, compounds, such as anthocyanins (flavanoids), in the duodenum are comparatively unstable [91], while the total polyphenols and anthocyanins in the simulated gastrointestinal digestion process are usually very stable, and the recovery rate is about 93–99% [92].

The flavonoids are in many foods, such as fruits and vegetables [93–96], nuts (walnuts and legumes) [97–100], spices, and drinks (red wine and tea) [101,102]. Chemically, flavonoids have a polyphenol structure, which gives them antioxidant activity. Though some of them are associated with these capacities, the biological activity of

2.3 Phenolic compounds

Polyphenols are pharmacologically active components with immunomodulatory activity [79]. This category contains flavonoids and phenolic acids, which are ubiquitous in plants and exist as free aglycones or esterified forms with glucose and other carbohydrates (glycosides) [80].
flavonoids goes beyond the properties of antioxidants. Certain types of flavonoids are effective against cancer [103,104], cardiovascular diseases (CVDs) [105–107], gastrointestinal changes [108,109], and related neurological syndromes, such as depression [110], epilepsy [111], and neurodegenerative diseases, i.e., AD [112,113].

3 Use of nutraceuticals in plant-based food against acute and chronic diseases

Currently, plant-based diets, vegetarianism, and veganism are gaining popularity. A properly composed plant diet provides all the necessary nutrients but can also have a positive effect on health [114]. Food of plant origin is credited with a positive influence in the prevention and treatment of many diseases. Table 2 presents a summary of the activity of some of the plant products.

3.1 Asthma attack and bronchitis

A diet of fresh fruits and vegetables can have a significant impact on the health of people with asthma. Foods of animal origin are rich in vitamin D, whereas vegetables are rich in β-carotene (carrots and leafy green vegetables). Moreover, food is a good source of magnesium, for example, spinach and pumpkin seeds [115]. Fruits and vegetables are also significant sources of antioxidants, such as beta-carotene and vitamins E and C. These substances aid in stopping particles called “free radicals,” which led to inflammation. Nutrients can improve the reaction of the immune system (the body’s resistance to bacteria) and can reduce inflammation in the respiratory tract [116,117]. Low vitamin D levels can cause more asthma attacks [118,119]. Rich in vitamin E plant-based diet is particularly beneficial for asthma [120]. Raw almonds, hazelnuts, seeds, and cruciferous vegetables (such as broccoli and kale) are good sources of this vitamin. Vitamin E can help reduce coughing and wheezing caused by asthma [121]. Investigations on asthma and diet have shown that undernourished young people are bound to have more frequent asthma symptoms. Lung function has also been proven to be worse in people who do not eat food with sufficient levels of vitamins C and E and ω-3 unsaturated fatty acids [122,123].

3.2 Broken bone

A bone break is an ailment where a ceaseless crack of bones happens. Likewise, breaks can be caused by certain ailments that debilitate bones [124], such as osteoporosis, certain malignancies, or osteogenesis imperfecta [125]. Bone tissue is principally an extracellular framework, not living cells. Consequently, open breaks and osteotomies require cautious protection methods and preventive utilization of anti-toxins [126]. An appropriate diet for healthy bones provides products containing vegetables, whole-meal products, nuts, and seeds. Calcium is found in green vegetables, dried beans, dark belt molasses, sesame seeds, and almonds [127]. Other nutrients are additionally significant for bone good condition, such as vitamin D, magnesium, vitamin B₁₂, vitamin C, and vitamin K [128].

3.3 Common cold and flu

The basic virus is a viral disease of the nose and throat (upper respiratory parcel). The normal chilly, otherwise called the regular cold, is a viral contamination of the upper respiratory parcel, which predominantly influences the respiratory mucosa of the nose, throat, sinuses, and larynx [129]. Signs and side effects under 2 days after the infection contamination may show indications, such as sore throat, runny nose, sniffing, and fever [130,131].

Vitamins C and D have the most noteworthy advantage for patients and can decrease the danger of pneumonia. Different enhancements, such as echinacea, vitamin E, and zinc, have some clinical information [132]. Zinc represses viral replication and has been used in preliminary efforts for the treatment of the basic virus. The past survey recognized 18 randomized controlled preliminaries that enrolled 1,781 members, everything being equal, and contrasted zinc and a fake treatment (without zinc) [133]. It has been demonstrated that taking zinc within 24 h of the beginning of side effects can diminish the span of the regular cold [134].

3.4 Pneumonia and respiratory infection

Pneumonia is an infection that inflames the air sacs in one or both lungs. It is practically difficult to stay away from infections and microorganisms. However, certain dangerous components can build the opportunity of getting intense
Table 2: In vitro and in vivo trials of plant-based food against different diseases

| Sources                | Common or scientific names | Bioactive/functional components | Type of study | Disorders            | Improvement                                                                                                                                                                                                 | References |
|------------------------|-----------------------------|---------------------------------|---------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Vegetables             | Morinda officinalis         | Fructooligosaccharide           | In vivo       | ADs                  | Significantly influence the brain function                                                                                                                                                               | [193]      |
|                        | Bok choy                    | Flavonols                       | In vitro      | Colon cancer         | Inhibit the cell proliferation of the human colon adenocarcinoma cell line                                                                                                                                  | [194]      |
| Spinach                |                             | Glycolipids                     | In vitro      | Cancer               | Significantly affect human cancer cell proliferation                                                                                                                                                     | [195]      |
| Carrot                 |                             | Polyacetylenic oxypilins falcariol and falkarinol | In vitro      | Colorectal cancer    | Significantly reduce the risk of colorectal cancer                                                                                                                                                        | [196]      |
| Potato                 |                             | Peptide                         | In vivo       | Kidney failure       | Significantly reduce in the number of apoptotic cells                                                                                                                                                     | [197]      |
| Red cabbage            |                             | Phenolic acids and flavonoids   | In vivo       | CVDs                 | Significantly reduce the levels of cholesterol, triglycerides, and lipoproteins                                                                                                                            | [198]      |
| Fruits                 | Apple                       | Phenolics and flavonoids        | In vivo       | Mammary tumors       | Significantly prevent mammary cancer                                                                                                                                                                       | [199]      |
|                        | Banana peel                 | Phenols                         | In vivo       | Acute liver failure  | Significant decrease in liver function, total cholesterol, triglycerides, low-density lipoprotein, and very-low-density lipoprotein                                                                       | [200]      |
|                        | Mango                       | Gallic acid and gallotannins    | In vivo       | Inflammation diseases | Significantly reduce the inflammatory response                                                                                                                                                           | [201]      |
|                        | Pomegranate and their peel  | Non-enzymatic and enzymatic antioxidant molecules | In vivo       | Human fertility      | The amount of male sex hormones, such as testosterone, follicular stimulating hormone, and luteinizing hormone, was increased with an increase in the level of pomegranate and their peel | [202]      |
|                        |                             |                                 |               |                      |                                                                                                                                                                                                            |            |
|                        | Grapefruits                 | Limonin and naringin            | In vivo       | Osteoporosis         | Reduce the calcium loss and higher plasma IGF-I level in rats fed with grapefruits                                                                                                                           | [203]      |
|                        | Guava-strawberry, guava-    | Phenolic acids and flavonoids   | In vivo       | Hyperglycemic and    | Reduce the levels of plasma glucose, urea creatinine, total cholesterol, and triacylglycerol levels in rats fed with functional puree                                                                       | [204]      |
|                        | blackberry, guava-soursop   |                                 |               | hypercholesterolemic |                                                                                                                                                                                                            |            |
| Seeds                  | Soybean                     | Isoflavone                      | In vivo       | Cardiovascular       | Soybean diet significantly reduced the serum LDL cholesterol level                                                                                                                                          | [205]      |
|                        | Sesame seeds                | Sesamin and sesamolin          | In vivo       | Liver diseases       | The rats fed with sesame seeds revealed that the activity of enzymes involved in fatty acid synthesis, including fatty acid synthase, glucose-6-phosphate dehydrogenase, ATP-citrate lyase, and pyruvate kinase, was significantly reduced | [206]      |
|                        | Chia seeds                  | Polyphenols and ALA             | In vivo       | Obesity              | The activity of plasma increased in the formulated diet while lowering the activity of thiol levels, plasma catalase, and glutathione peroxidase                                                                  | [207]      |

(Continued)
| Sources         | Common or scientific names | Bioactive/functional components                                                                 | Type of study | Disorders                  | Improvement                                                                                                           | References |
|-----------------|---------------------------|-----------------------------------------------------------------------------------------------|---------------|---------------------------|----------------------------------------------------------------------------------------------------------------------|------------|
| Flaxseed        | α-Linolenic acid          | In vivo CVD diabetes                                                                          |               | Administration of flaxseed improves the lipid profile and reduces the LDL cholesterol level | [208]       |
| Pumpkin seed    | Phenolic compounds, tocopherol isomers, and phytosterols | In vivo  Cancer arthritis                                                                     |               | Induce cell cycle arrest, reduce inflammation, and improve magnesium absorption, which results in good health of bones along with regulated sugar level | [209]       |
| Nuts            | Almond                    | Vitamins, unsaturated fats, and minerals                                                      | In vivo       | Lead toxicity             | Increased the growth and nutritional consumption by reducing the appetite depressant effect of lead on gastrointestinal tract | [210]       |
| Hazelnut        | Monounsaturated fatty acids and PUFA | In vitro Nonalcoholic fatty liver hyperlipidemia                                               |               | Diet contains different doses of hazelnut oil that affects the serum cholesterol profile and induced a high level of HDL | [211]       |
| Cashew nuts     | Phenolic acid and flavonoids | In vivo Gall stone anemia                                                                    |               | Increased the formation of red blood cell by the administration of iron, improved the ability of carrying oxygen to the other tissues | [212]       |
| Spices and herbs| Bay leaf                  | Essential oils                                                                                | In vivo       | Diabetes                  | Extract of leave (L. nobilis) has significant impact on blood glucose level                                           | [213]       |
|                 | Asafetida                 | Asafoetida                                                                                    | In vivo       | Chronic and acute pain    | Asafetida exhibited a significant antinociceptive impact on chronic and acute pain rats                               | [214]       |
|                 | Black cumin               | Cuminaldehyde, cymene, and terpenoids                                                         | In vivo       | Renal toxicity            | Significantly increased the minerals, vitamin D, nutritional markers, and antioxidant enzymes in rats fed with black cumin seed powder | [215]       |
respiratory contamination [135]. A high-protein diet is beneficial to patients with pneumonia. Food sources, such as nuts, seeds, and beans, have mitigating properties. In addition, they fix harmed tissues and construct new tissues in the body. Green vegetables, such as kale, lettuce, and spinach, comprise abundant in supplements that can help treat this respiratory contamination. They contain cell reinforcements, which shield the body from irresistible substances. Citruses are plentiful in vitamin C, such as oranges, berries, and kiwis, which help fortify the safe framework, accordingly advancing quick recovery. Likewise, they contain cell reinforcements, which protect the human body [136].

3.5 Coronavirus disease (COVID-19)

COVID-19 is a group of infections that cause human respiratory sicknesses. Extreme acute respiratory syndrome, middle east respiratory syndrome, and the regular virus are COVID-19. Elderly people and individuals with hidden clinical issues, such as cardiovascular infection, diabetes, constant respiratory illnesses, and malignancy, are predisposed to COVID-19 [137]. Food sources of plant origin increase the number of beneficial microbes. By utilizing a lot of water, minerals (such as magnesium, selenium, or zinc), micronutrients, spices, food sources plentiful in vitamins C, D, and E, and a healthy lifestyle, individuals can defeat this disease [12,138,139]. Numerous investigations have shown that the amazing cell reinforcement glutathione and the bioflavonoid quercetin can prevent diseases, including COVID-19. Thus, plant-based food varieties assume an imperative part in improving the resistance [140].

3.6 Diabetes

It is commonly known that eating plant-derived substances from botanical and organic foods, such as legumes, whole grains, fruits, vegetables, nuts, [141] and natural products are advantageous treatments against type 2 diabetes [142]. Plant-based diets are eating patterns that highlight legumes, whole grains, vegetables, fruits, nuts, and seeds and depress nearly all livestock products [143]. A group of studies greatly subsidize the function of vegetarian diets and foods and their nutritional substances in lowering the chances of type 2 diabetes [144]. Confirmation from interposing and experimental studies revealed the assistance of plant-derived foods in healing macro- and microcirculatory problems and type 2 diabetes. Ideal nutrients to block and control type 2 diabetes are arguable. Although authentication recommends that the class and origin of carbohydrates (unprocessed versus processed), lipids (unsaturated versus saturated and cis-trans), and proteins (herbal versus animal) serve a vital purpose in the elimination and handling of type 2 diabetes. Plant-based diets are critical and have a variety of prospective mechanisms in the improvement of the endurance of insulin, furthermore the of fit bodyweight, increment in fiber and plant-based nutrients, food-micro-floral relations, and in lowering hydrogenated fat, progressive glycation end results, nitrosamines, and cofactor of iron [145].

Less processed and agricultural-based foods have better opposition and glycemic management by presenting multiple procedures [146]. Herbal foods are rich in soluble fiber, phytochemicals, and magnesium, all of which encourage insulin sensitivity [147]. Antioxidants like polyphenols can retard glucose intake, restore insulin production, minimize hepatic glucose yield, and upgrade glucose absorption [148]. Fiber, which is present mostly in plant foods, harmonizes post-meal glucose reaction and is provoked by probiotics to generate short-chain fatty acids that may enhance glucose feedback, motioning of insulin, and insulin activity [149]. Moreover, the dwindling impedance of insulin is linked with foods that aid in satisfaction, weight reduction, are rich in fibers, and are less energy dense [150]. Soluble fibers boost insulin response and eliminate swelling [151]. Ultimately, a meal rich in herbal foods and less in protein portion is more influential in digestion by accelerating good microbial species and declining the assembly of trimethylamine N-oxide, a composite bonded to insulin strength [152].

In the long run, vegetable origin proved to prevent weight reduction and obesity [153], which are defensive characteristics in the insulin fight, compared meat consumption that trigger gradually increasing weight. Likewise, when less caloric and more proteinaceous food is taken for weight reduction, it will nullify to support slimness [154]. Smith et al. [155] found that for overweight and menopausal women, a simple, protein-rich diet terminated the remedial consequences in the reduction of weight loss on voluntary muscles, and insulin impulsiveness is possible because of the magnified oxidative burden.

3.7 CVD

Plant-based diets come with various flavors, but they all promote ingredients linked to heart health, such as whole
cereals, bananas, tomatoes, lentils, almonds, and olive oil [156]. These foods are high in fiber, vitamins, and minerals [157], tend to lower blood pressure and LDL cholesterol, minimize the risk of diabetes, and maintain a healthy weight, both of which reduce the risk of CVD [158]. Flavonoids obtained from dietary plant consumption support vascular endothelial cells, probably as antioxidants that inhibit low-density lipoprotein oxidation [159]. Research has linked that plant-based diets are reduced the risk of cardiovascular outcomes, especially whole grains, fruits, and berries [160]. According to the evidence from prospective cohort research, eating many plant-based foods (including fruits and vegetables, almonds, and whole grains) reduces the risk of coronary heart disease and stroke. Besides, mono-unsaturated fatty acids and PUFAs, ω3 fatty acids, antioxidant vitamins, minerals, and phytochemicals are supreme substances in CVD [161].

3.8 AD

Numerous epidemiological studies propose a connection between lifestyle, diet, AD, and different types of dementia. Besides, it has been demonstrated that metabolic conditions and issues, such as insulin opposition, weight, cardiovascular illnesses, diabetes, and AD, are unequivocally related. Dietary mediations and other preventive procedures can be powerful ways to deal with stopping or postponing the danger of AD, intellectual decay, and other non-mental comorbidities [162]. Numerous supplements take part in biochemical responses; for instance, admission of an eating regimen abundant in probiotics, cell reinforcements, plant-based food varieties, ω3 polyunsaturated unsaturated fats, soybeans, and nuts can help moderate AD. Besides, less utilization of creature-determined proteins, refined sugars, and low admission of saturated fats can be helpful in such a manner. Furthermore, plant-derived polyphenols are seen as important compounds that can help reduce the effects of AD [112].

3.9 Cancer

Botanical foodstuffs, such as fruits, vegetables, legumes, nuts, and cereals, are good sources of nutrients. Because this food is composed of some phenolic compounds and antioxidants, it reduces the risk of oxidative stress and saves cells from an injury that creates diseases like cancer. By promoting fiber utilization, plant foods can block the production of abnormal cells [163]. Moreover, fiber has been proven to protect against colorectal carcinoma [164]. Scientific studies have shown that whole grains, vegetables, fruits, beans, and nuts contain supplements and phytocomponents and exhibit the capability of altering gene expression [165]. Earlier studies exhibited that the most widely considered thing was the consequences of botanical food and nutrition on breast, colorectal, and gastrointestinal tumors. Organic and botanical diets exhibited remarkable protection against tumors and in addition to other cancers, long-lasting illnesses and disorders [166].

4 Conclusion

In this review article, a great deal of effort has been made to provide an understanding of how plant-based foods can be used in improving the immunity against acute and chronic diseases. Recently, it has been reported that plant-based foods are needed to maintain appropriate human body conditions. These foods mainly consist of fruits, vegetables, legumes, lentils, and beans. Functional components are present in leaves, roots, seeds, and grains and play significant roles in human health. The immune system can boost some plant-derived components, such as vitamins, minerals, antioxidants, and phenolic compounds, because these components aid in forming T cells, B cells, and antibodies and enhance the function of selenoproteins and neutrophils. A strong immune system can protect against acute diseases, such as viral diseases (COVID-19, pneumonia, common cold, and flu) and bacterial diseases (asthma and bronchitis). Chronic diseases, including cancer, diabetes, CVD, and AD risk, can be reduced by consuming plant-based foods because they are composed of components that inhibit oxidation and reduce blood sugar and cholesterol levels.

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