

Immunomodulatory Herbs & Fruits: A Comprehensive Review

Pratham Patel^{1*}, Mr. Nadim Chhipa², Dr. Pragnesh Patani³

¹Khyati College of Pharmacy, Palodia, Ahmedabad

²Associate Professor, Department of Pharmaceutical Chemistry and Quality Assurance, Khyati College of Pharmacy, Palodia, Ahmedabad

³Principal and Professor, Department of Pharmacology, Khyati College of Pharmacy, Palodia, Ahmedabad

***Corresponding Author:** Pratham Patel

Khyati College of Pharmacy, Palodia, Ahmedabad, Email: prathampatel17123@gmail.com

Abstract

The immune system, the body's defensive mechanism, protects the host from disease invasion. Immune system dysfunction is the root cause of many diseases, including allergies, asthma, arthritis, cancer, and other infectious disorders. Age-related changes in the immune system increase an older person's susceptibility to infections, vaccination failure, and possibly even autoimmunity and cancer. Immunomodulator medications boost the immune system's capacity to fight infections on both a specific and non-specific level. In Unani literature, numerous herbs with immunomodulatory qualities are mentioned as means of enhancing mental and physical well-being. Leucocytes, also known as white blood cells, are vital to the immune system because they may produce antibodies that fight a range of diseases that lead to illness. Individuals are now conscious of how the immune system is essential to preserving their well-being.

Thus, there has been a significant rise in the demand for foods that boost immunity. Naturally occurring fruits are often employed as immunomodulators; rigorous scientific evidence is all that is needed to support their efficacy. Fruits are rich in bioactive components, such as minerals, vitamins (A, C, E, etc.), and phytochemicals (β -carotene, flavonoids, tannins, and phenolics, etc.), as several studies have shown. By encouraging lymphocyte development, scavenging free radical species, reducing oxidative stress, and boosting anti-inflammatory in addition to immunomodulatory mechanisms and platelet aggregation support, these substances have the potential to boost human immunity. Thus, regularly including the appropriate number of fruits in our diet could strengthen our immune system and support our the body's organic defenses. In this prelude, we attempt to summarize the significant role that fruits' many phytochemicals and bioactive compounds play in bolstering our immune system.

KEYWORDS:

- Immune system
- Immunomodulator medications
- Unani literature
- Demand for immune-boosting foods
- Naturally occurring fruits
- Bioactive components
- Phytochemical functions

Introduction

The immune system is a sophisticated network of cells, tissues, and organs that work synergistically to defend against pathogens, such as bacteria, viruses, and fungi, while maintaining homeostasis. It consists of two primary components: the innate and adaptive immune systems. The innate immune system provides immediate, non-specific defense through physical barriers, innate immune cells (like macrophages and neutrophils), and inflammatory responses. In contrast, the adaptive immune system develops a targeted response against specific pathogens via T and B lymphocytes, which also provides immunological memory.[1][2][3] Immunity is the body's capacity to neutralize and eradicate harmful microorganisms and their byproducts, protecting the human in the process [4]. The immune system's age-related alterations enhance an aged person's vulnerability to infectious illnesses, vaccination failure, and potentially even autoimmunity and cancer [5].

Immunomodulation, the process of regulating the immune system, can be achieved through various means, including dietary supplements. Herbs and fruits have been used traditionally to support immune function, and contemporary research has increasingly validated these uses. In supporting immune health has garnered increasing scientific interest.[6][7] Immune system modulation refers to any alteration in the immune response that can include any aspect of the immune system, including its activation, expression, amplification, or inhibition reply. As a result, an immunomodulator is a drug that affects the immune system. Immunomodulators typically come in two varieties: immunosuppressants and inducers of immunity. This This review consolidates current

findings on the effectiveness of these natural products in enhancing immune responses with highlighting their mechanisms of action and potential therapeutic applications.[8][9]

This review aims to evaluate the current scientific evidence on immunomodulatory herbs and fruits, their mechanisms of action, and practical applications. We assess how these natural products can be integrated into daily life to support immune health, providing a comprehensive guide to their preparation and use.[10][11]

Immunomodulatory herbs

1. Echinacea(*Echinacea purpurea*)



Echinacea is a plant genus within the family Asteraceae (previously termed the Compositae) and is comprised of 11 taxa of herbaceous and flowering plants. Echinacea preparations (which are mainly based on three commercially important species; *Echinacea purpurea*, *Echinacea angustifolia*, and *Echinacea pallida*) are commonly used for preventing and alleviating the symptoms of bacterial and viral infection. Furthermore, some Echinacea preparations are known to exert antioxidant and anti-inflammatory activity espousing to its potential immunomodulatory activities. Both in vitro and in vivo studies demonstrated that different extracts from Echinacea, either from roots, above-ground parts, or a mixture of both, could stimulate and signal immune responses. Both aqueous extracts and alcoholic extracts are used. Differences between the species, the soil in which the plants are cultivated, the parts of the plant used, and the extraction procedures can result in substantial differences in chemical composition and biological activity.[12][13]

2. Elderberry(*Sambucus nigra*)



The berries of elder are one of our most treasured immune tonics—they are effective, nourishing, and delicious when prepared as a dark purple syrup. Taken daily throughout the fall and winter, elderberry offers us protection against colds, flu, and other viral infections. One study demonstrated elderberry's antimicrobial effects against two strains of the influenza virus and several bacteria that are commonly responsible for secondary, or concomitant, sinus infections with the flu. And in the case of an illness, elderberry is immune stimulating, diaphoretic (helps to break a fever), and anticatarrhal (decreases mucus in the respiratory passages). Studies show a lessening in the duration and severity of cold symptoms as well as the flu.[14]

3. Astragalus(*astragalus membranaceus*)



One of the biggest genera in the Leguminosae family, Astragalus is found throughout temperate and arid climates as annual, perennial, and subshrub shrubs. The number of species in the genus Astragalus is thought to exceed 3000. In traditional Chinese medicine (TCM), the roots of Astragalus are one of the major constituents of many herbal formulations. The Astragali Radix or "Huang Qi" is the dried roots of Astragalus membranaceus (*A. membranaceus*), which is a major component in tonic formulations used in TCM and is also popular worldwide. These days, astragalus is used to treat a wide range of illnesses, including cancer, viral infections, cirrhosis, diabetes, hypertension, leukemia, and nephritis. Above all, there is no evidence of toxicity. Furthermore, astragalus has antibacterial, anti-aging, anti-stress, diuretic, and liver-protecting properties in addition to boosting immunity. Astragalus is classified as a Grade-III National Protected Plant in China due to its medical significance and uses.[15][16]

4. Turmeric(*Curcuma longa*)



Due to its vivid yellow color, turmeric (*Curcuma longa*), commonly referred to as "Indian saffron," is a spice herb that is indigenous to Southeast Asia and the Indian subcontinent. It belongs to the ginger family (Zingiberaceae) and has been studied for more than 200 years. Turmeric is mostly produced in India, where it has been used for millennia as a flavoring ingredient and in Ayurvedic medicine. Turmeric derived from ground-dried root has varying amounts of volatile and non-volatile oils, proteins, lipids, minerals, carbohydrates, curcuminoids, and moisture according to its origin and growth conditions. Curcumin, which is marketed commercially, is actually a blend of three chemicals known as curcuminoids. The most common compound is curcumin (60–70%), which is followed by bisdemethoxycurcumin (10–15%) and demethoxycurcumin (20–27%). Curcumin does not clearly outperform the other two chemicals or the mixture as a whole; instead, curcuminoids varied in potency, effectiveness, and stability. In addition to curcuminoids, the other active ingredients in turmeric. Curcumin's immunomodulatory properties stem from its interactions with a variety of immunomodulators, which include not only elements like dendritic cells, macrophages, and B and T lymphocytes, but also molecular elements that contribute to inflammatory processes like cytokines and different transcription factors and they lead to signalling pathways.[17][18]

5. Ginseng(*panax ginseng*)



For over 5000 years, ginseng, a highly prized natural remedy, has been used, mostly in Far Eastern countries. China's Emperor Shen-Nung was the first to recognize the medical benefits of ginseng and a number of other herbs, and he also created what is regarded as the world's first pharmacopoeia. The popular name for the root of many plants in the Araliacea family's genus *Panax* (P.) is ginseng. The term "Panákeia" in ancient Greek is the source of the genus name *Panax*. It means "all healing" or "cure of all diseases." Similar to this, the word "ginseng" comes from the Chinese word "jen-shen," which translates to "plant-man" and may allude to the root's human form. The Greek word "panacea," whose etymology is identical to that of "panax," also implies that the ginseng root is a genuine and authentic panacea. Due to the anti-inflammatory qualities of many ginseng species, which are strongly linked to their capacity to modify the immune system, they have been utilized for generations.[19]

6. Green Tea (*Camellia sinensis*)



In terms of its primary constituents, green tea's chemical makeup is comparable to that of the plant's fresh leaves. It has a large number of polyphenolic chemicals, which make up as much as 30% of the dry weight of tea leaves. Most of the polyphenols in green tea are flavanols, generally known as catechin. Epicatechin, epicatechin-3-gal Le (ECG), epigallocatechin (EGC), and epigallocatechin Wlate (EGCG) are the main catechins found in green tea. depicts the chemical structures of these compounds. Moreover, theophylline, caffeine, dopamine, and phenolic acids, like additionally, green tea contains trace amounts of pllic acid.[20]

7. Garlic(*allivum sativum*)



Throughout human history, garlic (*Allium sativum*) has been used both medicinally and as a food. Garlic's ability to lower blood pressure has been associated with its synthesis of hydrogen sulfide and allicin, which is freed from alliin and the enzyme alliinase . Allicin has been proven in investigations on both human and animal cells to have vasodilating and angiotensin II-inhibiting activities. Reviews of garlic preparations and blood pressure as well as human primary research have yielded conflicting results. A 1994 meta-analysis revealed encouraging outcomes in those with mild hypertension, but it concluded that there wasn't enough data to support the use of garlic as a therapeutic treatment. It is appropriate to present an updated systematic review and metaanalysis of studies examining the impact of garlic preparations on blood pressure given the rising usage of complementary and alternative medicines for hypertension. Subgroup metaanalyses of hypertensive and normotensive subjects have been made possible by the incorporation of extra data from research conducted after 1994.[21]

SR NO.	HERBS	BIOACTIVE COMPOUNDS	PREPARATION	USAGE	REFERENCE NO.
1.	Echinacea (<i>Echinacea purpurea</i>)	Alkamides, polysaccharides, flavonoids	• Tisanes (steep 2-3 grams of dried herb in 250 mL boiling water for 10-15 minutes) • Tincture (extracted in alcohol) • Capsules.	Typically taken during the onset of cold symptoms or as a preventive measure.	12,13
2.	Elderberry (<i>Sambucus nigra</i>)	Anthocyanins, flavonoids, vitamins A and C.	• Syrup (cook elderberries with water and sugar, strain, and bottle) • Tisane extract	Commonly used to prevent and treat flu and cold symptoms.	14
3.	Astragalus (<i>Astragalus membranaceus</i>)	Saponins, flavonoids, polysaccharides.	• Tisanes (boil 10 grams of dried root in 500 mL water for 30 minutes) • Powdered supplement • Soup ingredient	Often used in soups or as a daily tonic for immune support.	15,16
4.	Turmeric (<i>Curcuma longa</i>)	Curcuminoids, including curcumin.	• Spice (add to food), • Tisanes (boil 1 teaspoon of turmeric powder in 250 mL water) • Supplements	Consumed daily as a spice or supplement for its anti-inflammatory and immune-enhancing properties.	17,18
5.	Ginseng (<i>Panax ginseng</i>)	Ginsenosides, polysaccharides including antioxidant benefits, Peptides.	• Tisanes (Steep dried Ginseng root in hot water for 10-15 minutes) • Tincture (Extract Ginseng root in alcohol) • Tablets • Capsules	Typically used for enhancing overall immune function and energy, with a common dosage of 200-400 mg of standardized extract daily.	19
6.	Green Tea (<i>Camellia sinensis</i>)	Catechins (particularly epigallocatechin gallate (EGCG), theaflavins, L-theanine.	• Tisanes (steep green tea leaves in hot water for 3-5 minutes) • Extract (Use standardized EGCG extracts) • Capsules/Tablets	Used for its antioxidant and immune-boosting properties, with typical doses of 250-500 mg of EGCG daily.	20
7.	Garlic (<i>Allium sativum</i>)	Allicin, S-allylcysteine, Di-allyl sulfides.	• Raw (Consume fresh garlic cloves) • Extract (Garlic oil or powdered extracts) • Supplement	Used for its antimicrobial and immune-enhancing properties, with typical doses of 600-1,200 mg of garlic powder daily.	21

Immunomodulatory fruits

1. Apples (*Malus domestica*)



Apples, or *Malus domestica*, are a widely consumed fruit that are rich in many different phytochemicals. Several studies have indicated that eating apples can improve one's health by lowering one's risk of developing diabetes, asthma, cancer, and cardiovascular disease. Apples have strong antioxidant properties that limit the growth of cancer cells and lower cholesterol and lipid oxidation. Apples that have a peel have a total antioxidant capacity equal to 83 μmol of vitamin C. This means that one apple, or around 100 g, has the same antioxidant capacity as 1500 mg of vitamin C, other than vitamin c it also contains Procyanidin B2, Rutin, Quercetin glycosides, Chlorogenic acid, Phloridzin, Epicatechin, Catechin.[22][23][24]

2. Bananas(*Musa paradisiaca* Linn)



The banana is a member of the genus *Musa* and family *Musaceae*, and it grows best in humid climates. It is rich in several different types of bioactive compounds, including phytosterols, carotenoids, biogenic amines, and polyphenols. It also has a good number of minerals, such as iron needed by those with high blood pressure and anemia, and potassium good for muscles. The amount of iron consumed affects how the body reacts to different diseases that enter the body. About 25% of the daily required amount of vitamin B, which is necessary for the production of several antibodies and an increase in red blood cell count, is found in bananas. Moreover, vitamin B is in charge of the increase in T lymphocyte counts. Bananas contain around 0.4 mg of vitamin B6 per 100 g of fruit. Ascorbic acid, the most powerful water-soluble antioxidant, may be found in bananas; the quantity varies from 6.9 to 10 mg/100 g of fruit. Bananas include ascorbic acid, dopamine, and other antioxidants that lower plasma oxidative damage and increase low-density lipoprotein resistance to oxidative modification. Because dopamine's o-dihydroxy structure contains an amino residue, it has a hydrophilic nature. According to Singh et al. (2016), it is equivalent to potent antioxidants like ascorbic acid and gallic acid and has a higher rate of radical quenching than catechin. Dopamine concentrations in banana peel and pulp range from 2.5 to 10 and 80 to 560 mg/100 g, respectively. It also contains α -Carotene, Quercetin, Dopamine, Ascorbic acid, Vitamin B6, Catechin, Gallic acid.[25][26][27]

3. Blueberries(*Vaccinium corymbosum*)



By controlling the balances in proinflammatory cytokines (interleukins like IL-6, IL-12, and IL-1 β), blueberries have been shown to have anti-inflammatory properties. The two anthocyanins found in blueberries in the highest concentration are malvidin-3-glucoside and malvidin-3-galactoside. When compared to malvidin-3-galactoside, malvidin-3-glucoside has generally been shown to have superior anti-inflammatory activity. The nuclear factor-kappa B pathway was used to monitor the anti-inflammatory properties of blueberries that included malvidin-3-glucoside and malvidin-3-galactoside in endothelial cells. Berries contain around 788.6 $\mu\text{g/g}$ f.w. of malvidin-3-galactoside. It was discovered that parts of fermented blueberry-blackberry wine that were high in anthocyanins and proanthocyanidins might prevent mice macrophages from responding inflammatory when exposed to lipopolysaccharide. An increase in Given 250 g of blueberries per day for six weeks, highly fit athletes showed reduced oxidative stress, natural killer cell activity, and anti-inflammatory cytokines. These findings demonstrated a positive correlation between anthocyanin content and immune function. Blueberries contain polysaccharides that can effectively suppress tumor development by 73.4%, making them an excellent immunomodulator. In mice, blueberries can enhance hepatic immunity in addition to protecting hepatocytes from oxidative damage and controlling T-cell activity (Ma et al., 2018). Monoglucosides, monoarabinosides, and monogalactosides of cyanidin, petunidin, peonidin, delphinidin, and malvidin are the many forms of anthocyanins present in blueberries. Overall it contains Anthocyanins, Vitamin C, Chlorogenic acid, Malvidin-3- galactoside, Kaempferol-3- glucoside, Cyanidin-3- galactoside, Petunidin-3- galactoside, Quercetin-3- Ogalactoside.[28][29][30]

4. Grapes(*Vitis vinifera*)



The nonclimacteric fruit known as grapes, or *Vitis vinifera*, is produced on woody vines that are both perennial and deciduous. A great water-soluble antioxidant, vitamin C, is abundant in grapes. Numerous epidemiological investigations have demonstrated that vitamin C scavenges reactive oxygen species, or free radicals, from our bodies, shielding lipids, DNA, and cells from oxidative damage. Grapes range in vitamin C concentration from 31 to 61 mg/100 g. According to Imran et al, grapes have several significant polyphenols that contribute to their health benefits, including antioxidant, antimicrobial, anti-inflammatory, anticancer, antiaging, and cardioprotective qualities. These polyphenols include anthocyanins, flavanols, flavan-3-ols, proanthocyanidins, and resveratrol. Grape anthocyanins and proanthocyanidins may influence immune system activity by promoting the production of $\gamma\delta$ T lymphocytes. These cells are abundant in the epithelial linings of the lungs, reproductive system, and stomach. They typically defend our body against external intruders initially. $\gamma\delta$ T cells are thought to play the functions of both suppressor and effector. Similar to CD8+ cells, $\gamma\delta$ T cells have the ability to induce apoptosis in both malignant and infected cells. Other than that, $\gamma\delta$ T cells encourage the production of IFN- γ and the death of cancerous cells, hence enhancing immunity against malignancies. A crucial attribute of $\gamma\delta$ T cells is their "suppressor activity." It was noticed that during the last stages of an infection, $\gamma\delta$ T cells interacted with macrophages, causing the macrophage cells to undergo apoptosis. Thus, it stopped the immune system's inflammatory reactions. According to research, bioactive components in grapes imitate molecular patterns linked with pathogens, keeping these cells ready to fight off any outside invaders. Overall it contains Vitamin C, Total phenolics, Anthocyanins, Proanthocyanidins, Gallic acid, Catechin (flavan-3-ol), Resveratrol, Quercetin, flavonol, Kaempferol.[31][32]

5. Kiwi fruit(*Actinidia chinensis*)



Before, the kiwi fruit was called the Chinese gooseberry. The common names for *Actinidia chinensis* and *Actinidia deliciosa* are green and gold kiwi fruit, respectively, it is a rather abundant source of potassium, phytochemicals, vitamin C, vitamin E, folate, and enzymes, particularly actinidin. Research has shown that adding kiwi fruit to one's diet can have positive effects on the immunological system, the gastrointestinal system, and the cardiovascular system. The immunomodulatory action of several useful components of gold and green kiwis. In mice previously treated with cholera toxin and diphtheria and tetanus toxoid, a meal supplemented with kiwi fruit extract resulted in a comparatively greater level of specific mucosal antibodies and improved natural killer cell activation (Shu et al., 2008). One of the primary functions of natural killer cells, which are cytotoxic

lymphocytes and an integral part of the immune system, is the elimination of malignancies and virally-infected cells. Given that kiwi fruit extract may increase splenocytes' natural killer cell activation, it can be said to possess the system of immunomodulation. Furthermore, it can alter cell-based immunity since it stimulated Th-1 cells, which increased the production of IFN- γ in mice given kiwi fruit extract. Increased cytokine production and delayed in vivo oxidative damage in mice given kiwi fruit juice orally supported the immunomodulatory activity (biological response modifier like activity) of kiwi fruit. Kiwi fruits have been shown to improve human immunity as well. Consuming kiwi fruits decreased the intensity and duration of influenza and cold symptoms in both young children and the elderly. Overall it contains Vitamin C, Vitamin E (α -tocopherol), β -Carotene, Folate, Lutein + zeaxanthin, β -Cryptoxanthin.[33][34][35]

6. Oranges(*Citrus sinensis*)



Oranges, or *Citrus sinensis*, are well-known for their nutritional and therapeutic qualities around the world. Citrus fruit consumers have a little risk of developing serious illnesses including cancer, hypertension, cataracts, strokes, and cardiovascular disorders, according to published research. The antioxidant characteristics of bioactive components including vitamin C, flavonoids, β -carotene, and folic acid—all of which are abundant in citrus fruits—are responsible for this protective effect. It has a good supply of vitamin C, a water-soluble antioxidant that prevents the production of free radicals and is essential for the immune system to function properly. They prevent DNA oxidation and promote the production of white blood cells. Oranges have a vitamin C content of 53–88 mg/100 g. While vitamin C plays a significant role in oranges' antioxidant capacity, the fruit's overall antioxidant potential is also influenced by nonnutritive elements including carotenoids and flavonoids. Oranges are also rich in folic acid, which supports Treg cell growth and helps the immune system work normally. It is present in around 0.03 mg/100 g. It contributes significantly to the prevention of cancer by regulating the expression of genes involved in cell proliferation and DNA methylation. Overall it contains Vitamin C, Folic acid, β -Carotene, Hesperidin, Naringin, Tangeretin, Nobiletin.[36][37][38][39][40]

7. Dragon fruit(*Selenicereus undatus*)



A subspecies of the cactus *Hylocereus* in the family Cactaceae is known as dragon fruit. The red dragon fruit is one of the about 16 species in the genus. An abundance of natural substances, including phenolics, flavonoids, carotenoids, anthocyanins, and terpenoids, may be found in the peel of red dragon fruit. Pectin, galacturonic acid, mannose, galactose, xylose, and rhamnose are also present. Antioxidant nutrients are essential to the immune system for hematopoiesis, cell membrane defense against reactive oxygen species (ROS), and the removal of harmful microbes. Reactive oxygen species (ROS) can cause a variety of illnesses, such as AIDS, hemorrhagic shock, rheumatoid arthritis, metabolic problems, cardiovascular disease, and neurodegenerative diseases of the

gastrointestinal tract. A chemical that modifies the immune system is called an immunomodulator. The innate and adaptive immune systems, which are made up of incredibly intricate biochemical processes, make up immunity. Polysaccharides, terpenoids, saponins, alkaloids, isoflavonoids, glucosides, tannins, fatty acids, steroids, triterpenes, and flavonoids are a few substances that can act as immunomodulators.[41][42][43]

SR NO.	FRUITS	BIOACTIVE COMPOUNDS	PREPARATION	USAGE	REFERENCE NO.
1.	Apple (<i>malus domestica</i>)	Flavonoids (Quercetin, catechin, epicatechin), Polyphenols (Chlorogenic acid, procyanidins), Vitamin C (Ascorbic acid), Dietary Fiber (Pectin, cellulose)	• Raw (Eaten fresh or added to salads) • Cooked/Baked (Used in apple pie, baked apples, or apple sauce) • Blended (Added to smoothies or juiced)	Immune Support (Vitamin C and polyphenols enhance immune function), Anti-Inflammatory (Quercetin and other flavonoids help reduce inflammation), Digestive Health (Dietary fiber supports gut health)	22,23,24
2.	Bananas (<i>Musa paradisiaca Linn</i>)	Vitamin C (Ascorbic acid), Vitamin B6 (Pyridoxine), Prebiotics (Inulin, fructooligosaccharides), Antioxidants (Dopamine, catecholamines)	• Raw: Eaten as is or added to fruit salads. • Blended: Used in smoothies or shakes. • Baked: Incorporated into banana bread or muffins. • Frozen: Sliced and frozen for use in smoothies or as a snack.	Immune Function (Vitamin C supports immune health), Digestive Health (Prebiotics promote beneficial gut bacteria), Energy Boost (Natural sugars provide quick energy)	25,26,27
3.	Blueberries (<i>Vaccinium corymbosum</i>)	Anthocyanins (Delphinidin, cyaniding), Vitamin C (Ascorbic acid), Flavonoids (Quercetin, kaempferol), Fiber (Soluble and insoluble fiber)	• Raw: Eaten fresh or added to salads. • Blended: Used in smoothies or yogurt. • Baked: Incorporated into muffins, pancakes, or bread. • Frozen: Used in smoothies or as a frozen snack.	Immune Health (Antioxidants and vitamin C support immune function), Cognitive Health (May improve memory and cognitive function) Anti-Inflammatory (Helps reduce inflammation)	28,29,30
4.	Grapes (<i>Vitis vinifera</i>)	Resveratrol (A polyphenol with antioxidant properties), Flavonoids (Quercetin, catechins), Vitamin C (Ascorbic acid), Phenolic Acids (Gallic acid, caffeic acid)	• Raw: Eaten fresh or added to salads. • Juiced: Freshly juiced or used in beverages. • Dried: Consumed as raisins. • In Cooking: Added to sauces or dressings.	Anti-Inflammatory (Resveratrol and flavonoids reduce inflammation), Cardiovascular Health (Supports heart health and improves blood circulation), Immune Support (Vitamin C enhances immune defense)	31,32
5.	Kiwi (<i>Actinidia chinensis</i>)	Vitamin C (Ascorbic acid), Flavonoids (Quercetin, kaempferol), Carotenoids (Lutein, beta-carotene), Fiber (Soluble and insoluble fiber)	• Raw: Eaten fresh, sliced, or added to fruit salads. • Blended: Used in smoothies or as a topping. • In Cooking: Added to savory dishes or desserts.	Immune Support (High vitamin C content boosts immune function), Digestive Health (Fiber aids in digestion and promotes gut health), Skin Health (Vitamin C supports skin health and collagen production)	33,34,35
6.	Oranges (<i>Citrus sinensis</i>)	Vitamin C (Ascorbic acid), Flavonoids (Hesperidin, naringenin), Carotenoids (Beta-carotene), Fiber (Pectin)	• Raw: Eaten as a whole fruit or segments. • Juiced: Freshly squeezed juice. • In Cooking: Used in salads, marinades, and dressings.	Immune Support (High vitamin C content boosts immune function), Skin Health (Vitamin C aids in collagen production), Digestive Health (Fiber supports gastrointestinal health)	36,37,38,39,40

			• Baked: Incorporated into baked goods like cakes.		
7.	Dragon Fruit (<i>Selenicereus undatus</i>)	Vitamin C (Ascorbic acid), Antioxidants (Betalains, carotenoids), Fiber (Soluble fiber), Polyphenols (Various phenolic compounds)	• Raw: Eaten fresh by cutting and scooping out the flesh. • Blended: Used in smoothies or fruit bowls. • In Salads: Added to salads for a colorful touch. • Juiced: Freshly juiced or used in beverages • Jelly(peel and dice the fruit then Blend the dragon fruit pieces and strain to obtain juice then Heat the juice with honey and agar-agar (a gelling agent) on the stove until it dissolves and thickens then Pour the mixture into molds and let it cool until it sets into a jelly)	Immune Health (Vitamin C supports immune system function), Digestive Health (Fiber aids in digestion and gut health), Antioxidant Protection (Helps combat oxidative stress)	41,42,43

Conclusion

It is well knowledge that allopathic treatment for immunomodulation in the elderly has a high rate of unanticipated pharmacological adverse effects. This is the point at which unani medicine becomes relevant. Herbal medicine's ability to modify the immune system may provide a cutting-edge method for treating a range of illnesses. Numerous medications in the Unani medical system have been discovered to be safe and effective in modifying the immune system. It is evident that medicinal herbs are very important in the fight against different illnesses. Many therapeutic plants and plant extracts have been documented to have important Numerous research have been conducted to determine Immunomodulator substances having the intended both a restricted toxicity and pharmacological action. The goal of this review is to provide scientific an explanation of how various useful sources that modulate immunity. A few organic resources plants have the potential to boost immunity similar to rhododendron spiciferum, Boerhaavia diffusa, caapparis zeylanica, Luffa, and Caesalpinia bonducella cylindrical, Asparagus, Withania somnifera, and racemosus, etc.

We are shielded from illnesses, poisons, allergenic proteins, infections, and unwelcome biological intrusions by our immune system. Any disruption to its functions might leave the host vulnerable to a wide range of diseases. All of the fruits covered above have encouraging immune-stimulating properties overall. A sufficient number of fruits must be consumed in order for our immune system to work at its best. Together with nonnutritive phytochemicals like tannins, carotenoids, flavonoids, and phenolic acids, they are rich in micronutrients including vitamins A, C, and E. These bioactive substances are critical for the production of antibodies, phagocytosis stimulation, pro-inflammatory cytokine activity inhibition, lymphocyte proliferation, and improved natural killer cell function. They maintain the surveillance state of our immune system and are essential in promoting cells engaged in both innate and the developed immunological reaction. The main way that free radicals save our body's cells from oxidative damage and strengthen our immunity is by scavenging them. Consequently, a diet lacking in fruits causes immunosuppression and increases our body's susceptibility to illness. Research indicating the precise mechanism of these bioactive chemicals' function is lacking, despite intriguing data about their significance in immune system regulation. Further in vivo research is required to fully comprehend the functions of different phytochemicals. This thorough analysis clarifies the makeup of phytochemicals in fruits as well as their mode of action; this knowledge might be further used to the development of innovative, naturally occurring immune-booster functional meals.

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