ROLE OF TRADITIONAL HOME REMEDIES AND MODERN NUTRACEUTICALS IN IMMUNITY ENHANCEMENT

Abstract: The immune system plays a vital role in protecting the human body against infections and diseases. In recent years, increased exposure to environmental pollution, lifestyle stress, and changing dietary habits have led to a significant decline in immune efficiency, making individuals more susceptible to various illnesses. Strengthening immunity has therefore become a global health priority. Traditional home remedies, long practiced in Indian and other ancient medicinal systems, utilize naturally available herbs such as **Turmeric (*Curcuma longa*)**, **Tulsi (*Ocimum sanctum*)**, **Ginger (*Zingiber officinale*)**, **Garlic (*Allium sativum*)**, and **Honey**, all of which possess potent antioxidant, antimicrobial, and anti-inflammatory properties that support immune health.

In parallel, **modern nutraceuticals** like **Vitamin C**, **Vitamin D**, **Zinc**, and **probiotics** have been scientifically validated for their roles in enhancing distinctive and adaptive immunity by promoting cellular defense mechanisms and maintaining gut microbiota balance. The combination of traditional herbal approaches with modern nutraceutical supplementation demonstrates a synergistic effect, offering a holistic and evidence-based strategy for immune modulation. Such integration has gained particular relevance during pandemic situations, where natural and preventive immunity-boosting methods play a critical role in maintaining public health.

This study highlights the complementary relationship between traditional remedies and modern nutraceuticals, emphasizing their mechanisms of action, therapeutic relevance, and potential in developing sustainable immunity-enhancing strategies for future healthcare.

Keywords: Traditional medicine, Immunity, Home remedies, Nutraceuticals, Turmeric, Tulsi, Ginger, Garlic, Honey, Vitamin C, Vitamin D, Zinc, Probiotics, Antioxidants, Pandemic immunity.

1. Introduction

1.1 Background

For centuries, herbs have played a vital role in India's traditional medicinal systems, serving as a foundation for natural healthcare. Traditionally used to enhance the flavor and aroma of foods, these herbs are now widely recognized for their therapeutic potential in strengthening immunity, improving digestion, reducing inflammation, balancing metabolism, and supporting overall health. Abundant in natural antioxidants, essential vitamins, minerals, and bioactive phytochemicals, these herbs contribute to the body's defense against oxidative stress and the onset of chronic degenerative diseases. (Gautam *et al*., 2020; Sharma & Dwivedi, 2021).

1. **Immunity**

Immunity refers to the body's **biological defense mechanism** that protects against harmful pathogens such as bacteria, viruses, and other disease-causing agents. It is primarily mediated by the **immune system**, which identifies and neutralizes foreign substances.

Broadly, immunity is classified into **innate (natural)** and **acquired (adaptive)** types.

- **Innate immunity** provides the first line of defense through physical barriers, phagocytic cells, and inflammatory responses.
- **Acquired immunity**, on the other hand, develops over time through exposure to pathogens or by **vaccination**, which introduces harmless antigens and trains the immune system for a faster and stronger response upon re-exposure (Murphy & Weaver, 2016; Chaplin, 2010).

Moreover, **immunity-enhancing foods and nutraceuticals**—rich in vitamins, minerals, antioxidants, and bioactive compounds—play a crucial role in maintaining and strengthening immune function, thereby reducing susceptibility to infections (Gombart, Pierre, & Maggini, 2020).

1. **Definition and Scope of Nutraceuticals**

The term "nutraceutical" was first introduced by Dr. Stephen DeFelice in 1989, combining the words "nutrition" and "pharmaceutical." It refers to foods or food components that provide medical or health benefits, including the prevention and treatment of disease (Brower, 1998; DeFelice, 1995). Nutraceuticals bridge the gap between food and medicine, forming a key component of preventive healthcare strategies in modern society.

1.3.1 Definition

According to the **Foundation for Innovation in Medicine (FIM)**, a nutraceutical is defined as "a food, or part of a food, that provides medical or health benefits, including the prevention and/or treatment of

disease" (DeFelice, 1995). Nutraceuticals can include **isolated nutrients, dietary supplements, herbal products, probiotics,** and **functional foods** that deliver physiological benefits beyond basic nutrition.

1.3.2 Classification

Nutraceuticals can be broadly categorized as follows (Nasri et al., 2014; Santini & Novellino, 2018):

Table 1: Classification of Nutraceuticals

Type	**Examples**	**Health benefits**
Nutrients	Vitamins (A, C, D, E, K), Minerals (Zinc, Selenium, Iron)	Improve metabolism, immunity; antioxidant activity.
Phytochemicals	Turmeric (Curcumin), Garlic (Allicin), Green tea (Catechins)	Anti-inflammatory, antioxidant, anticancer activity
Probiotics	*Lactobacillus, Bifidobacterium*	Expand gut health and immunity.
Dietary Supplements	Omega-3 fatty acids, Amino acids	Cardioprotective, anti-inflammatory.
Functional foods	Fortified dairy, cereals, and beverages	Support nutritional balance and immunity

1.3.3 Scope of Nutraceuticals

1.3.3.1 Preventive Healthcare

Nutraceuticals act as diet-based preventive managers, reducing the risk of chronic illnesses such as cardiovascular disease, diabetes, arthritis, cancer, and obesity. (DeFelice, 1995; Santini & Novellino, 2018)

1.3.3.2 Assistants to Conventional Therapy

Used along with pharmaceutical drugs, nutraceuticals help increase therapeutic outcomes and diminish drug-related side effects (e.g., antioxidants reducing chemotherapy toxicity). (Nasri et al., 2014)

1.3.3.3 Linking Nutrition and Medicine

They fill the hole between basic nutrition and pharmacological treatment, contributing functional health benefits outside basic nourishment. (Brower, 1998)

1.3.3.4 Functional Food Development

Nutraceuticals are utilized in developing functional foods fortified with bioactive compounds (e.g., omega-3 milk, vitamin-enriched cereals). (Gautam et al., 2022)

1.3.3.5 Regenerative and Anti-aging Potential

Some nutraceuticals (like polyphenols, carotenoids, and probiotics) have cell-protective and anti-aging effects, helping maintain metabolic balance and longevity. (Santini & Novellino, 2018)

1.3.3.6 Immunity Enhancement and Pandemic Relevance

The COVID-19 pandemic expanded the scope of nutraceuticals for immune variety, antiviral defense, and inflammation control. (Lordan et al., 2021; Gombart et al., 2020)

1.3.4 Table 2: Role of Nutraceuticals in Disease Prevention

Role	Example	Mechanism of action	Disease prevention	Reference
Antioxidant Defense	Vitamin C, Vitamin E, Polyphenols, Flavonoids, Selenium	Neutralize free radicals; reduce oxidative stress; protect cellular components from damage	Prevents oxidative cell injury, aging, cancer, and degenerative diseases	Nasri et al., 2014; Gombart et al., 2020
Anti-inflammatory Action	Omega-3 fatty acids, Curcumin, Resveratrol, Garlic	Inhibit COX and LOX pathways; suppress cytokine production (IL-6, TNF-α)	Reduces inflammation in arthritis, cardiovascular and metabolic disorders	Gautam et al., 2022; Santini & Novellino, 2018
Immune Modulation	Vitamin C, Vitamin D, Zinc, Selenium	Regulate immune cell activity (T-cells, macrophages); enhance antibody response	Strengthens immune defense against infections and supports vaccine response	Gombart et al., 2020; Lordan et al., 2021
Gut Health Improvement	Probiotics (*Lactobacillus*, *Bifidobacterium*), Prebiotics	Balance gut microbiota; improve intestinal barrier; modulate gut-associated lymphoid tissue (GALT)	Prevents gastrointestinal infections, enhances systemic immunity	Lordan et al., 2021
Cardioprotective Role	Omega-3 fatty acids, Phytosterols, Coenzyme Q10	Reduce LDL cholesterol, improve endothelial function, decrease triglycerides	Prevents atherosclerosis, hypertension, and coronary heart disease	Santini & Novellino, 2018

Metabolic Regulation	Polyphenols, Chromium, Dietary Fiber, Alpha-lipoic acid	Improve insulin sensitivity; regulate glucose and lipid metabolism	Helps in prevention of type 2 diabetes and metabolic syndrome	Nasri et al., 2014
Neuroprotective Effects	Omega-3 fatty acids, Curcumin, B-vitamins	Reduce neuroinflammation and oxidative stress; promote neurotransmission	Prevents neurodegenerative diseases like Alzheimer's and Parkinson's	Gautam et al., 2022
Cancer Prevention	Lycopene, Sulforaphane, Flavonoids, Catechins	Induce apoptosis, inhibit carcinogenic enzymes, block tumor growth signaling pathways	Lowers risk of certain cancers (breast, prostate, colon)	Santini & Novellino, 2018
Anti-aging & Regenerative Action	Resveratrol, Coenzyme Q10, Vitamin E	Enhance mitochondrial function; reduce cellular senescence	Promotes longevity and delays aging-related decline	Santini & Novellino, 2018
Antimicrobial Support	Garlic (allicin), Honey, Turmeric	Inhibit bacterial and viral replication; strengthen mucosal immunity	Protects against common bacterial and viral infections	Gombart et al., 2020; Nasri et al., 2014

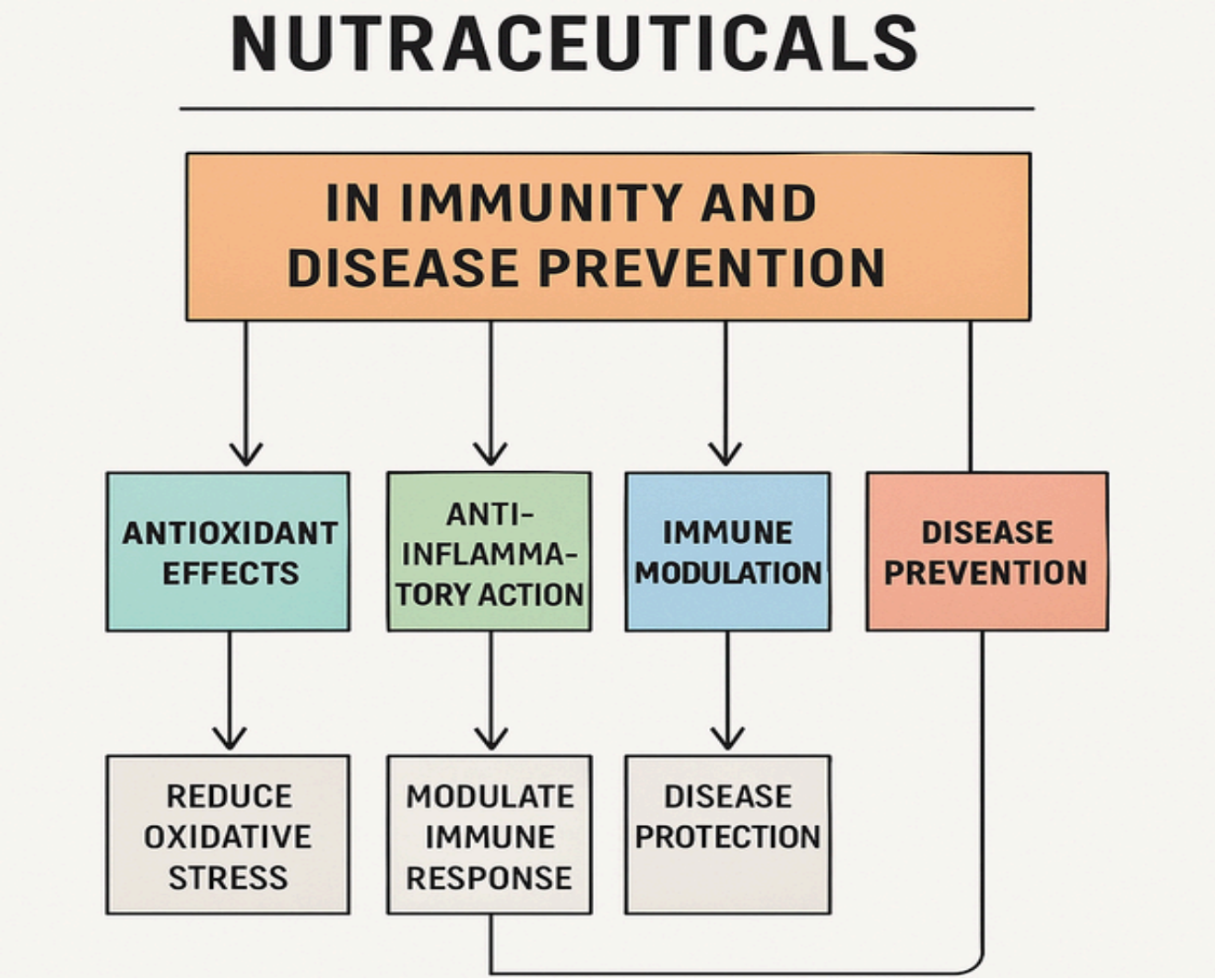

Fig.1: Mechanism of action of nutraceuticals in immunity and disease prevention.

Nutraceuticals exert beneficial health effects through antioxidant activity, anti-inflammatory action, immune modulation, and overall disease protection. *(Adapted from Gombart et al., 2020; Gautam et al., 2022; Santini & Novellino, 2018)*.

1.3.5 Purpose of the Report

This project report explores:

- The basic concepts of immunity and its relation to nutrition.
- Traditional herbs used historically and culturally (with special emphasis on Indian traditional medicine)
- Modern nutraceuticals (vitamins, minerals, probiotics) and their roles in immunity
- The synergy between traditional herbal remedies and modern nutraceuticals, especially in the context of pandemics (including COVID 19)
- Evidence from COVID-19 era research on how nutraceuticals and herbs may support immunity, modulate disease severity, and influence public health outcomes

2. Immunity: Basics

2.1 An Overview on Immune system

The immune system serves as the body's primary defense mechanism against potentially harmful or foreign agents. These agents, referred to as pathogens, include microorganisms such as bacteria, viruses, and fungi, as well as parasites like helminths and protozoa. In addition to infectious agents, the immune system also targets abnormal cells, including cancer cells, and may respond to foreign tissues or organs introduced during transplantation (Murphy & Weaver, 2016; Abbas, Lichtman, & Pillai, 2018).

To function effectively, the immune system must possess the ability to differentiate between "self" and "non-self" components. This recognition process allows immune cells to tolerate the body's own tissues while mounting a defensive response against foreign antigens. The capacity to identify and eliminate "non-self" elements while maintaining self-tolerance is fundamental to immune homeostasis and protection (Chaplin, 2010; Alberts et al., 2022).

2.2 Nutrition and Immune Function

Nutrition plays a crucial role in maintaining an **optimal immune response** by supplying immune cells with the necessary nutrients required for their development, activation, and function. Adequate intake of **micronutrients** including essential **vitamins (A, C, D, E, B6, B12)** and **minerals (zinc, selenium, iron, and copper)** is vital for supporting both **innate and adaptive immune mechanisms**. In addition, certain **macronutrients**, such as **amino acids (arginine, glutamine)**, **fatty acids (omega-3 and omega-6)**, and **cholesterol**, play significant roles in modulating inflammatory responses, cell signalling, and membrane integrity of immune cells (Calder, 2020; Gombart, Pierre, & Maggini, 2020).

Deficiencies or imbalances in these nutrients can impair immune cell function, increase susceptibility to infections, and delay recovery. Conversely, optimal nutritional status enhances resistance to pathogens and contributes to the regulation of immune homeostasis (Calder, 2020; Maggini et al., 2018).

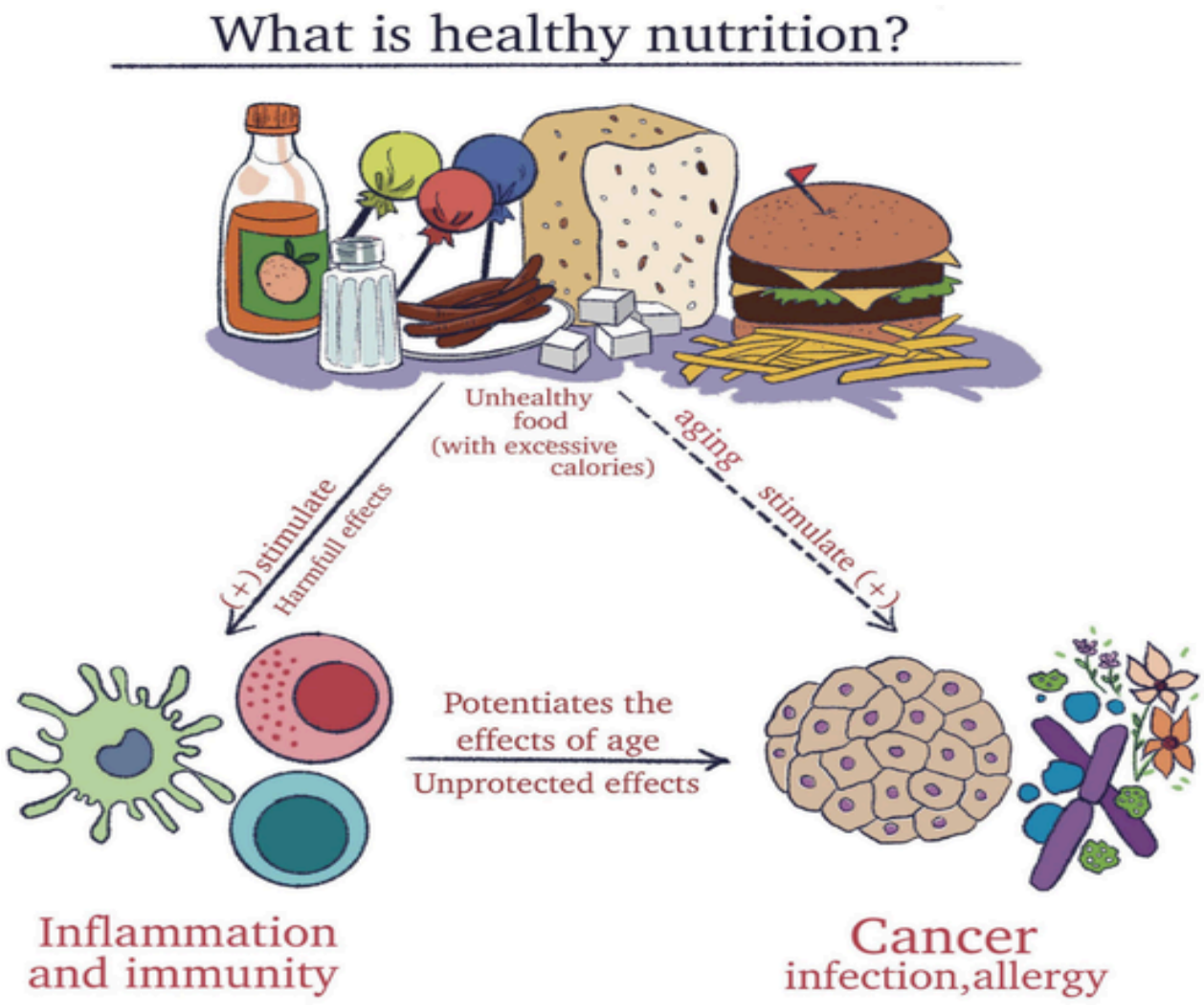

Fig.2: The importance of understanding the meaning of a healthy diet and concomitantly to recognize the harmful effect of pro-inflammatory foods that impact the immune system (Munteanu & Schwartz, 2022)

2.3 Immunity and Disease Prevention

A healthy immune system contributes significantly to the prevention of infectious diseases by recognizing and neutralizing pathogens before they establish infection. Vaccination complements this natural defense by inducing adaptive immunity, thereby providing long-term protection (Chaplin, 2010). Beyond infectious diseases, the immune system also plays a crucial role in the observation and elimination of precancerous and malignant cells, highlighting its importance in non-communicable disease prevention (Abbas, Lichtman, & Pillai, 2018).

Furthermore, lifestyle factors such as diet, physical activity, sleep, and stress management influence immune competence. Nutraceuticals and functional foods rich in antioxidants, probiotics, and bioactive compounds have been shown to strengthen immune defense and reduce disease vulnerability (Gautam et al., 2022).

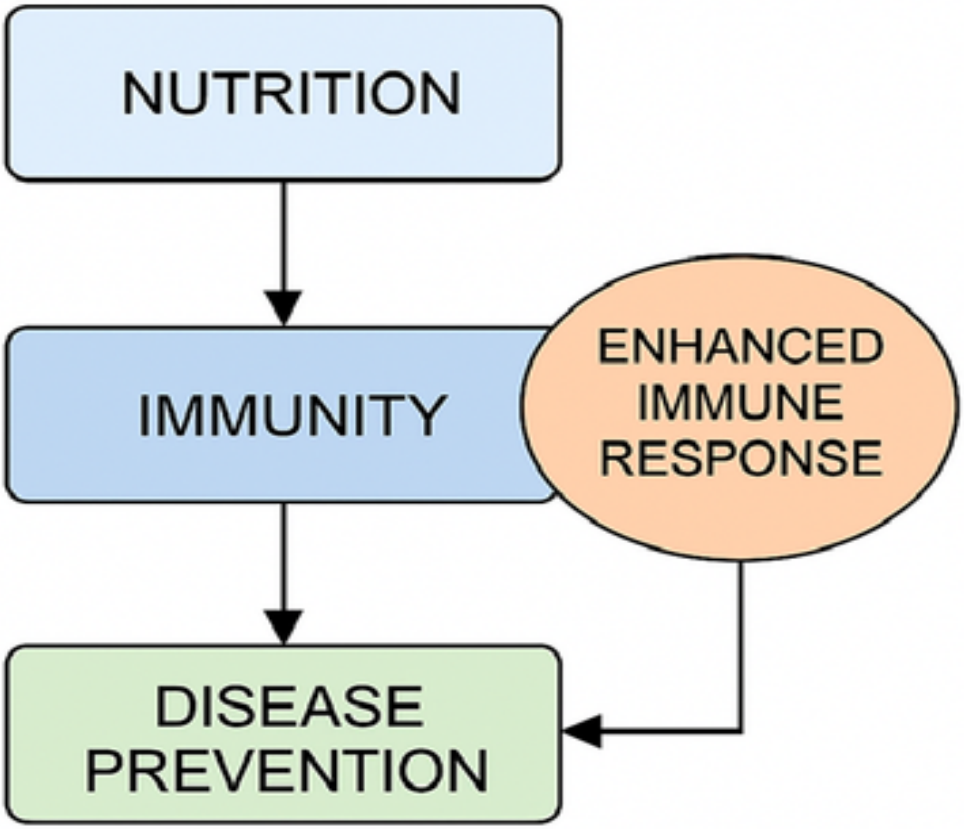

Fig.3: Nutrition, Immunity and Disease Prevention (Munteanu & Schwartz, 2022)

3. Traditional Herbs in Immunity Enhancement

3.1 Cultural and Historical Perspective

For **millennia**, herbal therapy has played a significant role in regulating the immune system. Many herbs have long been used to enhance immunity in traditional medical systems such as **Ayurveda**, **Traditional Chinese Medicine (TCM)**, and **Unani**. Modern scientific research has now validated the immunomodulatory potential of several of these herbs, leading to their inclusion in modern therapeutic practices.

According to the **World Health Organization (WHO)**, more than **75% of the global population** still relies on **traditional medicine**, primarily herbal-based, for their primary healthcare needs. Historically, **plants and herbs** have been indispensable companions of humankind, providing **food, shelter, and natural remedies** for a variety of illnesses. Ancient civilizations, including **Indian (Ayurveda)**, **Egyptian**, **Chinese**, **Japanese (Kampo)**, and **Greco-Arab (Unani-Tibb)** medical systems, have extensively relied on herbs for the treatment and prevention of diseases.

In recent decades, there has been a **renewed global interest** in traditional herbal medicine, supported by increasing **scientific studies** exploring the pharmacological potential of numerous medicinal plants. This fusion of **ancient wisdom and modern research** continues to enhance our understanding of the role of herbs in **immune modulation and overall health maintenance** (Verma & Sarvanan, 2025).

3.2 Common Traditional Herbs and their roles

Traditional herbal systems such as Ayurveda, Traditional Chinese Medicine (TCM), and Unani have long utilized medicinal plants to strengthen immunity and maintain physiological balance. Modern pharmacological research has validated the immunomodulatory, anti-inflammatory, and antioxidant properties of these herbs (Verma & Sarvanan, 2025).

3.2.1 Ayurvedic Herbs

- **Ashwagandha (*Withania somnifera*):** Acts as an *adaptogen*, enhances T-cell proliferation, strengthens immune resilience, and reduces stress-induced immunosuppression.
- **Tulsi/Holy Basil (*Ocimum sanctum*):** Boosts innate immunity by stimulating cytokine synthesis; has antibacterial, antiviral, and anti-inflammatory properties.
- **Guduchi (*Tinospora cordifolia*):** Promotes antibody generation, activates macrophages, and supports detoxification processes.
- **Amla (*Emblica officinalis*):** Rich in vitamin C and antioxidants, it enhances humoral immunity and protects immune cells from oxidative damage.
- **Turmeric (*Curcuma longa*):** Contains curcumin, which regulates cytokine production, reduces inflammation, and prevents chronic immune activation.

3.2.2 Traditional Chinese Medicine (TCM) Herbs

- **Huang Qi (*Astragalus membranaceus*):** Enhances resistance to infections, boosts white blood cell activity, and modulates cytokine balance.
- **Reishi Mushroom (*Ganoderma lucidum*):** Exhibits antiviral, anti-inflammatory, and adaptogenic effects by improving NK cell and macrophage function.
- **Ginseng (*Panax ginseng*):** Increases vaccine efficacy, stimulates antibody production, and enhances stamina and immune recovery.
- **Wu Wei Zi (*Schisandra chinensis*):** Acts as an adaptogen, improving stress response and immune stability.

3.2.3 Unani and Other Traditional Systems

- **Garlic (*Allium sativum*):** Stimulates antibody formation, enhances cytokine release, and displays broad-spectrum antimicrobial activity.
- **Ginger (*Zingiber officinale*):** Functions as both an immunostimulant and anti-inflammatory agent through activation of NK cells and macrophages.
- **Black Seed (*Nigella sativa*):** Known for its immunomodulatory and antibacterial actions; supports adaptive immune balance.

- **Aloe (*Aloe vera*):** Improves macrophage activity and supports wound healing and mucosal immunity.

Table 3: Common Traditional Herbs and Their Immunological Roles

Herb's name	**Primary immunological roles**	**Mechanism**
Ashwagandha	Immunostimulant	Increases T-cell activity and reduces stress-induced immune suppression.
Tulsi	Cytokine modulator	Enhances cytokine synthesis and respiratory immunity.
Guduchi	Immunomodulator	Activates macrophages and enhances antibody response.
Amla	Antioxidant & immune booster	Rich in Vitamin C; supports adaptive immunity.
Turmeric	Anti-inflammatory	Inhibits cytokines and TNF-α production.
Astragalus	Adaptogen	Enhances WBC activity and immune endurance.
Ginseng	Immunoadjuvant	Improves vaccine and drug efficacy.
Garlic	Immunostimulant	Promotes cytokine release and antibody formation.
Ginger	Immunomodulator	Activates macrophages and NK cells.
Black seed	Immunoregulatory	Enhances adaptive immune balance.

3.3 Evidence Supporting the Role of Traditional Herbs in Immunity

- Multiple studies have demonstrated that **ashwagandha** enhances both humoral and cell-mediated immunity by increasing immunoglobulin levels and controlling cytokine balance. It upregulates macrophage and natural killer (NK) cell activity (Singh et al., 2021).
- **Curcumin**, the main active compound, has been shown to regulate T-cell proliferation, suppress pro-inflammatory cytokines (IL-6, TNF-α), and act as a potent antioxidant (Hewlings & Kalman, 2017).
- **Tulsi** exhibits broad-spectrum immunomodulatory activity by enhancing Th1 cytokine response and promoting antibody production (Cohen, 2014).
- Research indicates that **Giloy** polysaccharides stimulate macrophages, improve phagocytosis, and elevate nitric oxide production (Saha & Ghosh, 2012).
- Rich in vitamin C and polyphenols, **amla** enhances leukocyte function and protects immune cells from oxidative damage (Krishnaveni & Mirunalini, 2011).
- **Allicin**, a sulfur-containing compound, obtained from **garlic**, exerts immunostimulatory effects by activating macrophages and lymphocytes, while reducing the risk of infections (Arreola et al., 2015).

3.4 Consideration for use

Although traditional herbs are helpful for improving immunity, some points need to be carefully considered:

- **Quality and Purity:** The amount of active compounds can differ from one product to another. Using standardized and good-quality herbal preparations ensures safety and proper results (Singh et al., 2021).
- **Right Dose and Form:** The benefits of herbs depend on how much and how they are taken. For example, curcumin from turmeric is better absorbed when used with piperine from black pepper (Hewlings & Kalman, 2017).
- **Combination with Other Medicines:** Some herbs can change how regular medicines work — such as garlic with blood thinners or ashwagandha with sleep medicines — so they should be used carefully (Arreola et al., 2015).
- **Safety:** Herbs are generally safe, but too much or long-term use can sometimes cause side effects. Scientific testing helps make sure they are safe (Cohen, 2014).
- **More Research Needed:** Many studies have been done on animals or small groups of people. Larger human studies are needed to confirm their real benefits and safety (Saha & Ghosh, 2012; Krishnaveni & Mirunalini, 2011).

4. Modern Nutraceuticals in Immunity Enhancement

Dietary supplements rich in biologically active compounds, known as nutraceuticals, are increasingly recognized for their ability to boost immune function by influencing multiple key pathways in the immune system. Among the most studied groups are vitamins (A, C, D, E, and the B-complex), mineral salts (e.g., zinc, selenium, copper, magnesium), polyunsaturated omega-3 fatty acids (PUFAs), plant-derived

phytochemicals (such as polyphenols and β-glucans), and probiotic microorganisms (Medoro et al., 2023)

- **Vitamins:**
- Vitamin A assists with gut-barrier integrity and supports B- and T-cell development, as well as macrophage cytokine production.
- Vitamin C acts as an antioxidant and plays roles in fibroblast function, epithelial barrier maintenance, and enhancing B- and T-cell proliferation and antibody synthesis.
- Vitamin D modulates immune cell behavior by suppressing pro-inflammatory cytokines and promoting antimicrobial peptide production in cells such as macrophages and epithelial cells.
- Vitamin E influences innate immune responses, reducing oxidative stress in immune cells and improving T- and B-cell activity in older individuals.
- B-vitamins support immune cell metabolism and function: for example, deficiencies may impair T-cell responses or enhance pro-inflammatory signaling.
- **Mineral salts:**
- Zinc is essential for both innate and adaptive immunity; its deficiency can dampen NK-cell activity, reduce immune cell differentiation, and weaken barrier defenses.
- Selenium supports immune homeostasis and antioxidant enzyme function and has been shown to enhance NK-cell cytotoxicity, especially in older adults.
- **Polyunsaturated omega-3 fatty acids (n-3 PUFAs):**

These fatty acids (e.g., DHA, EPA) and their metabolites (resolvins, protectins, maresins) help regulate inflammation by modulating immune-cell signaling pathways such as NF-κB, aiding resolution of inflammation and supporting immune balance.

- **Phytochemicals and fungal-derived bioactive:**

Plant- and fungus-derived compounds (e.g., polyphenols, β-glucans) have demonstrated immune-regulatory properties—such as enhancing NK-cell or macrophage activity, supporting autophagy in immune cells, and balancing pro- and anti-inflammatory cytokines.

- **Probiotics:**

Certain probiotic strains contribute to immune health by strengthening the gut barrier, interacting with immune receptors (like Toll-like receptors) in the intestinal mucosa, and enhancing functions such as phagocytosis, NK-cell activity, and antibody production.

4.1 Limitations and Safety Considerations

Modern nutraceuticals like vitamins, minerals, omega-3 fatty acids, probiotics, and plant compounds are useful for improving immunity. However, there are some important **limitations and safety issues** that should be understood before using them regularly.

4.1.1 Quality and Standardization

Not all nutraceutical products are made the same. The amount of active ingredients can differ between brands, which can change how well they work. Poor-quality products may even contain harmful substances like heavy metals or chemicals (Daliu et al., 2019).

4.1.2 Limited Human Studies

Many studies on nutraceuticals have been done in animals or for a short time in small groups of people. Because of this, scientists still need more long-term research to know the best dose, safety, and effectiveness in humans (Martinez-Lopez et al., 2020).

4.1.3 Overuse and Side Effects

Taking too much of certain nutrients can cause health problems. For example, high doses of **vitamin A, D, or E** can be toxic because they build up in the body. Too much **zinc or selenium** can also weaken the immune system instead of helping it (Calder et al., 2020).

4.1.4 Interaction with Medicines

Some nutraceuticals can affect how regular medicines work. For instance, large amounts of **vitamin E** may increase bleeding risk in people using blood-thinning drugs. Probiotics may interfere with some medicines that suppress the immune system (Gombart et al., 2020). Always consult a doctor before mixing supplements with medications.

4.1.5 Different Effects in Different People

People don't respond to nutraceuticals in the same way. Age, health condition, diet, and genes can all change how well these products work or if they cause side effects (Martinez-Lopez et al., 2020).

4.1.6 Misleading Health Claims

Some products are advertised as "immune boosters" without strong scientific proof. This can mislead people into self-medicating and ignoring proper medical treatment when needed (Daliu et al., 2019).

5. Synergy: Traditional Herbs + Modern Nutraceuticals & Pandemic Use

5.1 Concept of Synergy

Combining traditional herbs with modern nutraceuticals can offer a more complete immunity. Herbs supply many natural compounds that support immune balance and reduce inflammation, while nutraceuticals like vitamins, minerals, and probiotics correct the specific nutrient gaps.Together, these two approaches can work synergistically. Their combined action may improve overall immune strength and resistance to infections (Daliu et al., 2019).

5.2 Use in the Context of Pandemics

During pandemics such as COVID-19, limited medical treatments were available at first. Because of this, many people turned to dietary supplements and herbal remedies to strengthen their immunity and reduce infection risk (US Pharmacist, 2021).This trend showed the growing public attention in natural and preventive health approaches when conventional options were still under development.

5.3 Example: COVID-19 and Nutritional Interventions

Research from the COVID-19 period provides strong evidence for the immune benefits of certain nutrients:

- Lack in vitamin D, zinc, and selenium was linked with worse infection results and higher mortality rates (Mousa et al., 2022).
- Reviews highlighted that vitamin C, vitamin D, and zinc help control inflammation and support antiviral immune activity (Bae et al., 2020; Calder et al., 2020).
- Probiotics and macronutrient balance were also reported to help maintain gut health and regulate immune responses in SARS-CoV-2 infection (Conte & Toraldo, 2020).

5.4 Practical Considerations & Public Health Implications

Supplements and herbs aid immunity but cannot replace proper nutrition.

Public health strategies should focus on:

- Encouraging healthy diets rich in natural immune-supporting foods,
- Correcting nutrient deficiencies,
- Promoting safe and evidence-based supplement use, and
- Integrating these approaches with standard medical care.

The synergy between traditional herbal medicine and modern nutraceuticals offers a holistic and preventive model for health, especially in global health emergencies. However, further scientific validation, standardization, and regulatory control are essential to ensure both safety and effectiveness (Martinez-Lopez et al., 2020).

6. Evidence from the COVID-19 Era

6.1 Nutrient Status and COVID-19 Outcomes

Many studies showed that people with low vitamin D levels (25-hydroxyvitamin D) were more likely to experience severe COVID-19 infection, deferred recovery, and gentler viral clearance (D'Avolio et al., 2020).This shows that maintaining good nutritional status, especially vitamin D, may help improve immune defense and infection outcomes (arXiv, 2021).

6.2 Supplementation Trials and Limitations

Many clinical trials and experimental studies have explored the roles of vitamin D, vitamin C, zinc, and probiotics in COVID-19 prevention and treatment.

However, the findings are unpredictable. Some studies showed benefits, while others found little or no effect.

Experts highlight that supplement use should be observed as supportive, not as a replacement for medical care or vaccines (Harvard Health, 2021).

6.3 Implications for Future Pandemics

The COVID-19 pandemic emphasized how nutrition and immune health are closely linked.Nutraceuticals and traditional herbs can be useful as preventive or balancing trials, helping to support immunity.

However, they should be used together with vaccines and medical treatments, not as substitutes.In future pandemics, participating good nutrition, balanced diets, and evidence-based supplementation into public health strategies may improve overall outcomes (Calder et al., 2020).

7. Discussion

7.1 Integrative Perspective

Using traditional herbs together with modern nutraceuticals offers a balanced and complete way to improve immunity.

This collective approach may be especially supportive for people who have low nutrient consumption, weak immunity, or live in polluted and high-stress environments.

Herbal therapies support overall immune balance, while nutraceuticals like vitamins and minerals correct specific deficiencies.

Together, they can reinforce both innate and adaptive immune responses (Daliu et al., 2019; Calder et al., 2020).

7.2 Gaps and Research Needs

Even though evidence is growing, more research is still required to confirm the profits of combining herbs and nutraceuticals.

Current challenges include:

- A lack of large, high-quality clinical trials testing herbal–nutrient blends.

- The need for standardization of herbal products in terms of purity, dosage, and safety (Martinez-Lopez et al., 2020).
- Identifying which groups benefit most- for example, people who are nutrient deficient against those who are not.
- Studying the longstanding effects and probable drug interactions when used alongside conventional medicines (Gombart et al., 2020).

7.3 Practical Recommendations

To make the best use of herbs and nutraceuticals for immune health, some practical steps are recommended:

- Focus on correcting common nutrient deficiencies such as vitamin D, zinc, and iron (Calder et al., 2020).
- Use herbs naturally in food and as spices, rather than in high doses without professional advice.
- Take nutraceutical supplements under medical guidance, not as substitutes for vaccines or prescribed medicines (Harvard Health, 2021).
- Ensure product quality, safety testing, and proper labeling, and promote public education about responsible use (Daliu et al., 2019).

8. Conclusion

Traditional herbs have been dominant to natural healthcare systems for centuries, and modern nutraceuticals bring the benefit of targeted micronutrient or probiotic interferences. Together, they hold important potential for immunity enhancement and disease prevention. In the face of pandemics like COVID-19, their roles become even more relevant but must be grounded in evidence, safety, and integrative public-health strategy. The synergy of herbs + nutraceuticals offers a holistic path forward; yet more research is needed to realize it fully.

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