CHAPTER 20

Ayurvedic Medicinal Plants as Immunity Stimulant: A Comprehensive Guide

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SUMMARY

The ancient Indian traditional medical system known as Ayurveda has long recognized the value of natural treatments, such as medicinal plants, in enhancing immune system function and general well-being. The main Ayurvedic medicinal herbs recognized for their ability to stimulate immunity include *Ocimum sanctum* (Tulsi), *Emblica officinalis* (Amla), *Azadirachta indica* (Neem), and *Withania somnifera* (Ashwagandha), show a range of immunomodulatory benefits, such as increased immune cell activity, anti-inflammatory responses, and antioxidant qualities. Gaining knowledge about and utilizing the benefits of these Ayurvedic medicinal herbs can greatly boost immunity and enhance general well-being. In Ayurveda, ashwagandha is a typical adaptogenic plant used to decrease stress and strengthen immunity. It is thought to strengthen the body's resistance to a range of illnesses and infections. In Ayurveda, tulsi is revered as a sacred herb. It can help boost immunity and fight infections because of its antibacterial and immunomodulatory qualities. Neem possesses antiviral, antibacterial, and antifungal properties. It is useful in treating and preventing a variety of infections since it strengthens the immune system and purifies the blood. This chapter elaborates on certain medicinal plants known for their immune-stimulating properties.

HISTORY OF THE AYURVEDIC SYSTEM

Human beings are widely dependent on the traditional system of medicines for the rapid curing of different kinds of pathological conditions. The Ayurvedic system of medicine was the most ancient system of healing. It originated in India approximately five thousand years ago. The main goal of the Ayurvedic system of medicines is to keep every living organism healthy. It is also known as the "mother of healing" due to its greater influence on other systems of medicine including Tibetan, Greek, and Chinese medicines (Rutuja et al., 2022). The word Ayurveda is derived from the combination of two words; Ayur means life and Veda means to know. Hence Ayurveda can be defined as the "science of life". Vata (Space and Air), pita (Fire and Water), and kapha (Earth and Water) are the three basic biological components in which Ayurveda divides life. The aforementioned basic elements are further extracted from the five elements known as earth (dharti), water (jal), energy, space (Akash), and wind [vayu (Gosavi et al., 2022)]. Ayurveda is a group of medicinal plants and herbs that have the ability to treat diseases by implementing a holistic approach. On the other hand, when any cell or tissue gets infected, immunity comes to rescue and acts as a first-line protective agent in the prevention of a plethora (abundant). Due to this reason, at the present time, immunomodulation holds an important place in dealing with different pathological conditions. Here is a brief description of immunity.

IMMUNITY

The human body is exposed to various kinds of infections due to the presence of contagious bacteria and viruses in the surroundings. Immunity is the ability of the body to recognize and fight against the harmful impacts of disease-causing invaders, such as bacteria and viruses. The system of providing defense and resistance against the likeliness of pathological conditions is known as the immune system (Saini, 2021). The stimulation of immunity or immunostimulation is pivotal in the

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prevention and procurement of different diseases. As aforementioned, the enhancement of immunity plays a significant role against pathogens. Immunity stimulation can be defined as the mechanism of boosting the immunity or immune system by using different kinds of immunostimulating agents in the form of medicines and other functional food (Panda et al., 2020).

TYPES OF IMMUNITY

Innate immunity

The human body has different barriers that provide defense against invaders. Innate immunity comprises the first line of defense that human beings possess. The skin is considered a physical barrier and the outermost line of defense against pathogens. Innate immunity responds immediately to the invasion of any harmful foreign agent via the secretion of different chemicals like mucous, gastric acid, saliva, sweat, and tears to provide resistance. Innate immunity also causes inflammation of the infectious places that bring immune cells to the place of infection. The innate immune system consists of different cells, such as macrophages, neutrophils, eosinophils, mast cells, and dendritic cells. The innate immune system acts as the first line of defense against different pathogens. It has pattern recognition receptors (PRRs) that recognize particularly the structure present on the surface of the pathogen and activate the innate immunity until the other immune response comes (Carty et al., 2021). Moreover, platelets are the primary cells which work to maintain the homeostatic balance. They possess the most significant groups of PRRs, such as toll-like receptors (TLRs) that are found on the surface of the platelets. Likewise, innate immune cells also release cytokines which have anti-inflammatory and pro-inflammatory activities to stimulate the immune response (Dib et al., 2020).

Adaptive immunity

On the other hand, human beings also have adaptive immunity. It resists foreign invaders by the mechanism of adaptation. Whenever any pathogen (antigen) invades, our body produces a particular kind of protein (antibody) against the invader. This antibody circulates in the blood and immunizes the body against a specific antigen. This process is called adaptive immunity (Sompayrac, 2023).

CONCEPT OF IMMUNOLOGY IN AYURVEDA

In Ayurveda, immunity holds an important place. According to Ayurveda, the human body is said to be healthy (swastha) if it maintains homeostatic equilibrium. A word, *Vyadhikshamatva*, refers to a kind of resistance or defense against pathogens or diseases. This resistance is either innate or adaptive. It keeps the body (*sareera*) in a healthy condition. Likewise, ojus (A quantifiable liquid in the body responsible for energy and overall health) is also important in the process of disease prevention or procurement. It is a vital form of energy that is responsible for the strengthening of the immune system. A sufficient amount of ojus prevents the likeness of any pathology. In a nutshell, Ayurveda largely depends on a well-balanced (swastha) immune system to decrease the possibility of disease. In Ayurveda, Vyadhikshamatva, or body resistance is rejuvenated by a special type of therapeutic group of herbs called Rasayana (Pradeep et al., 2022).

Rasayana therapy

Rasayana therapy mainly deals with the nourishment of tissues of the whole body. It strengthens the immune system by providing the nutrients that are essential to deal with the pathologies. The word Rasyana is derived from the combination of two words Rasa (vital juice or fluid of the human body or serum) and Ayana (pathway to progress). So, Rasayana therapy is a special kind of therapy that prolongs the health of tissues and enhances immunity against diseases (Bhagwan & Ravindra 2020). The father of Indian medicines, Acharya Charaka, has labeled Rasayana as one the efficient sources of obtaining excellent quality rasadidhatus (tissue elements). It acts at different levels in distinguishable ways to strengthen the immunity of the human body (Bhagwan & Ravindra 2020).

AYURVEDIC MEDICINAL PLANTS AS IMMUNITY STIMULANT

The Ayurvedic plants which act as an immunostimulant by enhancing the immune response of the body against different infections are described below.

OCIMUM SANCTUM

In the Ayurvedic medicinal system, *Ocimum* (*O.*) *sanctum* holds a preeminent place and is known as the "Queen of Herbs" Tab 1. In the modern era of pharmacology, different research experiments have strengthened the shreds of evidence about the advantageous nature of *O. sanctum.* The main and most significant action of the *O. sanctum* plant is to strengthen the immune response by enhancing cellular and hormonal immunity (Singh, 2020). The pharmacological activities of *O. sanctum* are given in Fig 1.,

Morphology of the *O. sanctum* plant

The plant of *O. sanctum* has a peculiar appearance. It is the native shrub of India and other Asian countries. After getting mature the plant achieves a height of approximately 75 to 90 centimeters. The leaves of *O. sanctum* appear round with a

margin of 5 cm long. Its fruit shows a distinguishable phenotype. It is yellow to reddish and possesses beneficial effects to maintain the body's homeostasis (Kumar et al., 2022).

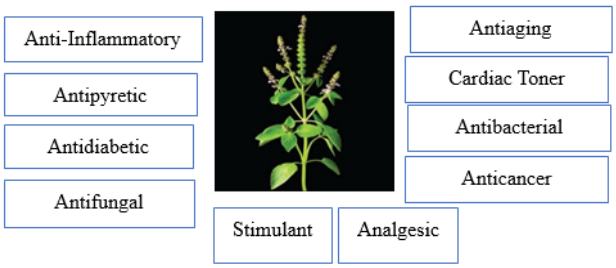

Fig 1. Health benefits of tulsi

Chemical constituents of *O. sanctum Linn*

Different parts of *O. sanctum* contain different but vital chemical constituents (Bano et al., 2017). The leaves contain terpenoids, alkaloids, flavonoids, saponins, phenols, and steroids. Likewise, the stem possesses flavonoids, phenols, tannins, and triterpenoids. The seeds of the *O. sanctum* plant have sitosterol and fatty acids. In a nutshell, we can say that the plant of *O. sanctum* as a whole contains flavonoids, alkaloids, saponins, anthocyanins, and other pharmacologically important components (Siva et al., 2016). Likewise, *O. sanctum* possesses novel therapeutic potentials due to the above-mentioned parts and constituents. It is an efficient cardiac toner. Cardiac toner increases the oxygen supply to the heart (Ganguly et al., 2022).

Immunomodulatory activity of *O. sanctum*

The *O. sanctum* plant shows immunomodulatory effects by enhancing the resistance against different ecto-and-endo parasites. It promotes different secretions, such as the release of cytokines, secretion of immunoglobulins, cellular co-receptor expression, and the phenomenon of phagocytosis. After the emergence of the 2019 novel coronavirus SARS-CoV-2, the mounting importance of immunity got more limelight (Callender et al., 2020). It has the ability to halt the phenomenon of viral multiplication intracellularly. The alcoholic extracts of the leaf of the *O. sanctum* plant show efficient activity against hepatic parasites and modulate the humoral response as well (Ghokeet et al., 2018). In a nutshell, the *O. sanctum* plant strengthens the activity of macrophages and consequently, enhances the innate immunity of the human body. It also contains an important constituent named ursolic acid which is beneficial in the treatment of different diseases related to the immune system (Tamoli et al., 2023).

Tab 1. Taxanomy of *Ocimum Sanctum* Linn (Kumar et al., 2022)

Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Asteriidae
Order	Lamiales
Family	Lamiaceae
Genus	*Ocimum*
Species	*O. sanctum*

Tab 2. Taxonomy of *Azadirachta indica* (Uzzaman, 2020)

Kingdom	Plantae
Sub Kingdom	Tracheobionta
Division	Magnoliophyta
Class	Eudicot
Subclass	Rosidae
Order	Sapindales
Family	Meliaceae
Genus	*Azadirachta*
Species	*A. indica*

AZADIRACHTAI NDICA PLANT

Neem is the common name for the *Azadirachta* (*A.*) *indica* plant most commonly found in India and Pakistan Tab 2. The *A. indica* plant is well-known for decades due to its increasing pharmacological importance Fig 2. The *A. indica* plant contains different chemical constituents which possess multiple important pharmacological activities. These components include azadirachtin, nimbolinin, quercetin, nimbin, salamin, and gedunin (Ojewumi et al., 2022).

Fig 2. Pharmacological importance of neem

Pharmacological importance of *A. indica*

The aqueous leaf extracts of the *A. indica* plant possess efficient immunostimulatory activity. Its leaves enhance the immune response by targeting non-specific immunity. Research has shown the fact that the insertion of 4% of *A. indica* leaf in fresh drinking water stimulates immunity (Dasgupta et al., 2023). It stimulates the human immune response by promoting the antigen-antibody reaction. It enhances the production of immunoglobulins, specifically immunoglobulin G and immunoglobulin-M. It contains various ingredients which activate the macrophages and lymphocytes by the phenomenon of the cell-mediated immune response. Due to these reasons, leaves and other components of *A. indica* are used in the

preparation of different medicines for the treatment of the Human Immunodeficiency Virus, HI as it aims to boost immunity (Asghar et al., 2022).

GLYCYRRHIZA GLABRA

Glycyrrhiza glabra Linn is most commonly known as the Mulethi in India and Pakistan. In the English language, it is called *Licorice*. It is beneficial in the treatment of different diseases and acts as an efficient immunostimulant Fig 3., and Tab 3. It is most commonly used to cure pathologies related to the respiratory tract. These pathological conditions include asthma, bronchitis, and the recently emerged COVID-19 virus. In addition, it acts by targeting the function of the membrane of macrophages involved in the immune response (Prajapati et al., 2021).

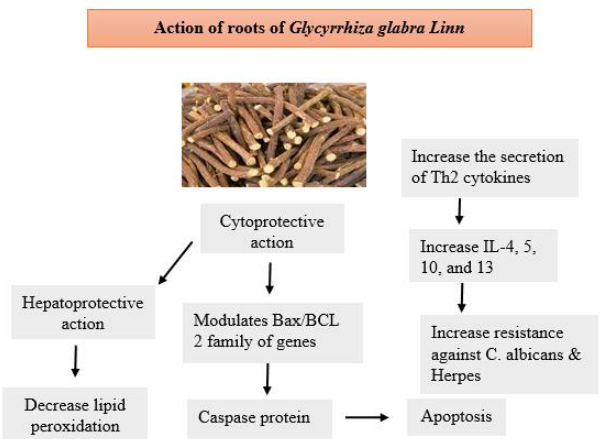

Fig 3. Immunomodulatory action of *Glycyrrhiza glabra Linn*

Chemical constituents and pharmacological importance of *G. glabra*

The *G. glabra* plant has some therapeutically significant components. These components include glycyrrhizic acid, glabridin, and isoliquiritigenin. These components have special therapeutic effects (Sarkar et al., 2023). The *G. glabra* plant contains different constituents that are required to deal with different kinds of diseases. These chemical constituents include glycyrrhizin, licochalcones, and glycyrrhizic acid. Due to the presence of the above-mentioned chemicals, this plant is well-known for its antioxidant, anti-inflammatory, immunostimulant, antitussive, anticancer, and antiviral activities. This plant has advantageous effects in the procurement of cough. Likewise, the roots of the plant are consumed to establish sexual wellness (Saikia et al., 2022).

G. glabra as an immunomodulator

It is one of the most cost-effective and easily available immunomodulators. The extracts of *G. glabra* possess the ability of immunostimulation. In these extracts, purified polysaccharide extracts are the most common for the modulation of macrophage-related immune activity (Bisht et al., 2022). Likewise, *G. glabra* in combination with other immunostimulant plants directly potentiates the T-cell function and enhances the immune response of the body (Kaur et al., 2017). In addition, some other extracts, such as hydroalcoholic extract of *G. glabra* and glycyrrhizic acid also have immunomodulatory impacts (Sheikhi et al., 2021). Due to the immunity-stimulant activity of the plant, it protects the different cells, tissues, and organs of the human body (Bisht et al., 2021).

Tab 3. Taxonomy of Gl*ycyrrhiza glabra Linn* (Lohar et al., 2020)

Kingdom	Plantae
Division	Angiospermae
Class	Dicotyledonae
Order	Rosales
Family	Leguminosae
Genus	*Glycyrrhiza*
Species	*G. glabra*

EMBLICA OFFICINALIS GAERTN. (AMALAKI)

The botanical name of Amalaki is *Emblica officinalis Gaertn.* and is labeled as a streamlined immunomodulator that possesses a holistic therapeutic activity Tab 4. It is most commonly known as Indian gooseberry and in the Hindi language, it is called Amla Fig 4 (Jaiswal et al., 2022).

Tab 4. Taxonomy of *Emblica Officinalis* Gaertn (Pawar & Sonar 2022)

Kingdom	Plantae
Division	Angiosperm
Class	Dicotyledonae
Order	Geraniales
Genus	Emblica
Species	E. officinalis

Chemical constituents of *E. officinalis*

It contains different chemical and biologically active ingredients which play a significant role in the pharmacological activities of the commonly known Indian gooseberry plant. It possesses various therapeutic uses. It is used as an anticancer, gastroprotective, and cytoprotective herb. Likewise, Indian gooseberry enhances memory, and its regular use helps in immunomodulation (Sandhyarani et al., 2022). It has pharmacological uses due to the presence of different disease-

curing chemical constituents. The constituents and strong medicinal properties of *E. officinalis* are presented in Fig 4.

E. officinalis Gaertn. as an immunomodulator

It is one of the best natural immunomodulators. It acts as a radical scavenger and promotes the activity of antiaging of different cells (Bhat et al., 2022). It acts as an immunostimulant. Likewise, it promotes the phenomenon of defense to counter the stress induced due to free radicals. The reason behind this immunostimulating activity of *E. officinalis* is the presence of ascorbic acid (Vitamin C) as one of the important constituents. The availability of Vitamin C enhances the activity of natural killer cells and promotes the cellular toxicity response based on antibody-dependent reaction (Variya et al., 2016). Vitamin C is required as a necessary component to promote many enzymatic activities. It acts as a cofactor or precursor in many enzyme reactions (Akbari, 2016). The potential of vitamin C as a potent immunostimulator has been recognized since 1930. The concentration level of vitamin C is high in macrophages and monocytes which exhibits the regulatory role of ascorbic acid as an immunomodulator. Likewise, it also modulates the process of expression of genes in human macrophages which are induced and instigated by the lipopolysaccharides (Parahuleva et al., 2016). It also acts as a synergistic pharmacological compound with other antibiotics and portrays anti-bacterial activity (Mousavi et al., 2019).

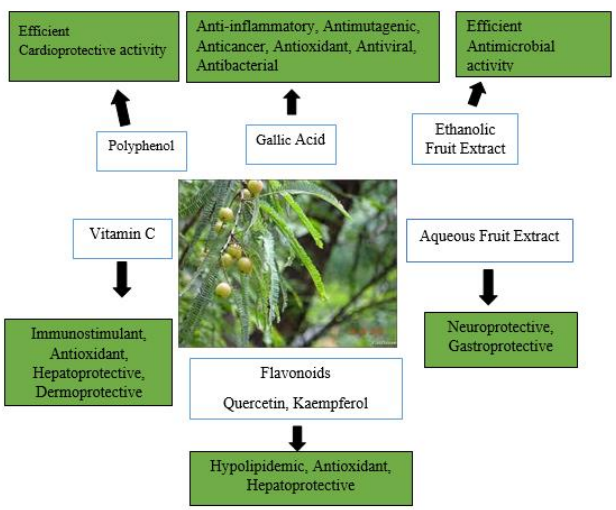

Fig 4. Therapeutic uses of *Emblica officinalis*

TERMINALIA CHEBULA RETZ

Terminalia chebula Retz or Haritaki given in Fig 5 is known as one of the most potent ayurvedic plants with a lot of pharmacological activities Tab 5. The dry form of the fruit of Haritaki is used most commonly for treatment purposes. It is known as *Harad* in Hindi and Myrobalan in English (Sultan et al., 2023).

Chemical constituents of *T. chebula*

It possesses many bioactive compounds. These compounds have different but very strong therapeutic potentials. It contains many phenolic compounds, such as anthraquinone and glycosides (Sultan et al., 2023). Likewise, it also possesses hydrolyzable and non-hydrolysable tannins. It has many other components, such as quercetin, maslinic acid, galloyl glucose, and oxalic acid (Ahmad et al., 2020).

Tab 5. Taxonomical Classification of *Terminalia chebula Retz* (Bulbul et al., 2020)

Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Myrtales
Genus	*Terminalia*
Species	*T. Chebula*

Pharmacological importance of *T. chebula Retz*

The studies (*In vitro)* have confirmed the distinguishable therapeutic role *T. chebula* in the procurement of a lot of pathological conditions. These pharmacological properties include anti-diabetic, antioxidant, antimicrobial, hepatoprotective, and neuroprotective activities. Some of its components also have immunomodulatory, particularly immunostimulant activity (Kim et al., 2022).

Tab 6. Taxonomical Classification of *Withania somnifera Dunal* (Gaurav et al., 2023)

Kingdom	*Plantae*
Division	*Angiosperm*
Class	*Eudicots*
Order	*Solanales*
Genus	*Withania*
Species	*W. somnifera*

Fig 5. *Terminalia chebula Retz* along with its Fruit

T. chebula Retz as an immunomodulator

It has an efficient immunomodulatory activity. It acts as an immunomodulator by enhancing hormonal antibodies. In addition, the extract of the plant has the potential to induce delayed-type hypersensitivity (Babar et al., 2022). Different studies have revealed some astonishing facts about the immunomodulatory effect of *T. chebula*. According to these studies, the aqueous extract of the *T. chebula* increases the number of lymphocytes and synergizes the immune response (Mane et al., 2020). Likewise, the extract of *T. chebula* enhances the levels of superoxide, catalase, glutathione, and dismutase (Nigam et al., 2020).

WITHANIA SOMNIFERA DUNAL

Withania somnifera Dunal is the botanical name of the Indian Winter Cherry Tab 6. In Hindi, it is known as the Asgandh or Punir. Similarly, in Urdu *W. somnifera*is called Asgand. It possesses many therapeutic uses. Moreover, this is a shrub that has the ability to act against drought conditions (Ahmad & Dar, 2017).

Chemical constituents of *W. somnifera Dunal*

It has many therapeutic uses and is also known as a miracle ayurvedic herb in the field of medicine due to the presence of a plethora of chemical components. During the study of the phytochemistry of the plant, many advantageous chemical constituents have been found in the aerial parts and roots. These parts contain 12 alkaloids, 40 withanolides, and many sitoindosides.

Pharmacological importance of *W. somnifera Dunal*

This plant has significant pharmacological activities due to the presence of the aforementioned biologically active chemical constituents. Different extracts of *W. somnifera* possess different pharmacological activities. These include immunomodulatory, hepatoprotective, hypolipidemic, cardioprotective, and hypoglycemic activities. Likewise, the plant also used to treat depression and anxiety conditions (Hussain et al., 2023).

Immunomodulatory actions of *W. somnifera Dunal*

It contains two distinguishable but important constituents, such as withanoside-4 and withanoside-A. *W. somnifera* plant has some trace elements as well that show immunomodulatory activity (Girme et al., 2020). The roots of *W. somnifera* are of great significance aimed at their immunostimulatory potential. These roots potentiate cell-mediated immunity and give adaptogenic responses as well. The root extracts of *W. somnifera* show antistress potential (Andriichuk et al., 2017).

CONCLUSION

The system of Ayurvedic medicines has been acknowledged for its mounting significance in the field of pharmacology. The Ayurvedic plants possess remarkable disease-curing potential. All ayurvedic medicines have a holistic capability to act as immunomodulatory, anti-inflammatory, anti-diabetic, anti-microbial, hepaprotective, and gastroprotective substances. Immunity plays a significant role in the procurement of pathological conditions. Due to their immunostimulatory potential, ayurvedic plants are of the main concern. Hence Ayurvedic medicines should be streamlined in the arena of pharmacology due to their fewer adverse effects.

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