Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/cpzbr369

IMMUNEBOOSTING HERBS TRADITIONALLY USED IN HOUSEHOLDS

Pratham M Gurav [1 *], Dr. Deepak Pokharkar [2] , Dr. Rupesh Pingale [3]

[1*]Pratham M Gurav Department of Quality Assurance M-Pharm , NCRD'S Sterling Institute of Pharmacy , Navi Mumbai , India .
[2]Dr. Deepak Pokharkar Department of Quality Assurance.
[3]Dr. Rupesh Pingale Department of Pharmacognosy.

***Corresponding Author :** Pratham Gurav
*Email : prathamgurav29@gmail.com Contact no. : 8080146406

Abstract :
The mammalian immune system is vital for defending the body against infectious diseases and harmful pathogens. This paper reviews various herbs traditionally used for their immune-boosting properties. Specifically, it explores ginger, black pepper, turmeric, Tulsi , fenugreek, and ashwagandha, highlighting their active constituents and health benefits. These herbs exhibit immunomodulatory, anti-inflammatory, and antioxidant properties, making them effective in enhancing both innate and adaptive immunity. With their rich phytochemistry, they provide natural alternatives to synthetic drugs, offering holistic immune support with fewer side effects. The use of these herbs, prominent in traditional medicine systems like Ayurveda, holds promise for both preventive health and therapeutic applications. The findings emphasize the importance of incorporating these herbs into daily routines to strengthen the immune system, particularly in the face of emerging diseases.

Key Words : Immune-boosting hearbs , traditionally used , fewer side effect , alternative to synthetic one .

INTRODUCTION :

The problems that the mammalian immune system solves are not restricted to higher animals; they are faced by all forms of life and are ignored by none. Emerging infectious diseases have as much potential to shape future human history as the epidemics and pandemics of the past. Managing this threat depends on understanding how to maximize the potential of our sophisticated immune system in the service of human health (1) . This may be defined as the body's ability to identify and resist large numbers of infectious and potentially harmful microorganisms, enabling the body to prevent or resist diseases and inhibit organ and tissue damage. The immune system is not confined to any one part of the body. Immune stem cells, formed in the bone marrow, may remain in the bone marrow until maturation or migrate to different body sites for maturation. Subsequently, most immune cells circulate throughout the body, exerting specific effects. The immune system has two distinct but overlapping mechanisms with which to fight invading organisms, the antibody-mediated defense system (humoral immunity), and the cell-mediated defense system (cellular immunity) (2). Beyond structural and chemical barriers to pathogens, the immune system has two fundamental lines of defense: innate immunity and adaptive immunity. Innate immunity is the first immunological

mechanism for fighting against an intruding pathogen. It is a rapid immune response, initiated within minutes or hours after aggression, that has no immunologic memory. Adaptive immunity, on the other hand, is antigen-dependent and antigen-specific; it has the capacity for memory, which enables the host to mount a more rapid and efficient immune response upon subsequent exposure to the antigen. There is a great deal of synergy between the adaptive immune system and its innate counterpart, and defects in either system can provoke illness or disease, such as inappropriate inflammation, autoimmune diseases, immunodeficiency disorders and hypersensitivity reactions. (3) The immune system refers to a collection of cells, chemicals and processes that function to protect the skin, respiratory passages, intestinal tract and other areas from foreign antigens, such as microbes (organisms such as bacteria, fungi, and parasites), viruses, cancer cells, and toxins. innate immunity and adaptive immunity. Innate immunity represents the first line of defense to an intruding pathogen. It is an antigen-independent (non-specific) defense mechanism that is used by the host immediately or within hours of encountering an antigen. The innate immune response has no immunologic memory and, therefore, it is unable to recognize or "memorize" the same pathogen should the body be exposed to it in the future (4). Adaptive immunity, on the other hand, is antigen-dependent and antigen-specific and, therefore, involves a lag time between exposure to the antigen and maximal response. The hallmark of adaptive immunity is the capacity for memory which enables the host to mount a more rapid and efficient immune response upon subsequent exposure to the antigen. Innate and adaptive immunity are not mutually exclusive mechanisms of host defense, but rather are complementary, with defects in either system resulting in host vulnerability or inappropriate responses (5) (6). Immunostimulants are inherently non-specific as they are envisaged as enhancements to a body's resistance to infection. They can act through innate as well as adaptive immune responses. In healthy individuals, the immunostimulants are expected to serve as prophylactic and promoter agents, that is, as immunopotentiators, by enhancing the basic level of immune response. In the individual with impairment of immune response, they are expected to act as immunotherapeutic agents (7) There are, however, many natural ingredients know to help boost your immunity. Since ancient times, herbs and spices were well known for their medicinal properties, with over 80 spices grown in different parts of the world, particularly in Asia. India is home to several spices that are used extensively in traditional medicine. According to the World Health Organization (WHO), around 80% of the world's population uses herbal medicines for primary health care, particularly across Europe and South Asia. Research indicates that many of these herbs not only have antiinflammatory properties but they also help build up the body's natural immunity. Moreover, unlike allopathic medicines like antibiotics, which can have serious side effects, most of these herbs and spices are relatively safe. Ayurveda stresses the use of plant-based medicines and treatments. Various plants identified in the Indian Ayurvedic system of medicine display a wealth of pharmacological properties. The Ayurvedic system of medicine is one of the oldest systems of medicine and includes various ethnopharmacological activities such as immunostimulation, tonic, neurostimulation, antiaging, antibacterial, antiviral, antirheumatic, anticancer, and adaptogenic (8). A number of medicinal plants as Rasayanas have been claimed to possess immunomodulatory activity, for example, Holy Basil, Ginger, Fenugreek, garlic, turmeric, and liquorice (9). This herbs have been used traditionally by our fourfathers and have best effects. In this review we are gonna see some natural ingredients which have herbal medicinal property for boosting our immunity and should be present in every ones house for basic treatment.

GINGER :

Synonyms: Zingiber, Zingiberis.
Biological source: Ginger consists of rhizomes of Zingiber officinale.
Family: Zingiberaceae
Description :
Ginger (Zingiber officinale Rosc.) belongs to the family Zingiberaceae. It originated in South-East Asia and then used in many countries as a spice and condiment to add flavor to food. Besides this, the rhizome of ginger has also been used in traditional herbal medicine. The health-promoting perspective of ginger is attributed to its rich phytochemistry. Jolad *et al*. grouped fresh ginger into two wide range categories, i.e. volatiles and non-volatiles. Volatiles include sesquiterpene and monoterpenoid hydrocarbons providing the distinct aroma and taste of ginger. On the contrary, non-volatile pungent compounds include gingerols, shogaols, paradols, and zingerone. (10)
Active constituents :
Ginger contains a number of pungent constituents and active ingredients. Steam distillation of powdered ginger produces ginger oil, which contains a high proportion of sesquiterpene hydrocarbons, predominantly zingiberene. The major pungent compounds in ginger, from studies of the lipophilic rhizome extracts, have yielded potentially active gingerols, which can be converted to shogaols, zingerone, and paradol. The compound 6-gingerol appears to be responsible for its characteristic taste. Zingerone and shogaols are found in small amounts in fresh ginger and in larger amounts in dried or extracted products. (11)
Beneficial effects :
Ginger has staring potential for treating a number of ailments including degenerative disorders (arthritis and rheumatism), digestive health (indigestion, constipation and ulcer), cardiovascular disorders (atherosclerosis and hypertension), vomiting, diabetes mellitus, and cancer. It also has anti-inflammatory and anti-oxidative properties for controlling the process of aging (12). Furthermore, it has antimicrobial potential as well which can help in treating infectious diseases. (13) Generation of free radicals or reactive oxygen species (ROS) during metabolism beyond the antioxidant capacity of a biological system results in oxidative stress, which plays an essential role in heart diseases, neurodegenerative diseases, cancer, and in the aging process. (14) (15) (16) The bioactive molecules of ginger like gingerols have shown antioxidant activity in various modules.
Inflammatory disorders such as gastritis, esophagitis, and hepatitis, which are caused not only by infectious agents such as viruses, bacteria, and parasites but also by physical and chemical agents like heat, acid, cigarette smoke, and foreign bodies, are recognized as risk factors for human cancer. Ginger consumption before exercise might reduce naturally occurring quadriceps muscle pain during moderate-intensity cycling exercise. This effect may be due to anti-inflammatory effect of ginger and further investigation need to prove it in human (17) (18).

BLACK PEPPER :

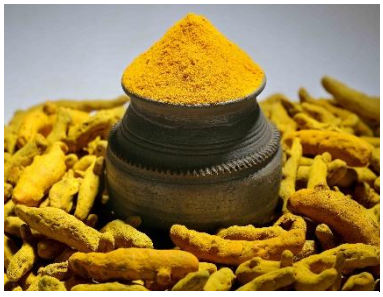
Synonyms: Piper nigrum, Kali mirch, Kali miri, Common pepper, Pepper vine, True pepper.
Biological source: Black pepper comes from the dried berries of the Piper nigrum vine, a flowering plant in the Piperaceae family.
Family: Piperaceae
Description :
Piper nigrum L belonged from Piperaceae family [6,7]. Piperaceae family consist of 5 genera that are Piper, Peperomia, Zippelia, Manekia, and Verhuellia, essentially divided into two major important genera: Piper contained around 2,000 species and Peperomia contained around 1,600 species (19). Black pepper contains several bioactive compounds that help to treat various diseases like tumors, asthma, diarrhea, thyroids, arthritis, obesity, dermatitis, acute liver failure, autoimmune disease, hypertension, and cardiovascular disease (20) and several health benefits of black pepper are depicted in (Figure 1). Black pepper is used to treat fever, tooth ache, inflammation, muscle cramps, anxiety, and depression (21). It is also used as an antibacterial, antifungal, antiviral, antioxidant, anti-cancerous, insecticidal, and larvicidal characteristic (22). Black pepper was recently discovered to help in healing wounds and provide nutrients for the body (23). It has been shown to improve fertility and neurological functions (24). Peppercorn also helps to secrete both pancreatic and intestinal enzymes, which help in digestion [16]. Piperine is a major phytochemical present in black pepper [2]. It also provides flavor, aroma, and color to food preparations (25).
Active constituents :
Numerous researchers identified that black pepper contained several phytochemical compounds like alkaloids, flavonoids, steroids, phenols, terpenes, tannins, and amides (26) (27) that have numerous benefits. Black pepper is a good source of nutrients, vitamins, minerals, carbohydrates, proteins, and secondary metabolites (28). The biochemical constituents of black pepper are piperine 2.1-8.9%, oleoresin 2.31-12%, essential oil 0.4-6.9%, starch 28-51%, and fatty acids 1.8-15%. The most prevalent bioactive chemical present in black pepper are β-caryophyllene30%, limonene 13.4%, β-pinene 8%, α-pinene 4.6%, sabinene 6%, caryophyllene oxide 9%, 3-carene 30%, and camphene 11% (Figure 2) (29) (30). There were a few phytochemicals discovered, including hydroxytyrosol 4-O-glucoside, 6-hydroxyluteolin 7-O-rhamnoside,2-hydroxybenzoic acid, apigenin 6,8-di-C-glucoside, scopoletin, rhoifolin, sesamin, and hydroxytyrosol (31).
Beneficial effects :
Peppercorn (black pepper) is an excellent source of magnesium, which helps in blood clotting, the formation of bones and muscles, and anti-inflammation (32). Black pepper contains antioxidants, alkaloids, flavonoids, steroids, essential oils, and phenolic substances that help boost the immune system, improve digestion, and protect tissues (33). Black pepper is an excellent source of vitamin A, vitamin K, vitamin E, vitamin B1, vitamin B2, vitamin B5, and Vitamin B6 (34). It also contains minerals including copper, iron, calcium, phosphorus, potassium, sodium, niacin, folate, fluoride, selenium, zinc, and chromium (35). Due to the presence of antioxidants, nutrients, and bioactive chemicals in black pepper, it's worked as an antimicrobial activity (36), boost immunity, control cholesterol levels, and help to increase the shelf life of food (37).
The immunomodulatory potential of piperine have demonstrated promising potential. Bezerra et al. reported that the incubation of tumor cell lines with 5-fluorouracil (5-FU) in the presence of piperine produced an increase in growth inhibition, observed by lower IC_{50} values for 5-FU. At the same time, leucopoenia induced by treatment with 5-FU was reduced by the combined use with piperine,

showing improved immunocompetence hampered by 5-FU (38). In the study of Bernardo et al. , which evaluated the effect of piperine to B cell functioning and on the humoral immune response to T-un/dependent antigens, it was found that, in vitro, it inhibits proliferative response induced by lipopolysaccharide (LPS) and immunoglobulin α-IgM antibody. Also, piperine resulted in inhibition of IgM antibody secretion and reduced expression of cluster of differentiation CD86 (39). A recent study of Lee et al. demonstrated that piperine in combination with gamma-aminobutyric acid (GABA) mediated p38 and JNK MAPK activation, which increased EPO and EPO-R expression, resulting in up-regulation of IL-10 and NF-κB (40).

In addition to immunomodulation, piperine exhibits significant anti-allergic activity in ovalbumin-induced allergic rhinitis in mice. Piperine significantly ameliorated sneezing, rubbing, and redness induced by sensitization of nerve endings resulted from histamine released in response to antigen-antibody reaction, but also decreased nitric oxide (NO) levels due to lower migration of eosinophils into nasal epithelial tissue. As in the histopathological section of the nasal mucosa, it was found that piperine treatment attenuated inflammation, redness, and disruption of alveoli and bronchiole (41). In an ovalbumin-induced asthma model, the administration of piperine decreased the infiltration of eosinophils and reduced airway hyperresponsiveness by suppressing T cell activity and Th2 cytokine production (42).

Black pepper contains piperine, which reveals a variety of additional pharmaceutical characteristics, including anticolon toxin, antimicrobial, anticancerous, antiobesity, antiviral, antiparastic, antibacterial, antifungal, antitumors, anti-asthmatics, anti-apoptotic, antispasmodic, antiplatelets, antithyroids, antidepressant, antimutagenic, antipyretic, antispermatogenic, antihypertensive, anti-metastatic, pesticides, and insecticides characteristics (43) (44)

TURMERIC :



Synonyms: Saffron Indian; haldi (Hindi); Curcuma; Rhizoma cur-cumae.

Biological source: Turmeric is the dried rhizome of *Curcuma longa* Linn. (syn. *C.domestica* Valeton)., belonging to family Zingiberaceae.

Family: Zingiberaceae

DESCRIPTION :

(Fig. 1). Curcumin has been in use for its medicinal benefits since centuries but the first documented case of its use as a drug emerged only in 1937 when it was utilized to treat biliary disease. Since then its therapeutic potential has been explored in inflammatory diseases, neoplastic disease, cardiovascular and neurodegenerative disease, diabetes, cystic fibrosis and other disorders. Due to a vast number of biological targets and virtually no side effects, curcumin has achieved the potential therapeutic interest to cure immune related, metabolic diseases and cancer (45) (46) (47) (48)(Table 1). Majority of the studies suggested that the biological effects of curcumin are mainly derived from its ability to either bind directly to various proteins such as cyclooxygenase-2 (COX-2), lipoxygenase, GSK3b and several other regulatory enzymes or by its ability to modulate intracellular redox state (49). Modulation of cellular redox homeostasis exerts an indirect but more global effect on a number of cellular processes, since several critical transcription factors such as activator protein 1 (AP1), nuclear factor-kappaB (NF-κB), nuclear factor of activated T cells (NF-AT), p53 etc. are

sensitive to even minor fluctuations in the cellular redox milieu (50) (51). These transcription factors in turn control cell cycle, differentiation, stress response and other physiological processes (52) (53). The intricate mechanism of action of curcumin involves various biological targets viz transcription factors: NF-AT, AP-1, signal transducers and activator of transcription (STAT), p53 and kinases: mitogen-activated protein kinases, cytokines release, and the receptors found on different immune cell type. These actions of curcumin greatly affect the innate and adaptive arms of immunity, especially in the pathological conditions. Curcumin effectively modulates the function of T cells, B cells, dendritic cells (DCs), monocytes, macrophages (mφ) and neutrophils. Overwhelming reports have supported the anti-inflammatory action of curcumin and its potential role in the therapy of numerous immune cell related diseases. Although curcumin does not have a drug profile yet, the safety and non-toxic effect of oral curcumin (12 g/day) which is much higher than its regular in-take as food supplement have been established by the drug governing agency (54) (55) Recently, the pre-clinical and clinical studies that were conducted at different places have been reviewed (56). However, there are certain limitations concerning the use of curcumin as a drug. Due to its insolublility in water, curcumin has very poor bioavailability, its cellular uptake is slow and it gets metabolized very fast once inside the cell. Therefore it requires repetitive oral doses in order to achieve significant concentration inside the cells for any physiological effects. To address these limitations a large number of curcumin analogues have been prepared that have shown improved uptake, metabolism and activity.

Active constituents :

Turmeric is a mixture of compounds related to curcumin known as curcuminoids consisting of curcumin [i.e.diferuloylmethane or 1,7-bis (4-hydroxy-3-methoxy-phenyl) hepta-1, 6-diene-3, 5-dione)] as the major component, demethoxycurcumin, bisdemethoxycurcumin and cyclocurcumin (57) Curcumin, demethoxycurcumin and bisdemethoxycurcumin collectively known as curcuminoids (3-6%) are major polyphenolic compounds in turmeric rhizomes(Ravindranath and Satyanarayan 1980,Satyawati et al 1976). The main colouring principle of turmeric rhizome is 'Curcumin'. Other phenolic compounds present in turmeric rhizome are 1-hydroxy-1, 7-bis (4-hydroxy-3 methoxyphenyl)-(6E)-6-heptene-3, 5-dione;1-(4- hydroxy-3, 5-dimethoxyphenyl)-7-(4-hydroxy-3-methoxyphenyl)-(1E, 6E)-1, 6-heptadiene-3, 4-dione; 1, 5-bis (4-hydroxy-3-methoxyphenyl)-penta-(1E, 4E)-1, 4-dien-3-one; 1-(4-hydroxy-3-methoxyphenyl-5-(4-hydroxyphenyl)-penta-(1E, 4E)-1, 4-dien-3-one. The pale yellow to orange-yellow volatile oil (4-6%) obtained from turmeric consists of a number of mono and sesquiterpenes. The sesquiterpenes were named as curcumenone; dehydrocurdione; (4 S, 5 S)-germacrone 4,5-epoxide; bisabola 3, 10-diene 2-one; arturmerone (Roth et al 1998); bisacumol; bisacurone; curcumenol; isoprocurcumenol; zedoaron ediol; procurcu menol; etc. (58)

Beneficial effects :

Turmeric a great variety of pharmacological activities of turmeric have been reported. Curcumin is one of its major components being responsible for its various biological actions. It exhibits anti-parasitic, antispasmodic, anti-inflammatory, anticarcinogenic and gastrointestinal effects in vitro whereas it has shown anti-parasitic and anti-inflammatory activity through oral application in animal models (59). Antioxidant and anti-inflammatory properties are the two primary mechanisms that explain the majority of the effects of curcumin There is evidence that it can increase serum activities of antioxidants such as superoxide dismutase (SOD) (60) (61) (62).

A recent systematic review and meta-analysis of randomized control data related to the efficacy of supplementation with purified curcuminoids on oxidative stress parameters—indicated a significant effect of curcuminoids supplementation on all investigated parameters of oxidative stress including plasma activities of SOD and catalase, as well as serum concentrations of glutathione peroxidase (GSH) and lipid peroxides (63). In addition, curcumin is a lipophilic compound, which makes it an efficient scavenger of peroxyl radicals, therefore, like vitamin E, curcumin is also considered as a

chain-breaking antioxidant (64). In addition, a number of reactive oxygen/nitrogen species can initiate an intracellular signaling cascade that enhances pro-inflammatory gene expression.

Inflammation has been identified in the development of many chronic diseases and conditions (65) (66). These diseases include Alzheimer's disease (AD), Parkinson's disease, multiple sclerosis, epilepsy, cerebral injury, cardiovascular disease, metabolic syndrome, cancer, allergy, asthma, bronchitis, colitis, arthritis, renal ischemia, psoriasis, diabetes, obesity, depression, fatigue, and acquired immune deficiency syndrome AIDS Curcumin has been shown to block NF-κB activation increased by several different inflammatory stimuli . Curcumin has also been shown to suppress inflammation through many different mechanisms beyond the scope of this review, thereby supporting its mechanism of action as a potential anti-inflammatory agent (67).

Tulsi :

Synonyms: Holy basil.
Biological source: Tulsi is an aromatic perennial plant of Ocimum sanctum in the family
Family: Lamiaceae

DESCRIPTION :

Holy basil is native to the Indian subcontinent and grows throughout Southeast Asia. The plant is widely used in Ayurvedic and folk medicine, often as an herbal tea for a variety of ailments, and is considered sacred in Hinduism. It is also used as a culinary herb with a pungent flavor that intensifies with cooking. It is reminiscent of clove, Italian basil (Ocimum basilicum), and mint and has a peppery spiciness. It is considered an agricultural weed and an invasive species in some areas outside its native range. Tulsi is an aromatic shrub in the basil family Lamiaceae (tribe ocimeae) that is thought to have originated in north central India and now grows native throughout the eastern world tropics (68). Within Ayurveda, tulsi is known as "The Incomparable One," "Mother Medicine of Nature" and "The Queen of Herbs," and is revered as an "elixir of life" that is without equal for both its medicinal and spiritual properties (69). Within India, tulsi has been adopted into spiritual rituals and lifestyle practices that provide a vast array of health benefits that are just beginning to be confirmed by modern science. This emerging science on tulsi, which reinforces ancient Ayurvedic wisdom, suggests that tulsi is a tonic for the body, mind and spirit that offers solutions to many modern day health problems.
Active constituents :
There are many chemical constituents present in Ocimum sanctum such as, oleanolic acid, rosmarinic acid, ursolic acid eugenol, linalool, carvacrol, β-elemene, β-caryophyllene, and germacrene. Ocimum sanctum is considered to have diuretic, stimulant property. The Tulsi plant contains numerous active compounds and the major compounds are methylch- avicol, methylcinnamat, linolen, ocimene, pinene, cineol, anethol, estragol, thymol, citral, and camphor. (70) (71)
Beneficial effects :
Laboratory studies have shown that tulsi protects against toxic chemical-induced injury by increasing the body's levels of anti-oxidant molecules such as glutathione and enhancing the activity of anti-oxidant enzymes such as superoxide dismutase and catalase, which protect cellular organelles and

membranes by mopping up damaging free radicals caused by lack of oxygen (72) and other toxic agents. (73) (74) Tulsi also helps to prevent cancers caused by toxic compounds by reducing DNA damage (75) and inducing apoptosis in precancerous and cancerous cells, thereby reducing the growth of experimental tumors and enhancing survival. (76) (77) Modern research has revealed that tulsi has anti-bacterial, anti-viral and anti-fungal activity (78) that includes activity against many pathogens responsible for human infections. Tulsi has also been shown to boost defenses against infective threats by enhancing immune responses in nonstressed and stressed animals (79) (80) and healthy humans. (81) While no human trials have been published, there is experimental evidence that tulsi may help in the treatment of various human bacterial infections including urinary tract infections, (82) skin and wound infections, (83) typhoid fever, (84) cholera, (85) tuberculosis, (86) gonorrhea, (87) acne, (88) herpes simplex, (89) leishmaniasis, (90) various pneumonias (91) and fungal infections, (92) (93) as well as mosquito-borne diseases such as dengue, malaria and filariasis. (94) (95)

Fenugreek :

Synonyms: Methi.
Biological source: Fenugreek consists of leaves of Trigonella foenum-graecum.
Family: Fabaceae

DESCRIPTION :

Fenugreek (Trigonella foenum-graecum L.), plant is widely distributed throughout the world and which belongs to the family Fabacecae. The yields can be significant increase in quantity and quality through the suitable management of cultivation, irrigation and harvesting. In this context, fenugreek (Trigonella foenum graecum L.), an annual legume, is extensively cultivated in most regions of the world for its medicinal value (96).

Fenugreek is naturally found in field verges, uncultivated ground, dry grasslands, and hillsides in semi-highland and highland regions. Fenugreek is grown as a cool season crop in India and the Mediterranean region, both irrigated and as a rainfed crop. It grows on a wide range of preferably well drained soils with a pH ranging from 5.3 to 8.2. (71)

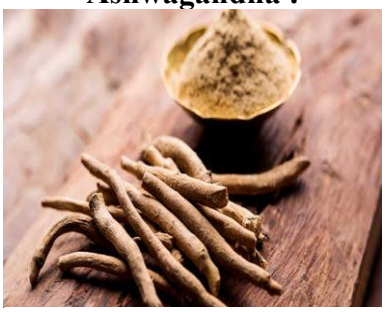
Active constituents :

The biological and pharmacological actions of fenugreek are attributed to the variety of its constituents, namely: steroids, N-compounds, polyphenolic substances, volatile constituents, amino acids, etc (97). Fenugreek seed contains 45-60% carbohydrates, mainly mucilaginous fiber (galactomannans), 20-30% proteins high in lysine and tryptophan, 5 - 10% fixed oils (lipids), pyridine alkaloids, mainly trigonelline (0.2 - 0.38%), choline (0.5%), gentianine and carpaine, the flavonoids apigenin, luteolin, orientin, quercetin, vitexin and isovitexin, free amino acids, such as 4-hydroxyisoleucine (0.09%), arginine, histidine and lysine, calcium and iron, saponins (0.6 - 1.7%), glycosides yielding steroidal sapogenins on hydrolysis (diosgenin, yamogenin, tigogenin, neotigogenin), cholesterol and sitosterol, vitamins A, B1, C and nicotinic acid and 0.015% volatile oils (n-alkanes and sesquiterpenes) (97).

Beneficial effects :

Fenugreek has a beneficial effect on cleansing the blood and as a diaphoretic it is able to bring on a sweat and to help detox the body. Due to pungent aroma of fenugreek, that is smelt on the skin and in under-arm perspiration. Fenugreek is also known for its lymphatic cleansing activity though its vital role is to irrigate the cells with nutrients and to remove toxic wastes, dead cells and trapped proteins from the body. Block in the lymphatic system can mean poor circulation of fluid, fluid retention, pain, energy loss and disease, anywhere in the body of a person. Fenugreek maintains mucus conditions of the body, mostly the lungs, by helping to clear congestion. It also acts as a throat cleanser and mucus solvent that also eases the urge to cough. Drinking water in which seeds of fenugreek have soaked helps in softening and dissolving, accumulating and hardening the masses of cellular debris. Fenugreek has been used to relieve colds, bronchial complaints, influenza, asthma, catarrh, constipation, sinusitis, pleurisy, pneumonia, sore throat, laryngitis, hay fever tuberculosis and emphysema (98). A research work on the effect of fenugreek on stimulatory immunomodulatory effect (as evidenced from body weight, relative thymus weight, hemagglutination titer, quantitative hemolysis assay, phagocytosis, cellularity of lymphoid organs of body, late type of hypersensitivity response, plaque forming cell assay, a lymph proliferation and increase in phagocytic index and phagocytic capacity of macrophages significantly) of aqueous extract of fenugreek at three doses (50, 100 and 200 mg per kg) of body weight for ten days on the immune system of Swiss albino mice was studied (99).

Ashwagandha :



This Photo by Unknown Author is

Synonyms: *Alicabon somniferum* (L.) Raf., *Larnax morrisonii* (Dunal) Miers, *Physalis alpini* J.Jacq, *Physalis flexuosa* L. Indian ginseng, poison gooseberryor, and winter cherry.
Biological source: It consists of the dried roots and stem bases of Withania somnifera Dunal, belonging to family Solanaceae.
Family: Solanaceae

DESCRIPTION :
Withania somnifera, known commonly as **ashwagandha,**[2][3][4] is an evergreen shrub in India, the Middle East, and parts of Africa. Several other species in the genus *Withania* are morphologically similar.[3] The plant, particularly its root powder, has been used for centuries in traditional Indian medicine.[5] Among the ayurvedic Rasayana herbs, Ashwagandha holds the most prominent place. It is known as "Sattvic Kapha Rasayana" Herb (Changhadi, 1938). Most of the Rasayana herbs are adaptogen / anti-stress agents. (100) Ashwagandha is commonly available as a churna, a fine sieved powder that can be mixed with water, ghee (clarified butter) or honey.
Active constituents :
The biologically active chemical constituents of *Withania somnifera* (WS) include alkaloids (isopelletierine, anaferine, cuseohygrine, anahygrine, etc.), steroidal lactones (withanolides, withaferins) and saponins (101) . Taking a deeper look, the active compound in the ashwagandha root is *triethylene glycol*. This is where the ingredient may get the possible benefit it can provide for sleep aid (102). Aside from triethylene glycol, there is a number of other active compounds in the ashwagandha herb that includes Isopelletierine, Anaferine, Cuseohygrine (103). Sitoindosides VII-X, withaferin-A, 5-dehydroxy withanolide-R, and Withasomniferin-A are the major components isolated from W. somnifera (104).

Beneficial effects :
Currently, ashwagandha supplements are often promoted for stress and anxiety, sleep, male infertility, and athletic performance. These supplements typically contain ashwagandha root, leaf, or root/leaf extracts. Ashwagandha is used to treat a number of conditions, including Arthritis, Anxiety, Cancer, Dementia, Parkinson's disease, Stress, and Tuberculosis (105). Ashwagandha is also said to have adaptogenic, anti-inflammatory, anticancer, antidepressant, cardioprotective, immunomodulatory, antibacterial, and antifungal properties. Ashwagandha may help improve physical performance, including strength, fitness, and recovery (106). Ashwagandha may help improve memory and focus (107). Ashwagandha may also help with obsessive-compulsive disorder, infertility, and hypothyroidism (108)

CONCLUSION :
Allopathic drugs are available for counteracting the oxidative stress and hence improve immunity, but the side effects and prohibitive cost of these allopathic drugs make it necessary to search for an alternative. Ayurvedic drugs have promising profile as far as drug development from natural source is concerned. One can expect herbal to act as lead compound for the development of economical, effective, and non-toxic immunomodulatory agent. There are other certain ways to boost the 'immune system' such as active lifestyle, physical exercise, healthy diet, relaxation, and sound sleep. Practically, the medicinal plants play a supplementary role in developing the immune system and fighting deadly viruses including COVID-19.Then why to use synthetic if we have best natural options.

Reference :

1. Nicholson LB. The Immune System. Essays in Biochemistry. 2016 Oct 26;60(3):275–301.
2. Ford SM. Roach's Introductory Clinical Pharmacology. Lippincott Williams & Wilkins; 2017.
3. Marshall JS, Warrington R, Watson W, Kim HL. An Introduction to Immunology and Immunopathology. Allergy, Asthma & Clinical Immunology [Internet]. 2018 Sep;14(S2). Available from: https://aacijournal.biomedcentral.com/articles/10.1186/s13223-018-0278-1
4. Turvey SE, Broide DH. Innate Immunity. Journal of Allergy and Clinical Immunology [Internet]. 2010 Feb;125(2):S24–32. Available from: https://www.ncbi.nlm.nih.gov/pmc /articles/PMC2832725/
5. Bonilla FA, Oettgen HC. Adaptive Immunity. Journal of Allergy and Clinical Immunology. 2010 Feb;125(2):S33–40.
6. Murphy KM, Weaver C, Mowat A, Berg L, Chaplin D, Janeway CA, et al. Janeway's immunobiology. 9th ed. New York London Gs, Garland Science, Taylor & Francis Group; 2017.
7. Kumar D, Arya V, Kaur R, Bhat ZA, Gupta VK, Kumar V. A review of immunomodulators in the Indian traditional health care system. Journal of Microbiology, Immunology and Infection. 2012 Jun;45(3):165–84.
8. Agarwal SS, Singh VK. Immunomodulators: a review of studies on Indian medicinal plants and synthetic peptides. Part - I: Medicinal plants. 1999 Jan 1;
9. Bhattacharya SK, Bhattacharya A, Chakrabarti A. Adaptogenic activity of Siotone, a polyherbal formulation of Ayurvedic rasayanas. PubMed. 2000 Feb 1;38(2):119–28.
10. Nafiseh Shokri Mashhadi, Reza Ghiasvand, Askari G, Hariri M, Darvishi L, Mofid MR. Anti-Oxidative and Anti-Inflammatory Effects of Ginger in Health and Physical Activity: Review of Current Evidence. International Journal of Preventive Medicine [Internet]. 2013 Apr;4(Suppl 1):S36. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC3665023/
11. Rahmani AH, Al, Aly SM. Active ingredients of ginger as potential candidates in the prevention and treatment of diseases via modulation of biological activities. International Journal of Physiology, Pathophysiology and Pharmacology [Internet]. 2014 Jul 12;6(2):125. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC4106649/
12. Dugasani S, Pichika MR, Nadarajah VD, Balijepalli MK, Tandra S, Korlakunta JN. Comparative antioxidant and anti-inflammatory effects of [6]-gingerol, [8]-gingerol, [10]-gingerol and [6]-

shogaol. Journal of Ethnopharmacology. 2010 Feb;127(2):515–20.
13. Shukla Y, Singh M. Cancer preventive properties of ginger: A brief review. Food and Chemical Toxicology. 2007 May;45(5):683–90.
14. Nicoll R, Henein MY. Ginger (Zingiber officinale Roscoe): A hot remedy for cardiovascular disease? International Journal of Cardiology [Internet]. 2009 Jan;131(3):408–9. Available from: https://www.sciencedirect.com/science/article/pii/S0167527307016853
15. Zheng W, Wang SY. Antioxidant Activity and Phenolic Compounds in Selected Herbs. Journal of Agricultural and Food Chemistry. 2001 Nov;49(11):5165–70.
16. Ohshima H, Tatemichi M, Sawa T. Chemical basis of inflammation-induced carcinogenesis. Archives of Biochemistry and Biophysics [Internet]. 2003 Sep 1 [cited 2021 Feb 5];417(1):3–11. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0003986103002832?via%3Dihub
17.Bárta I, Smerák P, Polívková Z, Sestáková H, Langová M, Turek B, et al. Current trends and perspectives in nutrition and cancer prevention. Neoplasma [Internet]. 2006 [cited 2020 Nov 11];53(1):19–25. Available from: https://pubmed.ncbi.nlm.nih.gov/16416008/
18.Ohshima H, Tatemichi M, Sawa T. Chemical basis of inflammation-induced carcinogenesis. Archives of Biochemistry and Biophysics [Internet]. 2003 Sep 1 [cited 2021 Feb 5];417(1):3–11. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0003986103002832?via%3Dihub
19.Saleem A, Naureen I, Naeem M, Tasleem G, Ahmed H, Farooq U. Therapeutic Role of Piper nigrum L (Black Pepper) and Pharmacological Activities. Scholars International Journal of Biochemistry. 2022 Jan 27;5(1):15–21.
20.Nysanth NS, Divya S, Nair CB, Anju AB, Praveena R, Anith KN. Biological control of foot rot (Phytophthora capsici Leonian) disease in black pepper (Piper nigrum L.) with rhizospheric microorganisms. Rhizosphere. 2022 Sep;23:100578.
21.Abd El-Hack ME, El-Shall NA, El-Kasrawy NI, El-Saadony MT, Shafi ME, Zabermawi NM, et al. The use of black pepper (Piper guineense) as an ecofriendly antimicrobial agent to fight foodborne microorganisms. Environmental Science and Pollution Research. 2022 Jan 9;29(8):10894–907.
22.Zhang C, Zhao J, Famous E, Pan S, Peng X, Tian J. Antioxidant, hepatoprotective and antifungal activities of black pepper (Piper nigrum L.) essential oil. Food Chemistry. 2021 Jun;346:128845.
23.Liang J, Sun J, Chen P, Frazier J, Benefield V, Zhang M. Chemical analysis and classification of black pepper (Piper nigrum L.) based on their country of origin using mass spectrometric methods and chemometrics. Food Research International. 2021 Feb 1;140:109877–7.
24.Takooree H, Aumeeruddy MZ, Rengasamy KRR, Venugopala KN, Jeewon R, Zengin G, et al. A systematic review on black pepper (Piper nigrum L.): from folk uses to pharmacological applications. Critical Reviews in Food Science and Nutrition. 2019 Feb 11;59(sup1):S210–43.
25.Amalraj A, Haponiuk JT, Thomas S, Gopi S. Preparation, characterization and antimicrobial activity of polyvinyl alcohol/gum arabic/chitosan composite films incorporated with black pepper essential oil and ginger essential oil. International Journal of Biological Macromolecules. 2020 May;151:366–75.
26.Ali A, Wu H, Ponnampalam EN, Cottrell JJ, Dunshea FR, Suleria HAR. Comprehensive Profiling of Most Widely Used Spices for Their Phenolic Compounds through LC-ESI-QTOF-MS2 and Their Antioxidant Potential. Antioxidants. 2021 May 4;10(5):721.
27.Rasheed M, Farhana Afshan, Muhammad R, Bina Shaheen Siddiqui, Tahsin Gulzar, Mahmood A, et al. Phytochemical studies on the seed extract of*Piper nigrum*Linn.. Natural Product Research. 2005 Oct 1;19(7):703–12.
28.Muhammad Asif Yousuf, Haji, Rasool F, Kashif ur Rehman, Usman F, Bilal Ahmad Ghalloo, et al. Chemical Profiling, Formulation Development, In Vitro Evaluation and Molecular Docking of Piper nigrum Seeds Extract Loaded Emulgel for Anti-Aging. 2022 Sep 14;27(18):5990–0.
29.Muhammad Asif Yousuf, Haji, Rasool F, Kashif ur Rehman, Usman F, Bilal Ahmad Ghalloo, et al. Chemical Profiling, Formulation Development, In Vitro Evaluation and Molecular Docking

of Piper nigrum Seeds Extract Loaded Emulgel for Anti-Aging. 2022 Sep 14;27(18):5990–0.
30.Simon Vlad Luca, Katarzyna Gaweł-Bęben, Strzępek-Gomółka M, Czech K, Anca Trifan, Gokhan Zengin, et al. Insights into the Phytochemical and Multifunctional Biological Profile of Spices from the Genus Piper. Antioxidants. 2021 Oct 19;10(10):1642–2.
31.Lee JG, Chae Y, Shin Y, Kim YJ. Chemical composition and antioxidant capacity of black pepper pericarp. Applied Biological Chemistry. 2020 Jul 9;63(1).
32.Turrini E, Sestili P, Fimognari C. Overview of the Anticancer Potential of the "King of Spices" Piper nigrum and Its Main Constituent Piperine. Toxins. 2020 Nov 26;12(12):747.
33.Ms B, I P, Mt S, Ma R, F S, W A. Black Pepper and Health Claims: A Comprehensive Treatise [Internet]. Critical reviews in food science and nutrition. 2013. Available from: https://pubmed.ncbi.nlm.nih.gov/23768180/
34.Milenković A, Stanojević L. Black pepper: Chemical composition and biological activities. Advanced Technologies [Internet]. 2021;10(2):40–50. Available from: https://scindeks-clanci.ceon.rs/data/pdf/2406-2979/2021/2406-29792102040M.pdf
35.Barhoom AM, Abu-Naser SS. Black Pepper Expert System. Information Systems Research [Internet]. 2018 Aug 29 [cited 2024 Nov 22];2(8):9–16. Available from: https://www.researchgate.net/publication/327284997_Black_Pepper_Expert_System
36.Ahmad N, Fazal H, Abbasi BH, Farooq S, Ali M, Khan MA. Biological role of Piper nigrum L. (Black pepper): A review. Asian Pacific Journal of Tropical Biomedicine [Internet]. 2012 Jan;2(3):S1945–53. Available from: https://www.sciencedirect.com/science/article/pii/S2221169112605243
37.Roy P, Garg AP. Enhancement of Refrigerated Shelf Life of Foods against Microbial Spoilage Using Indian Spices. European Journal of Nutrition & Food Safety [Internet]. 2023 Sep 11;15(10):38–50. Available from: https://www.researchgate.net/publication/373851938_Enhancement_of_Refrigerated_Shelf_Life_of_Foods_against_Microbial_Spoilage_Using_Indian_Spices
38.Bezerra DP, Farias F, Paula A, Pessoa C, de O, Silveira ER, et al. In vitro andin vivo antitumor effect of 5-FU combined with piplartine and piperine. 2008 Mar 1;28(2):156–63.
39.Stojanović-Radić Z, Pejčić M, Dimitrijević M, Aleksić A, V. Anil Kumar N, Salehi B, et al. Piperine-A Major Principle of Black Pepper: A Review of Its Bioactivity and Studies. Applied Sciences. 2019 Oct 12;9(20):4270.
40.Lee YM, Choi JH, Min WK, Han JK, Oh JW. Induction of functional erythropoietin and erythropoietin receptor gene expression by gamma-aminobutyric acid and piperine in kidney epithelial cells. Life Sciences. 2018 Dec 1;215:207–15.
41.Aswar U, Shintre S, Chepurwar S, Aswar M. Antiallergic effect of piperine on ovalbumin-induced allergic rhinitis in mice. Pharmaceutical Biology. 2015 Apr 14;53(9):1358–66.
42.Kim SH, Lee YC. Piperine inhibits eosinophil infiltration and airway hyperresponsiveness by suppressing T cell activity and Th2 cytokine production in the ovalbumin-induced asthma model. Journal of Pharmacy and Pharmacology. 2009 Mar 1;61(3):353–9.
43.Shaik AR, Y Suvarna. PHARMACOTHERAPEUTIC PROPERTIES OF BLACK PEPPER: A SYSTEMATIC REVIEW [Internet]. 2019. p. 293–304. Available from: https://www.researchgate.net/publication/338840306_PHARMACOTHERAPEUTIC_PROPERTIES_OF_BLACK_PEPPER_A_SYSTEMATIC_REVIEW
44.Neha P, Joshi MD. Piper nigrum: An overview of effects on human health. Research Journal of Science and Technology. 2020;12(4):331–7.
45.Coronella-Wood J, Terrand J, Sun H, Chen QM. c-Fos Phosphorylation Induced by H2O2 Prevents Proteasomal Degradation of c-Fos in Cardiomyocytes. Journal of Biological Chemistry. 2004 Aug;279(32):33567–74.
46.Sikora E, Bielak-Zmijewska A, Piwocka K, Janusz S, Radziszewska E. Inhibition of proliferation and apoptosis of human and rat T lymphocytes by curcumin, a curry pigment. Biochemical Pharmacology. 1997 Oct;54(8):899–907.
47.Ranjan D, Johnston TD, Wu G, Elliott L, Bondada S, Nagabhushan M. Curcumin Blocks

Cyclosporine A-Resistant CD28 Costimulatory Pathway of Human T-Cell Proliferation. Journal of Surgical Research. 1998 Jul;77(2):174–8.
48.Ch. Varalakshmi, Ali A, B.V.V. Pardhasaradhi, Srivastava RM, Singh S, Ashok Khar. Immunomodulatory effects of curcumin: In-vivo. International Immunopharmacology. 2008 May 1;8(5):688–700.
49.Churchill M, Chadburn A, Bilinski RT, Bertagnolli MM. Inhibition of Intestinal Tumors by Curcumin Is Associated with Changes in the Intestinal Immune Cell Profile. Journal of Surgical Research. 2000 Apr 1;89(2):169–75.
50.Bhattacharyya S, Mandal D, Saha B, Sen GS, Das T, Sa G. Curcumin Prevents Tumor-induced T Cell Apoptosis through Stat-5a-mediated Bcl-2 Induction. Journal of Biological Chemistry. 2007 Jun;282(22):15954–64.
51.Xie L, Li XK, Naoko Funeshima-Fuji, Kimura H, Matsumoto Y, Yoshitaka Isaka, et al. Amelioration of experimental autoimmune encephalomyelitis by curcumin treatment through inhibition of IL-17 production. International immunopharmacology. 2009 May 1;9(5):575–81.
52.Moon DO, Kim MO, Choi YH, Park YM, Kim GY. Curcumin attenuates inflammatory response in IL-1β-induced human synovial fibroblasts and collagen-induced arthritis in mouse model. International Immunopharmacology [Internet]. 2010 May 1 [cited 2020 Apr 11];10(5):605–10. Available from: https://www.sciencedirect.com/science/article/pii/S1567576910000706?via%3Dihub
53.In Duk Jung, Jeong YI, Lee CM, Kyung Tae Noh, Soo Kyung Jeong, Sung Hak Chun, et al. COX-2 and PGE2 signaling is essential for the regulation of IDO expression by curcumin in murine bone marrow-derived dendritic cells. International immunopharmacology. 2010 Jul 1;10(7):760–8.
54.Jeong YI, Sang Hoon Kim, In Hwan Jung, Lee, Jeong Ho Chang, Lee C, et al. Curcumin Suppresses the Induction of Indoleamine 2,3-Dioxygenase by Blocking the Janus-activated Kinase-Protein Kinase Cδ-STAT1 Signaling Pathway in Interferon-γ-stimulated Murine Dendritic Cells. 2009 Feb 1;284(6):3700–8.
55.Bhaumik S, Jyothi MDivya, Khar A. Differential modulation of nitric oxide production by curcumin in host macrophages and NK cells. FEBS Letters. 2000 Oct 9;483(1):78–82.
56.Zhang HG, Kim H, Liu C, Yu S, Wang J, Grizzle WE, et al. Curcumin reverses breast tumor exosomes mediated immune suppression of NK cell tumor cytotoxicity. Biochimica et Biophysica Acta (BBA) - Molecular Cell Research. 2007 Jul;1773(7):1116–23.
57.Gafner S, Sang Yup Lee, Cuendet M, Barthélémy S, Laurent Vergnes, S. Labidalle, et al. Biologic evaluation of curcumin and structural derivatives in cancer chemoprevention model systems. 2004 Nov 1;65(21):2849–59.
58.Google Scholar [Internet]. Google.co.in. 2024 [cited 2024 Nov 22]. Available from: https://scholar.google.co.in/scholar?q=Chemical+constituents+and+biological+activities+of+turmeric+(Curcuma+longa+L.)&hl=en&as_sdt=0&as_vis=1&oi=scholart
59.Cc A, Ll L. Biological Activities of Curcuma Longa L [Internet]. Memorias do Instituto Oswaldo Cruz. 2001. Available from: https://pubmed.ncbi.nlm.nih.gov/11500779/
60.Banach M, Serban C, Aronow WS, Rysz J, Dragan S, Lerma EV, et al. Lipid, blood pressure and kidney update 2013. International Urology and Nephrology. 2014 Feb 27;46(5):947–61.
61.Vp M, Ar S. Antioxidant and Anti-Inflammatory Properties of Curcumin [Internet]. Advances in experimental medicine and biology. 2007. Available from: https://pubmed.ncbi.nlm.nih.gov/17569207/
62.Panahi Y, Alishiri GH, Parvin S, Sahebkar A. Mitigation of Systemic Oxidative Stress by Curcuminoids in Osteoarthritis: Results of a Randomized Controlled Trial. Journal of Dietary Supplements. 2015 Feb 17;13(2):209–20.
63.Sahebkar A. Effect of curcuminoids on oxidative stress: A systematic review and meta-analysis of randomized controlled trials. Journal of Functional Foods [Internet]. 2015 Oct 1;18:898–909. Available from: https://www.sciencedirect.com/science/article/pii/S1756464615000092
64.Priyadarsini KIndira, Maity DK, Naik GH, Kumar MSudheer, Unnikrishnan MK, Satav JG, et al.

Role of phenolic O-H and methylene hydrogen on the free radical reactions and antioxidant activity of curcumin. Free Radical Biology and Medicine. 2003 Sep;35(5):475–84.
65.Js J. Anti-inflammatory Properties of Curcumin, a Major Constituent of Curcuma Longa: A Review of Preclinical and Clinical Research [Internet]. Alternative medicine review : a journal of clinical therapeutic. 2009. Available from: https://pubmed.ncbi.nlm.nih.gov/19594223/
66.M.C. Recio, I. Andujar, J.L. Rios. Anti-Inflammatory Agents from Plants: Progress and Potential. Current Medicinal Chemistry. 2012 Apr 24;19(14):2088–103.
67.Panahi Y, Hosseini MS, Khalili N, Naimi E, Simental-Mendía LE, Majeed M, et al. Effects of curcumin on serum cytokine concentrations in subjects with metabolic syndrome: A post-hoc analysis of a randomized controlled trial. Biomedicine & Pharmacotherapy. 2016 Aug;82:578–82.
68.Bast F, Rani P, Meena D. Chloroplast DNA Phylogeography of Holy Basil (Ocimum tenuiflorum) in Indian Subcontinent. The Scientific World Journal. 2014;2014:1–6.
69.Rani N, Tomar N, Upadhyaya S. Tulsi - Ocimum Sanctum: A Herbal Drug for Health Benefits. International Journal of Science and Healthcare Research. 2022 Dec 7;7(4):263–77.
70.Prasad S, Srivastava SK. Oxidative stress and cancer: Antioxidative role of Ayurvedic plants. Cancer. 2021;301–10.
71.Brar S, Sharma A. A review on medicinal herbs as immunity booster [Internet]. [cited 2024 Nov 22]. Available from: https://www.isfcppharmaspire.com/uploads/228/13795_pdf.pdf
72.Panda VS, N SR. Evaluation of cardioprotective activity of Ginkgo biloba and Ocimum sanctum in rodents. Alternative medicine review : a journal of clinical therapeutic [Internet]. 2009 Jun;14(2):161–71. Available from: https://pubmed.ncbi.nlm.nih.gov/19594225/
73.Shivananjappa M, Joshi M. Aqueous Extract ofTulsi(Ocimum sanctum) Enhances Endogenous Antioxidant Defenses of Human Hepatoma Cell Line (HepG2). Journal of Herbs, Spices & Medicinal Plants. 2012 Nov;18(4):331–48.
74.Manikandan P, Murugan RS, Abbas H, Abraham SK, Nagini S. Ocimum sanctum Linn. (Holy Basil) Ethanolic Leaf Extract Protects Against 7,12-Dimethylbenz[a]Anthracene-Induced Genotoxicity, Oxidative Stress, and Imbalance in Xenobiotic-Metabolizing Enzymes. Journal of Medicinal Food. 2007 Sep;10(3):495–502.
75.Siddique YH, Ara G, Beg T, Afzal M. Anti-genotoxic effect of Ocimum sanctum L. extract against cyproterone acetate induced genotoxic damage in cultured mammalian cells. Acta Biologica Hungarica [Internet]. 2007 Dec 1;58(4):397–409. Available from: https://pubmed.ncbi.nlm.nih.gov/18277466/
76.Jha AK, Jha M, Kaur J. Ethanolic extracts of Ocimum sanctum, Azadirachta indica and Withania somnifera cause apoptosis in SiHa cells. Research Journal of Pharmaceutical Biological and Chemical Sciences [Internet]. 2012 Apr 1;3(2):557–62. Available from: https://www.researchgate.net/publication/287480184_Ethanolic_extracts_of_Ocimum_sanctum_Azadirachta_indica_and_Withania_somnifera_cause_apoptosis_in_SiHa_cells
77.Manikandan P, Vidjaya Letchoumy P, Prathiba D, Nagini S. Combinatorial chemopreventive effect of Azadirachta indica and Ocimum sanctum on oxidant-antioxidant status, cell proliferation, apoptosis and angiogenesis in a rat forestomach carcinogenesis model. Singapore Medical Journal [Internet]. 2008 Oct 1 [cited 2024 Jun 19];49(10):814–22. Available from: https://pubmed.ncbi.nlm.nih.gov/18946617/
78.Kashyap DrSuman. Bioactive Botanicals from Basil (Ocimum sp.) [Internet]. Journal of Scientific & Industrial Research. 1999 [cited 2024 Nov 22]. Available from: https://www.academia.edu/94351884/Bioactive_Botanicals_from_Basil_Ocimum_sp_
79.Mediratta PK, Sharma KK, Singh S. Evaluation of immunomodulatory potential of Ocimum sanctum seed oil and its possible mechanism of action. Journal of Ethnopharmacology. 2002 Apr;80(1):15–20.
80.A.K. T, V.S. R. Immunomodulatory activity of Ocimum sanctum and its influence on cyclophosphamide induced immunosupression. [Internet]. The Indian Journal of Animal Sciences; 2008. Available from: https://www.researchgate.net/publication/

294654881_Immunomodulatory_activity_of_Ocimum_sanctum_and_its_influence_on_cyclophosphamide_induced_immunosupression

81.Mondal S, Varma S, Bamola VD, Naik SN, Mirdha BR, Padhi MM, et al. Double-blinded randomized controlled trial for immunomodulatory effects of Tulsi (Ocimum sanctum Linn.) leaf extract on healthy volunteers. Journal of Ethnopharmacology [Internet]. 2011 Jul;136(3):452–6. Available from: https://www.sciencedirect.com/science/article/pii/S0378874111003485

82.Ali H, Dixit S. In vitro antimicrobial activity of flavanoids of Ocimum sanctum with synergistic effect of their combined form. Asian Pacific Journal of Tropical Disease. 2012 Jan;2:S396–8.

83.Singh S, Malhotra M, Majumdar DK. Antibacterial activity of Ocimum sanctum L. fixed oil. Indian Journal of Experimental Biology [Internet]. 2005 Sep 1 [cited 2022 Feb 8];43(9):835–7. Available from: https://pubmed.ncbi.nlm.nih.gov/16187537/

84.Mandal S, Mandal MD, Pal NK. Enhancing chloramphenicol and trimethoprim in vitro activity by Ocimum sanctum Linn. (Lamiaceae) leaf extract against Salmonella enterica serovar Typhi. Asian Pacific Journal of Tropical Medicine. 2012 Mar;5(3):220–4.

85.Parag S, Nilosey Vijyayshree, Rami B, Patil BR. Antibacterial Activity of Ocimum sanctum Linn. and its application in Water Purification. Research Journal of Chemistry and Environment [Internet]. 2010 Sep 1;14(3):46–50. Available from: https://www.researchgate.net/publication/280004308_Antibacterial_Activity_of_Ocimum_sanctum_Linn_and_its_application_in_Water_Purification

86.Taghi Naserpour Fari, Amir, Shahram Shahraki Zah, Mohammad Naderi, Sharifi B. Anti Tuberculosis Effect of Ocimum sanctum Extracts in in vitro and Macrophage Culture. Journal of Medical Sciences(Faisalabad) [Internet]. 2006 Apr 15 [cited 2024 Nov 22];6(3):348–51. Available from: https://scialert.net/fulltext/?doi=jms.2006.348.351

87.Shokeen P, Ray K, Bala M, Tandon V. Preliminary Studies on Activity of Ocimum sanctum, Drynaria quercifolia, and Annona squamosa Against Neisseria gonorrhoeae. Sexually Transmitted Diseases. 2005 Feb;32(2):106–11.

88.Sawarkar HA, Khadabadi SS, Mankar DM, Farooqui IA, Jagtap NS. Development and Biological Evaluation of Herbal Anti-Acne Gel. International Journal of PharmTech Research [Internet]. 2010 Jul 1;2(3). Available from: https://www.researchgate.net/publication/267400044_Development_and_Biological_Evaluation_of_Herbal_Anti-Acne_Gel

89.R Yucharoen, S Anuchapreeda, Y Tragoolpua. Anti-herpes simplex virus activity of extracts from the culinary herbs Ocimum sanctum L., Ocimum basilicum L. and Ocimum americanum L. African Journal of Biotechnology [Internet]. 2019 [cited 2024 Nov 22];10(5):860–6. Available from: https://www.ajol.info/index.php/ajb/article/view/92439

90.Suzuki A, Shirota O, Mori K, Sekita S, Fuchino H, Takano A, et al. Leishmanicidal Active Constituents from Nepalese Medicinal Plant Tulsi (Ocimum sanctum L.). Chemical and Pharmaceutical Bulletin. 2009;57(3):245–51.

91.Saini A, Sharma S, Chhibber S. Induction of resistance to respiratory tract infection with Klebsiella pneumoniae in mice fed on a diet supplemented with tulsi (Ocimum sanctum) and clove (Syzgium aromaticum) oils. Journal of microbiology, immunology, and infection = Wei mian yu gan ran za zhi [Internet]. 2009 Apr;42(2):107–13. Available from: https://pubmed.ncbi.nlm.nih.gov/19597641/

92.Balakumar S, Rajan S, Thirunalasundari T, Jeeva S. Antifungal activity of Ocimum sanctum Linn. (Lamiaceae) on clinically isolated dermatophytic fungi. Asian Pacific Journal of Tropical Medicine. 2011 Aug;4(8):654–7.

93.Chandra R, Dwivedi V, Kumar Shivam, Jha AK. Detection of Antimicrobial Activity of Oscimum sanctum (Tulsi) & Trigonella foenum graecum (Methi) against some selected bacterial & fungal strains. Research Journal of Pharmaceutical Biological and Chemical Sciences [Internet]. 2011 Oct 1;2(4):809–13. Available from: https://www.researchgate.net/publication/269107198_Detection_of_Antimicrobial_Activity_of_Oscimum_sanctum_Tulsi_Trigonella_foenum_graecum_Methi_against_some_selected_bacterial_fungal_strains

94.A.J. Rajamma, Dubey S, S.B. Sateesha, Tiwari SN, Ghosh SK. Comparative larvicidal activity of

different species of*Ocimum*against*Culex Quinquefasciatus*. Natural Product Research. 2011 Dec 1;25(20):1916–22.
95. Inbaneson SJ, Sundaram R, Suganthi P. In vitro antiplasmodial effect of ethanolic extracts of traditional medicinal plant Ocimum species against Plasmodium falciparum. Asian Pacific Journal of Tropical Medicine. 2012 Feb;5(2):103–6.
96. Petropoulos G. Fenugreek [Internet]. Google Books. 2024 [cited 2024 Nov 22]. Available from: https://books.google.co.in/books?hl=en&lr=&id=BKalSd5bInAC&oi=fnd&pg=PP1&dq=The+genus+Trigonella.+GA
97. A. Mehrafarin, A. Qaderi, Sh. Rezazadeh, H. Naghdi Badi, Zand E. Bioengineering of Important Secondary Metabolites and Metabolic Pathways in Fenugreek (Trigonella foenum-graecum L.). Journal of Medicinal Plants [Internet]. 2010 Sep 1;9(35):1–18. Available from: https://www.researchgate.net/publication/279541625_Bioengineering_of_Important_Secondary_Metabolites_and_Metabolic_Pathways_in_Fenugreek_Trigonella_foenum-graecum_L
98. Wani SA, Kumar P. Fenugreek: A review on its nutraceutical properties and utilization in various food products. Journal of the Saudi Society of Agricultural Sciences. 2018 Apr;17(2):97–106.
99. Meghwal M. A Review on the Functional Properties, Nutritional Content, Medicinal Utilization and Potential Application of Fenugreek. Journal of Food Processing & Technology. 2012;03(09).
100. Singh N, Bhalla M, De Jager P, Gilca M. An Overview on Ashwagandha: A Rasayana (Rejuvenator) of Ayurveda. African Journal of Traditional, Complementary and Alternative Medicines [Internet]. 2011 Jul 15;8(5S). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3252722/
101. Mishra LC, Singh BB, Dagenais S. Scientific basis for the therapeutic use of Withania somnifera (ashwagandha): a review. Alternative Medicine Review: A Journal of Clinical Therapeutic [Internet]. 2000 Aug 1;5(4):334–46. Available from: https://pubmed.ncbi.nlm.nih.gov/10956379/
102. Kaushik MK, Kaul SC, Wadhwa R, Yanagisawa M, Urade Y. Triethylene glycol, an active component of Ashwagandha (Withania somnifera) leaves, is responsible for sleep induction. Lakshmana MK, editor. PLOS ONE. 2017 Feb 16;12(2):e0172508.
103. Kaur P, Robin, Makanjuola VO, Arora R, Singh B, Arora S. Immunopotentiating significance of conventionally used plant adaptogens as modulators in biochemical and molecular signalling pathways in cell mediated processes. Biomedicine & Pharmacotherapy. 2017 Nov 1;95:1815–29.
104. Mikulska P, Malinowska M, Ignacyk M, Szustowski P, Nowak J, Pesta K, et al. Ashwagandha (Withania somnifera)—Current Research on the Health-Promoting Activities: A Narrative Review. Pharmaceutics [Internet]. 2023 Mar 24;15(4):1057. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10147008/
105. Lopresti AL, Drummond PD, Smith SJ. A Randomized, Double-Blind, Placebo-Controlled, Crossover Study Examining the Hormonal and Vitality Effects of Ashwagandha (Withania somnifera) in Aging, Overweight Males. American Journal of Men's Health [Internet]. 2019 Mar;13(2):155798831983598. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6438434/
106. Morales-Brown P. Ashwagandha: Health benefits, side effects, and how to use [Internet]. www.medicalnewstoday.com. 2020. Available from: https://www.medicalnewstoday.com/articles/318407
107. Xing D, Yoo C, Gonzalez D, Jenkins V, Nottingham K, Dickerson B, et al. Effects of Acute Ashwagandha Ingestion on Cognitive Function. International Journal of Environmental Research and Public Health. 2022 Sep 20;19(19):11852.
108. Lopresti AL, Smith SJ. Ashwagandha (Withania somnifera) for the treatment and enhancement of mental and physical conditions: A systematic review of human trials. Journal of Herbal Medicine. 2021 Aug;28:100434.