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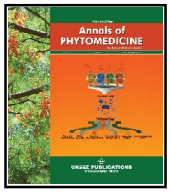

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Herbs that heal: Role of traditional herbal remedies as an immunity booster and effective against the infectious and systemic diseases

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Mentha piperita (L.)

Abstract

In the current scenario, an extensive study on diverse plant species is presently being done to assess traditional medicine for its possible therapeutic effects throughout the world. Indian medicinal plants have extraordinary healing properties that can treat a wide variety of human illnesses and ailments. Herbs are making a comeback, and today's herbal goods are safer and more secure than synthetic drugs, which encourages research into herbal medications. Protein, vitamin D, iron, vitamin B12, and folate are common nutritional deficits found in Indians which make them more susceptible to infection. The immune system is particularly vulnerable to oxidative stress, which plays a significant role in the high death rates linked to immune system dysregulation and other disorders. Herbs rich in vitamins, minerals, and antioxidants helps to prevent cell damage from free radicals or promote the development of cell-mediated and humoral immunity. Numerous Indian medicinal plants have been found to have immunostimulant properties, making them prospective medication sources for the treatment of different chronic illnesses as well as AIDS and other immunocompromised diseases. The immunomodulatory characteristics of numerous substances, including alkaloids, flavonoids, terpenoids, polysaccharides, lactones, and glycoside derivatives, are well reported. Since ancient times, several therapeutic plants and phytochemicals have been used to influence the immune system. This review provides a broad overview of medicinal herbs, including *Centella asiatica* (L.) Urb., *Moringa oliefera* Lam., *Withania somnifera* (L.) Dunal, *Murraya koenigii* (L.) Sprenge, *Euphorbia hirta* (L.), and *Mentha piperita* (L.). This review is presented to spread awareness of Indian herbal medicines as immunomodulators around the world, keeping in mind the enormous potential of medicinal plants and the pharmaceuticals made from them.

1. Introduction

In recent years, infectious diseases have been a top priority for a health organizations, mainly in developing countries. Emerging infectious diseases (EIDs) are a group of illnesses that have previously affected a population or have been detected there for the first time, but are now spreading quickly (Ogden *et al*., 2017). Humanity has consistently been afflicted with major pandemics and epidemics such as cholera, Spanish influenza (H1N1 virus), severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East Respiratory Syndrome coronavirus (MERS-CoV). The new coronavirus illness of the 2019 (COVID-19) pandemic is currently affecting the entire world (Sabin *et al*., 2020). The development of drug-resistance stains, tolerance capacities to insecticide, shoddy hygiene, and climate changes as well as an increase in human mobility are responsible causes for the rapid spreading of these diseases (Cutler *et al*., 2010). Mutations in strains of viruses and microorganisms lead to the development of infectious diseases with novel symptoms and consequences. It is mostly controlled by utilizing appropriate synthetic medications, such as antibiotics and antiviral agents, to treat existing disorders as well as preventive measures like vaccination (Chee *et al*., 2017; Maslow, 2017). We are still fighting both new diseases like the human immunodeficiency virus (HIV), COVID-19, which has mutated or has spread from animal reservoirs, and old viruses like the plague, which have plagued civilization for millennia. Some infectious diseases, such as tuberculosis (TB) and malaria, are widespread endemic conditions that place heavy yet consistent costs on populations. Overuse of antibiotics has several dangerous side effects including the suppression of bone marrow, drug resistance, tolerance, allergic reactions, and the removal of the body's normal flora of microorganisms (Kumar *et al*., 2021). Sometimes vaccination can also lead to various severe side effects like thrombosis with thrombocytopenia syndrome, Guillain-Barré syndrome (GBS), and Myocarditis in the case of COVID-19 vaccines.

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The World Health Organization (WHO) views immunization as the most potent medical treatment available to reduce deaths and lessen illness in our society. The immune system is critical to human health because it protects the body from invading pathogens and treats diseases. Each new contagion, vaccination, and environmental exposure promotes the regulation of the innate and adaptive immune systems which develop highly heterologous immunity. Improved immunity in humans could protect against specific infectious diseases and their long-term complications. The development of immunosenescence in the human population is observed which indicates slowly loss of certain immune system components that occur due to normal ageing and food habits. A weaker immune system and increased susceptibility to infection might result from nutrient deficiencies brought on by insufficient consumption of healthy foods (Maggini *et al*., 2018). Certain medications impair our immune system, which can make it harder to fight infections. A recent study suggests antibiotics could be altered and weaken the development of the immune system make more susceptible to infection. Modifying or boosting the host's immune responses is one of the ways to prevent or eliminate the etiologic agents that cause diseases (Ubeda and Pamer, 2012). Scientists are very interested in herbal and medicinal plants due to the side effect of current therapeutic medications and the cost of herbal products. Thus, it is, therefore, more preferable to supply various natural agents that act as anti-microbial, and antiviral and boost the normal body's immunological defense system. Medicinal plants and herbs are rich in various bioactive secondary metabolites having the potential to elicit the normal body's immune defense system and are beneficial for human health without any side effects. In present times, effort in plant research has greatly increased all over the world. Numerous studies have shown that medicinal plants are highly effective in various traditional systems of medicine. Numerous of medicinal plants are used as potential therapeutic agents against various disorders. The Food and Drug Administration (FDA) has documented that herbs are generally recognized as safe (GRAS) for human consumption (Burdock and Carabin, 2004).

Modern research on remedies of natural origin has pointed out that several herbs have complex actions on immune function and act at several sites in the overall cascade of immunological events and can act as sturdy immune stimulators. Modern research on traditional medicinal plants and herbs has noted a series of actions on immune function and can act as strong immune stimulators. Herbs containing bioactive compounds having immunomodulatory effects could have the potential as a preventive measure against such infectious diseases (Gangwar *et al*., 2021). According to published research, natural compounds including antioxidants, phytochemicals, and anti-inflammatory agents support the immune system's ability to combat viruses. The development of herbal formulations using medicinally important herbs is expected to modulate various components of the immune system which further prevents and also cures diseases. In the present article, we have summarized the different herbs *C. asiatica, M. oliefera, W. somnifera, M. koenigii, E. hirta,* and *M. piperita* that boost immunity in a variety of substances in it. The present information is extremely important in the future for promoting the immune response to a variety of diseases.

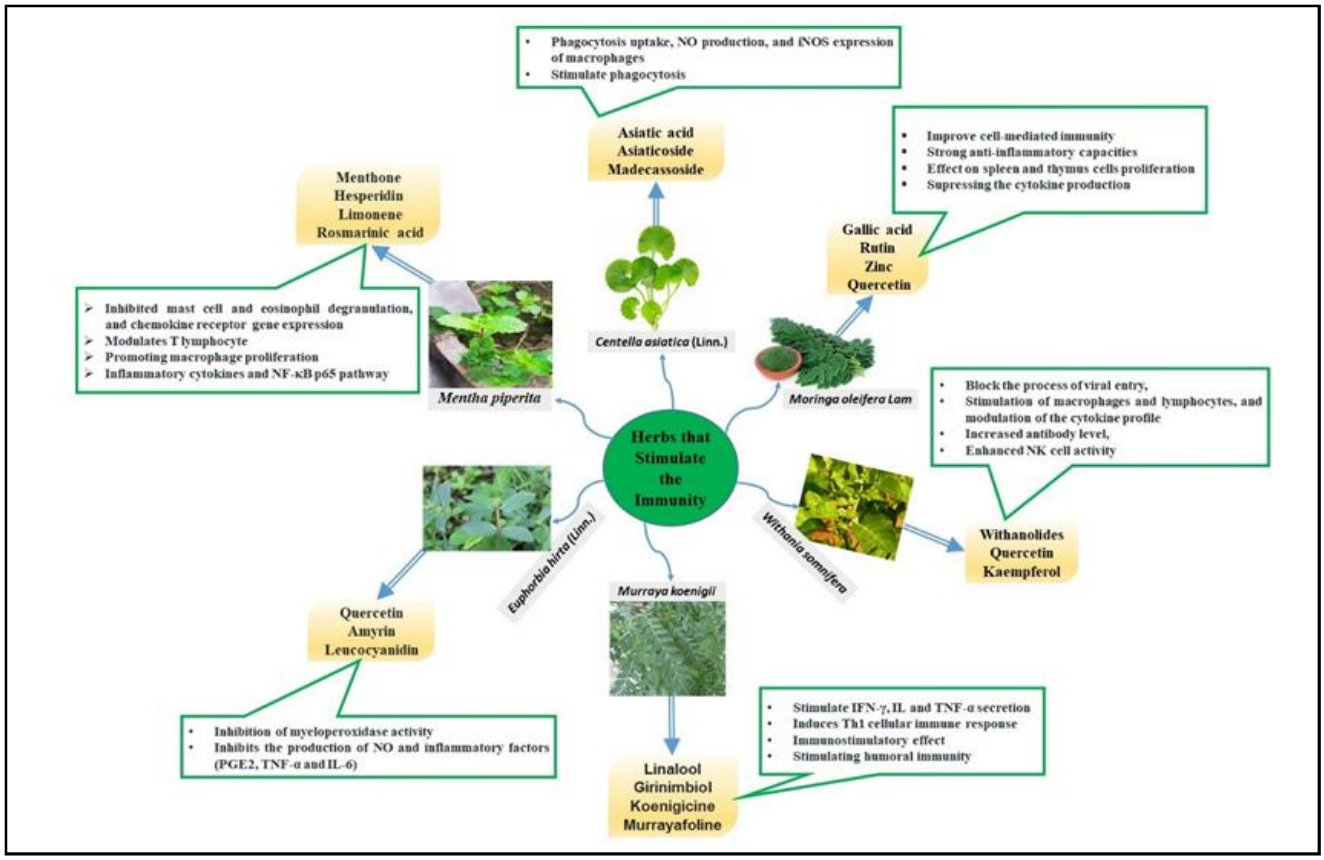

Figure 1: Diagrammatic overview of the immune-stimulatory effects of selected medicinal herbs.

1.1 *Centella asiatica* (L.) Urb.

Centella asiatica (L.) Urb. belongs to the family Apiaceae (also known as Umbelliferae) which is popularly known as 'Indian Pennywort or Gotu kola' found almost all over the world (Khare, 2007).

Figure 2: ***Centella asiatica*** **(L.) Urb.**

1.1.1 Morphological description and distribution

It is a small creeping, perennial herb with leaves and stems that can be utilized as a green leafy vegetable. *C. asiatica* is native across much of the tropical region of India, China, Pakistan, Sri Lanka, Indonesia, Malaysia, South Africa, and some islands in the Pacific. It is mostly found in wet sandy areas on flood plains, rivers, or streams of water. It has a slender stem, a brownish-reddish root arises at the node. The rosettes of shovel-shaped, reniform leaves appear alternately at the nodes. Flowers are covered by bracts with white or light purple-to-pink in color. During the rainy season, the plant cultivates most abundantly in marshy and damp areas. Seeds have a pedunculate embryo, a distinctive odour, and a bittersweet flavour (Joshi and Khan, 2008).

1.1.2 Parts used

The most commonly used part of *C. asiatica* for medicinal purposes is dried whole plants, leaves, and stems.

1.1.3 Ethnobotanical uses

For centuries, it has been used in traditional Chinese and Ayurvedic remedies. It is extensively used and consumed in Malaysia and Indonesia, in the form of raw as a salad or in numerous forms such as capsules, pills, tea, and juice. It is also served many times with sweet potato and coconut milk diminishing its bitterness. This plant has long been utilized as a cooling agent and a source of drinking water by Chinese and Thai people (Gohil *et al*., 2010). The whole plant is employed medicinally and is commonly applied for the treatment of high blood pressure, to enhance memory, to increase life span, and as a blood purifier. It has various crucial medicinal qualities, including antileprotic, antifeedant, antistress, antituberculosis activities, wound-healing abilities, and antibacterial and fungicidal activity for atherosclerosis (Samuel *et al*., 2022).

1.1.4 Phytoconstituents

Chemical analysis revealed that *C. asiatica* is a rich source of essential amino acids, flavonoids, terpenoids, phytosterols, essential oils (valerin, camphor, cineole), alkaloids, *etc*. Glycosides (triterpenoid glycosides) are the major chemical component present. Fresh leaves are rich in the content of vitamins: vitamin C (7 mg/100 g), vitamin A (738 IU), vitamin B1 (0.09 mg/100 g), and minerals such as Ca (171 mg/100 g), P (32 mg/100 g), K (468.59 mg/100 g) and Fe (5.6 mg/100 g). According to the European Pharmacopoeia, the presence of key bioactive components such triterpenes (asiaticoside, asiatic acid, madecassic acid, and madecassoside) serves as a biomarker component for the identification and also treatment of interest. (Sultan *et al*. 2014). *C. asiatica* plants are reported to contain aglycons (asiatic acid and madecassic acid) and glycosides: indocentelloside, brahmoside, brahminoside, theankuniside and isothankuniside (James and Dubery, 2011). Recent studies revealed the presence of two new flavonoids named castilliferol 1 and castillicetin 2 (both exhibiting antioxidant activity).

1.1.5 Immunostimulating effect

The effectiveness of macrophages in mounting inflammatory responses against infections depends on phagocytosis. Additionally, the first line of defense against infection is provided by the inflammatory mediators released during phagocytoses, such as reactive nitrogen species (RNS) and reactive oxygen species produced by activated macrophages (Rendra *et al*., 2019). Moreover, previous research accompanied by Sun *et al*. (2020) showed that the crude extract of *C. asiatica* contained triterpene components, especially asiatic acid and madecassoside. The enhanced phagocytic capacity of macrophages, NO production, and inducible nitric oxide synthase (iNOS) expression in a dose-response relationship was observed in a macrophages cell line in presence of asiatic acid and madecassoside derived from *C. asiatica* (L.) Urb. One of the most notable characteristics of activated macrophages is the increase in phagocytosis activity, which stimulates innate immune responses (Harun *et al*., 2021). Punturee *et al*. (2005) demonstrated the immunostimulant effect of an aqueous extract of *C. asiatica* on the mitogen-stimulated proliferation of human PBMCs and also observed the increased production of IL-2 and TNF-a. Many immune cells release the cytokine TNF-a in response to inflammatory conditions, infections, and environmental stressors (Rosenblum and Donato, 1989). Immunostimulating activity of *C. asiatica* has been noted on non-specific cellular immune responses and humoral immune responses. It is facilitated by interactions between active constituents of extracts and cell surface receptors or growth factors involved in mitogen activation (Punturee *et al*., 2005). The anti-inflammatory effect of *C. asiatica* could be contributed to the reduction in interleukin-1b (IL-1b), interleukin-6 (IL-6) and Tumour Necrosis Factor a (TNFa), as well as prostaglandin E2 (PGE2), and cyclooxygenase-2 (COX-2) (Somchit *et al*., 2004). Crude water extracts of *C. asiatica* demonstrated antiherpes simplex virus activity. In experimental animals, pigs fed with 1% and 2% *C. asiatica* for three months showed significantly reduced serum IL-10, indicating that it has the potential to suppress both anti-inflammatory and pro-inflammatory cytokines (Choi *et al*., 2016). Leaves are reported to have high antioxidant potential in three different pathways including inhibition of linoleic acid peroxidation (98.2%), superoxide free radical scavenging activity (86.4%), and

radical scavenging activity, DPPH (92.7%). The key phytochemical asiaticosside present in the leaf extract of *C. asiatica* exhibits higher antioxidant activity. The presence of natural antioxidants and vitamins in *C. asiatica* contributes to maintaining an effective immune response. *C. asiatica* extract has stimulated the immune system by increasing neutrophil phagocytic function by improving the chemotactic, phagocytic, and intracellular killing potency of human neutrophils (Mali and Hatapakki, 2022).

1.2 *Moringa oleifera* Lam.

Moringa oleifera Lam. belongs to the family Moringaceae and grows in tropical and subtropical regions of the world including, India. It is more commonly known as a drumstick tree or a 'horseradish tree (Sawian *et al*., 2007).

Figure 3: Leaves of *Moringa oleifera* Lam.

1.2.1 Morphological description and distribution

M. oleifera is one of the broadly used plants in traditional medicine. *M. oleifera* is the most cultivated species of a mono-generic family. It is a drought-tolerant, rapidly growing tree that is usually found in tropical and subtropical regions including India. Different species of Moringa range in size from tiny herbs to massive trees, but *M. oliefera* is a tree with a height ranging between 5-10 cm with a thick and straight trunk and whitish bark. The length of the moringa leaves ranges from 1-2.5 cm to 1-2 cm in diameter (Foidl *et al*., 2001). It has a tuberous tap root system, can grow in parched areas with low rainfall, and is well adapted to different soil and environmental conditions.

1.2.2 Parts used

Since every part of the *M. oliefera* plant is useful, it is also known as a "Miracle tree". The most commonly used part of *M. oliefera* is leaves for both edible and medicinal reasons, but in recent times, roots, stems, flowers, seeds, oils, and gums are also used (Ashfaq *et al*., 2012).

1.2.3 Ethnobotanical uses

For thousands of years, moringa has been used in traditional medicines as well as in industries. Some parts of the plants such as leaves has been also used as a vegetable and are incorporated into the diet because it has all the proportions in the necessary amounts required for a balanced diet which in turn will lead to a healthy body with a good immune system. The leaves are used to treat a variety of illnesses, including diabetes, malaria, typhoid, and even hypertension. They are also tremendously rich in antioxidants and other minerals (Sivasankari *et al*., 2014). It has many vital biological activities such as anti-inflammatory, antidiabetic, antioxidant, anti-hypotensive, antibacterial, and so on in addition to it protecting the liver and kidney as well as protecting the stomach from gastric ulcers (Prajapati *et al*., 2022).

1.2.4 Phytoconstituents

Biochemical analysis revealed that *M. oliefera* revealed that it contains various phytoconstituents such as polyphenolics, tannins, alkaloids, flavonoids, steroids, and terpenes and they are also a rich source of vitamin A and vitamin C. Leaves of moringa contain round 180-200 mg of vitamin C in about 100 g of the plant extracts which is higher than the conventional sources. The key flavonoids that are found in moringa leaves are kaempferol (7.6 mg/g), quercetin (0.3 mg/g), and myrecytin (5.9 mg/g). Gallic acid, chlorogenic acid, and caffeic acids are present as phenolic acids in leaves of moringa in the concentration ranges of 1.04, 0.03, and 0.55 mg/g of the dry weight, respectively (Mbikay, 2012). *M. oliefera* is also rich in reducing sugars, tannins, and saponins. Along with it, many anti-cancerous agents like isothiocyanates, glucosinolates, and glycerol-1-9-octadecanoate are also present in significant amounts (Berkovich *et al*., 2013).

1.2.5 Immunostimulant effect

Essential nutrients are required by the cells of the body to function appropriately including the immunological cells. Moringa powder has been found to have all the essential nutrients required for the proper functioning of all the cells (Ashfaq *et al*., 2012). Many countries in western Africa use moringa in their diets to treat children with undernourishment and ultimately increasing their immunity and decreasing the death rates (Kasolo *et al*., 2010). It has been shown that moringa powder increases the concentration and production of immune cells such as white blood cells when supplemented in the diets of children in Nigeria (Nurain, 2015). In addition, the leaves of moringa are rich in vitamin A which itself plays a very important role in cellular and humoral immunity as well as aid in generating antibodies and in the functioning of phagocytic cells. Essential elements are also present in subsequent quantities such as calcium which can also enhance immune functioning and the production of IL-2. Zinc can control the release of cytokines as well as can induce the production and propagation of CD_8^+ T cells. It was reported that the extract of *M. oliefera* leaves supposedly decreased TNF-a, interleukin-6, and IL-8 which were induced during inhalation of smoke caused by cigarettes and pollution. Quercetin present in the extract of moringa has also been reported to reduce inflammation by inhibiting the action of NF-k and subsequently down steaming inflammation (Cunningham, 1982).

1.3 *Withania somnifera* (L.) Dunal

Withania somnifera (L.) Dunal is more commonly known as Ashwagandha or the "Indian winter cherry" or "Indian ginseng" and belongs to the family Solanaceae. It has been mentioned in The Rasayana group of medications in the Ayurveda tradition of India.

Figure 4: ***Withania somnifera*** **(L.) Dunal.**

1.3.1 Morphological description and distribution

Ashwagandha is a small, woody shrub profusely grown in many dry regions of Asia, and Africa. It typically grows about 35-80 cm in height. The branches extend radially from the stem and the leaves are overcast green usually up to 10 cm in length. The fruit is orange in color and the flowers are green with a bell shape (Jain *et al*., 2012).

1.3.2 Parts used

The most commonly used part of *W. somnifera* for medicinal purposes is the roots, leaves, and flowers.

1.3.3 Ethnobotanical uses

It is the most common and widely used herb in India's traditional system of ayurvedic medicine because of its extensive benefits. It is available in the form of Churn, a form of powder mixed with water and honey. It is widely used for enhancing the functioning of the central and peripheral nervous system and the reproductive system. It is also used as an antistress agent because it enhances the body's pliability to stress created by free radicals and so on. Ashwagandha's root smells like that of a horse ("Ashwa") (smell-gandha) and this is from where it got its name. It is already used in the treatment of rheumatism, constipation, insomnia, leukoderma, *etc*. (Sharma, 1999). When the roots are applied in the paste form, they are used to reduce inflammation of the joints and therefore also as an antiarthritic agent (Bhandari, 1970). Among all the varieties available of ashwagandha, the Nagori variety is the utmost supreme. Different parts of the ashwagandha plants are used for different functioning, for example, leaves are used in the treatment of fever and swellings, flowers are specifically used as an astringent and aphrodisia, and the seeds are used for the removal of white spots (Singh *et al*., 2011). The phytoconstituents present in the ashwagandha extract have been shown to influence neurological, endocrine, and cardiovascular activity.

1.3.4 Phytoconstituents

W. somnifera consists of a large array of biologically active phytoconstituents including alkaloids steroids, saponins, glucosides, phenolic, and flavonoids. Among the various alkaloids present such as somnine, tropine, somniferine, choline, *etc*., withanine is the fundamental alkaloid. In addition, it also contains various essential vitamins, minerals, and amino acids. Many of its phytoconstituents are immunomodulatory in nature. Certain phytoconstituents isolated from ashwagandhas, withanolides such as withaferin A and 3-b-hydroxy-2,3-dihydro-withanolide F show their capabilities as antibacterial, antitumoral, and anti-inflammatory properties in addition to its benefits of immunomodulating (Budhiraja and Sudhir, 1987). It is also rich in iron. The roots of ashwagandha are composed of phytoconstituents called withanolides which are accountable for their remarkable medicinal properties.

1.3.5 Immunostimulant effect

Ashwagandha is widely used and known as an immunostimulant as well as an immunomodulator because it improves the defense of the body by increasing cell-mediated immunity. It also acts as an antioxidant to combat the damage and problems caused by free radicals to the immune cells as well as body cells. Much scientific data have already supported that ashwagandha is a tangible effective herb that can be used in many pharmacological actions such as neuroprotective, anti-inflammatory, antiarthritic as well as most importantly immunostimulant action (Siddiqui *et al*., 2012). *W. somnifera* has shown various immunomodulation in animal models. It has shown the reversal effects of immunosuppressing drugs such as cyclophosphamide. Treatment with the extract of ashwagandha has been shown to increase WBCs and platelet count. It has also shown a positive effect on NK cells as well as T-lymphocytes for cell-mediated immunity *via* cell killing by phagocytosis. These observational studies have been used to prove the property of *W. somnifera* as an immunological adjuvant in various infections and diseases (Grandhi *et al*. 1994). *W. somnifera* extract significantly improved the immune profile of healthy subjects by modulating the innate and adaptive immune systems by enhanced secretion of IL4 along with the enhanced expression of Th1 (IFN-g) (Tharakan *et al*., 2021).

1.4 *Murraya koenigii* (L.) Sprenge

Figure 5: ***Murraya koenigii*** **(L.) Sprenge.**

1.4.1 Morphological description and distribution

The curry leaf tree is native to India and nearby countries including Sri Lanka, Bangladesh, and the Andaman Islands. Curry leaves or kadi patta are very popular and are known for their unique flavour, and are widely used and consumed in India. In every part of India, it is widely cultivated and the leaves are predominantly associated with South Indian cuisines. The scientific name of the curry tree is *Murraya koenigii*, which is commonly known as sweet neem in Indian households. Curry leaves are small in size averaging 2-4 cm in length and 1-2 cm in width (Saini *et al*., 2015). The branches of the tree hold a cluster of glossy and green leaves that contained a mild and somewhat pungent bite with a nutty aroma and they retain their flavor and other makings even after drying. Curry leaf is also used in many of the Indian Ayurvedic and Unani remedies.

1.4.2 Parts used

The most commonly used part of *M. koenigii* for medicinal purposes is fresh or dried whole plant, leaves, and stems.

1.4.3 Ethnobotanical uses

This plant is also known for antitumor, hypoglycaemic, and anti-hypercholesterolemic activities (Kumari and Papiya, 2014; Khedkar, 2015). The Ayurvedic system of medicine uses powdered dry curry leaves mixed with honey and betel pepper nut juice to act as an antiperiodic in Ayurveda. Separately, the leaves were used for bruises, burns, eruption, and treatment of bites from poisonous animals in initial times. The branches of the plants were used as "Datun" by Indian people as they strengthen gums and had cleaning effects on teeth (Gupta *et al*., 2011). The leaves of this plant are used externally for application. Even though, *M. koenigii* is presently being used as a stimulant and antidysenteric for the treatment of diabetes mellitus (Handral *et al*., 2012). Leaves of *M. koenigii* are important elements in Indian cuisine that can improve appetite and digestion. Leaves have cooling, anthelmintic analgesic action, are known to cure piles, and reduce body heat, thirst, inflammation, and itching. The leaves, root, and bark own tonic, stomachic, antiemetic, purgative, and carminative properties (Bhandari, 2012). The treatment of influenza and rheumatism can also carry out with the leaves (Arulselvan and Subramanian, 2007).

1.4.4 Phytoconstituents

Curry leaves are a good source of proteins, carbohydrates, fibre, minerals, carotene, nicotinic acid, vitamin C, vitamin A, calcium, and oxalic acid. Apart from this, it also contains crystalline glycosides, carbazole alkaloids, koenine, koenidine, and koenimbine. In addition to these components like coumarin glycoside, *i.e*., scopotin, phosphorus, iron, thiamine, riboflavin, and niacin are also part of curry leaves. The essential oil obtained from leaves contain di-alpha phellandrene, D-sabinene, D-pinene, dipentene, D-terpinol, and caryophyllene (Sharma *et al*., 2020). A wide variety of alkaloids has been isolated from *M. koenigii* leaves including triterpenoid alkaloids cyclomahanimbine, tetrahydromahanimbine, murrayastine, murrayaline, and pyrayafolinecarbazole (Kumar *et al*., 2013).

1.4.5 Immunostimulating effect

The aromatic curry leaves are used to treat open wounds and decrease infection. Curry leaves are a home remedy for wounds or skin burns as they reduce inflammation and help the wounds or skin burns to heal easier and quickly. The natural ingredients of leaves also can kill all types of bacterial, fungal, and viral invasions in human body, thereby making people prone to common ailments including cough, cold, and flu. The extract obtained from the leaves owns positive effects to regulate immunology related to oxidative stress metabolism. This immunomodulatory and anti-inflammatory activity was manifested by interleukin (IL)-2, 4, 10 and tumor necrosis factor-alpha (TNF-a) expression (Paul *et al*., 2011). An animal study using an aqueous extract of *M. koenigii* demonstrated effective immunomodulation *via* antioxidant and immuno-suppressive mechanisms, which are crucial in the management of ethanol-induced liver injury where immunological activation or autoimmunity is implicated in its pathogenesis (Sathaye *et al*., 2011). An experiment on albino rats suggests the beneficial effect of *M. koenigii* in alleviating conditions related to inflammatory pain (Gupta *et al*., 2010). Leaves extracted on methanol confirmed a significant rise in the phagocytic index by the rapid elimination of carbon particles from the bloodstream. It also demonstrated an increase in the antibody titre against ovalbumin and protection against cyclophosphamide-induced myelosuppression. Thus, *M. koenigii* grasps potential as an immunomodulatory agent by stimulating humoral immunity and phagocytic function (Shah *et al*., 2008).

1.5 *Euphorbia hirta* (L.)

Figure 6: ***Euphorbia hirta*** **(L.).**

1.5.1 Morphological description and distribution

A small herb of the Euphorbiaceae family known as *Euphorbia hirta* (L.) is dispersed in the natural environment including farms, waste places, waysides, yards, gardens, *etc*., throughout India. It is commonly called 'dudhi'. The plant typically grows smaller in size and remains to lie on the soil surface. The dark green leaves grow on a thin stem which are arranged oppositely on a thin stem. The edges of the leaves are possessed purple spots near the midvein. A terminal or auxiliary growth of tiny flowers appears on the plant (Ghosh *et al.*, 2019). This generally distributed plant is not only found in India but other countries such as China, Australia, Africa, America, the Philippines, *etc*.

1.5.2 Parts used

The most commonly used part of *E. hirta* for medicinal purposes is leaves.

1.5.3 Ethnobotanical uses

E.hirta plant is used to treat many illnesses such as gastrointestinal disorders, respiratory diseases like cough, cold, asthma, bronchitis, hay fever, emphysema, various ocular ailments, and skin and mucous membrane problems (guinea worm, scabies, tinea, trash, aphtha) and tumor (Asha *et al*., 2016). In the southern part of India, it is used as ear drops and as a treatment for injuries. The fluid of the plant is habitually utilized for lumps and cuts to prevent pathogen infection. A decoction of leaves induces milk flow and the leaf chewed with palm kernel is used for the restoration of virility. It is also used to treat ulcers and is also eaten as a vegetable (Asha *et al*., 2016). Other traditional uses of *E. hirta* are including treatment for ulcers, dysentery, gastrointestinal infections, skin infections, diabetes mellitus, and respiratory disorders, especially diseases caused by microbial infections (Silalahi, 2021).

1.5.4 Phytoconstituents

A variety of secondary metabolites such as alkaloid, tannin, quinone, flavonoid, cardiac glycosides, coumarins, phlobatannin, steroid and phytosterol, terpenoids, and phenols are reported to be present in the plant (Devi *et al*., 2014). Flavonoids include quercetin, quercitrin, quercetin, and derivatives containing rhamnose, quercetin-rhamnoside, a chlorophenol acid, rutin, leucocyanidin, leucocyanidol, myricitrin, cyaniding 3,5-diglucoside, pelargonium 3,5-digucoside, and camphol, flavonol glycoside xanthrhamnin, hentriacontane, myricyl alcohol, inositol, tetraxerol, friedelin, a-sitosterol, ellagic acid, kaempferol. The isolated terpenoid sterols, including b-sitosterol, campesterol, cholesterol, and stigmasterol (Kausar *et al*., 2016). Essential oils including major constituents include 3,7,11,15-tetramethyl-2-hexadecon-1-ol, 6,10,14-trimethyl-2-pentadecanone, hexaecanal, phytol and n-hexadecanoic acid. Minor constituents include 2-butoxyethanol, tetradecane, phthalic acid, butyl tetradecyl ester, oleic acid, 13-hepta decyl-1-ol, 2-methyl-1-hexadecanol and 1,2-benzene dicarboxylic acid diisocylester (Asha *et al*., 2014).

1.5.5 Immunostimulating effect

A study reported that immunostimulant activity of *E. hirta* extract was found to stimulate antibody response, lysozyme, phagocytosis, and other hematological functions in fish at a higher concentration (Pratheepa and Sukumara, 2011). Ethanolic extract of *E. hirta* without showing cytotoxicity produced a remarkable anti-inflammatory effect *via* its active component of b-amyrin and showed a dose-related inhibition of LPS-induced NO production (Shih *et al*., 2010). *E. hirta* had promising immunostimulatory action and was found to be a potent bronchodilator in a dose-dependent manner (Sundari *et al*., 2004). Additionally, it has been claimed that the aqueous extracts have analgesic, antipyretic, anxiolytic, sedative, and anti-inflammatory properties as well as an inhibitory effect on platelet aggregation (Khare, 2007). Intraperitoneal injection of *E. hirta* was shown to excite macrophages as evidenced by the increase in a phagocytic index and revealed immunomodulatory action, according to an experiment with ethanolic extract of the plant (Vijaya and Padmavathi, 2010). Experiments on methanolic extract of *E. hirta* leaves revealed that it possesses anti-inflammatory properties, as shown by the inhibition of ear edema and granuloma formation in mice and it could effective interference with the thrombosis process (Rahman *et al*., 2019).

1.6 *Mentha piperita* (L.)

Figure 7: ***Mentha piperita*** **(L.).**

1.6.1 Morphological description and distribution

Mint is one of the aromatic and short-lived plants which is widespread all over the world in many environments but specifically found in moist environments and wet soil. This plant can grow from 10-120 cm in height and contain dark green to light green leaves arranged oppositely. The stem of the plant is reddish brown. It is one of the fastest-growing herbs and can cultivate in the presence of sunlight also. As this herb has a speedy growth rate it is one of the common herbs found in households (Herro and Jacob, 2010). It is most frequently considered mentha or peppermint. This easily-grown plant possessed a characteristic aroma and the leaves can be harvested at any time. Fresh leaves as well as dried leaves can be used for various preparations due to their wonderful fragrance and health benefits.

1.6.2 Parts used

The most commonly used part of *M. piperita* for medicinal purposes is leaves.

1.6.3 Ethnobotanical uses

From ancient times, the leaves of *M. piperita* have been used for health benefits. In India, it is widely used for flavoring tea. As a traditional medicine, mint has cooling sensation properties, provides strength to the stomach, and helps to relieve digestion-related issues and moderate skin problems (Tafrih *et al*., 2021). Mint leaves are also used as mouth fresheners to cure bad breath. Mint is popularly known as a flatus-relieving that is used to provide relief from gastric discomforts, a stimulant, and a stomachic that help in providing a better appetite. Traditionally, the juice of mint leaves along with honey and lemon juice supports digestion and treats colic, morning sickness, summer diarrhea, biliousness, flatulence, and threadworms (Sharma and Gautam, 2022). The antipruritic or anti-itching properties of mint help cure the irritation and rash caused by insect bites and stings when mixed with a little camphor. Mint helps to eliminate toxins from the body while also dismissing congestion especially related to common colds or sinus problems. It controls the growth of harmful bacteria and fungi in the body and helps cure asthma and other allergies to some extent (Sharangi and Guha, 2013).

1.6.4 Phytoconstituents

The mint's main chemical compounds consist of limonene, cineole, menthone, menthofuran, isomenthone, menthyl acetate, isopulegol, menthol, pulegone, and carvone (Rohloff, 1999; Alankar, 2009). Flavonoid glycosides contain substances like hesperidin, luteolin-7-o-rutinoside, isorhoifolin, narirutin, and others (Areias *et al*., 2001). The phenolic acids like rosmarinic, rosmarinic, caffeic, salvianolic, dehydro-salvianolic, cinnamic, protocatechuic acid glucoside, lithospheric, sinapic, shikimic, 3-o-caffeoylquinic, p-hydroxybenzoic, and o-coumaric are all abundant in *M. piperita*. Menthol, carvone, menthofuran, piperitenone, a-pinene, piperitone, linalool, menthone, and pulegone are volatile bioactive components of Mentha spp. associated essential oils (Eftekhari *et al*., 2021).

1.6.5 Immunostimulating effect

The vitamin and minerals like phosphorus and calcium-rich leaves of mint including vitamins, *i.e.*, A, C, D, and E improve the immune system of the body. It helps to prevent cellular damage and demises the risk of any chronic illness. Mentha spp. show anti-inflammatory characteristics. This property of essential oils from *M. piperita* has been known through 5-lipoxygenase (5-LOX) inhibition assay *in vitro* (Tsai *et al*., 2013). A study on rats detected an antiallergenic activity among the flavonoid glycosides derived from *M. piperita*, including eriocitrin, narirutin, hesperidin, luteolin-7-O-rutinoside, isorhoifolin, diosmin, rosmarinic acid and 5, 7-dihydroxycromone-7-O-rutinoside. In this study, luteolin-7-O-rutinoside exhibited a powerful repressing effect on histamine release induced by compound 48/80 and an antigen-antibody reaction (Inoue *et al*., 2002). The immunomodulating effects of *M. piperita* and its ingredients have been studied in animal models. Intraperitoneal administration of peppermint oil, 1-menthol, and 1, 8-cineole to guinea pigs suppressed homologous passive cutaneous anaphylaxis mediated by IgE antibodies (Arakawa and Osawa, 2000).

2. Conclusion

The immune system is an integrated system contains cells, molecules, and tissues that work together to prevent, detect, and eliminate pathogens that enter the body. Indian civilisation used traditional medicinal plants (herbs) to strengthen immunity and combat bacteria and infections. Numerous Indian medicinal plants have been found to have immunostimulant properties, making them prospective medication sources for the treatment of different chronic infections and immunocompromised conditions like AIDS, cancer, and COVID-19. Furthermore, a variety of secondary metabolites, including alkaloids, glycosides, saponins, flavonoids, coumarins, and sterols, have immunomodulatory activity. According to the above review, numerous medicinal plants exhibit immunomodulatory activity in experimental models at a specific dose. Immunomodulators have been recognised as being of interest as immune system boosters to combat viral or external damage, immune suppressors to manage the aberrant immunological response occurring during autoimmune illnesses, or adjuvants, which support by modifying nonimmune targets. Some medicinal plants may stimulate the immune system including *C. asiatica, M. oliefera, W. somnifera, M. koenigii, E. hirta, and M. piperita*. Also, various secondary metabolites (*e.g.*, alkaloids, glycosides, saponins, flavonoids, coumarins, and sterols) exhibit a wide range of immunomodulating activity. This type of research with immuno-medicinal herbs will benefit populations in need of herbal treatment to treat immune diseases without the use of synthetic drugs, as well as prevent or reduce the side effects of synthetic drugs. New immunomodulatory plants are critical for the development of drugs with fewer side effects, lower costs and greater potency and effectiveness for immune and related diseases.

Conflict of Interest

The authors declare no conflicts of interest relevant to this article.

References

Alankar, S. (2009). A review on peppermint oil. Asian J. Pharm. Clin. Res., **2**:27-33.

Arakawa, T. and Osawa, K. (2000). Pharmacological study and application to the food of mint flavour-antibacterial and antiallergic principles. Aroma Res., **1**:20-23.

Areias, F.; Valentao, P.; Andrade, P.; Ferreres, F. and Seabra, R. (2001). Phenolic fingerprint of peppermint leaves. Food Chem., **73**:307-311.

Arulselvan, P. and Subramanian, S.P. (2007). Beneficial effects of *Murraya koenigii* leaves on antioxidant defense system and ultra-structural changes of pancreatic a-cells in experimental diabetes in rats. Chem. Biol. Interact., **165**:155-164.

Asha, S.; Deevika, B. and Mohamad Sadiq, A. (2014). *Euphorbia hirta* Linn - a review on traditional uses, phytochemistry and pharmacology. World J. Pharm. Res., **3**(4):180-205.

Asha, S.; Thirunavukkarasu, P.; Mani, V.M. and Sadiq, A.M. (2016). Antioxidant activity of *Euphorbia hirta* Linn leaves extracts. European J. Med. Plants, **7:1**-14.

Ashfaq, M., Basra, S. and Ashfaq, U. (2012). Moringa: A miracle plant for agroforestry. J. Agric. Soc. Sci., **8**(3):115-122.

Berkovich, L., Earon, G., Ron, I., Rimmon, A., Vexler, A. and Lev-Ari, S. (2013). *Moringa oleifera* aqueous leaf extract down-regulates nuclear factor-kappa B and increases cytotoxic effect of chemotherapy in pancreatic cancer cells. BMC Complement. Altern. Med., **13**: 212-219.

Bhandari, C.R. (1970). Ashwagandha (*Withania somnifera*) "Vanaushadhi Chandroday" (An Encyclopedia of Indian Herbs). Publisher: CS Series of Varanasi Vidyavilas Press, Varanasi, India, **1:**96-97.

Bhandari, P. (2012). Curry leaf (*Murraya koenigii*) or Cure leaf: Review of its curative properties. J. Med. Nutr. Nutraceuticals, **1**(2):92.

Budhiraja, R.D. and Sudhir, S. (1987). Review of biological activity of withanolides. JSIR, **46**:488-491.

Burdock, G.A. and Carabin, I.G. (2004). Generally recognized as safe (GRAS): History and description, Toxicol. Lett., **150**(1):3-18.

Chee, W.A.; Angie, M.J. and Matthew, A. (2017). Nitroimidazoles: molecular fireworks that combat a broad spectrum of infectious diseases. J. Med. Chem., **60**(18):7636-7657.

Choi, M.J.; Zheng. H.M.; Kim, J.M.; Lee, K.W.; Park, Y.H. and Lee, D.H. (2016). Protective effects of *Centella asiatica* leaf extract on dimethylnitrosamine induced liver injury in rats. Mol. Med. Rep., **14**(5):4521-4528.

Cunningham, R.S. (1982). Effects of nutritional status on immunological function. Am. J. Clin. Nutr., **35**:1202.

Cutler, S.J.; Fooks, A.R. and van der Poel, W.H. (2010). Public health threat of new, reemerging, and neglected zoonoses in the industrialized world. Emerg. Infect. Dis., **16**(1):1-7.

Devi, K.; Subramani, R.; Nakulan, V.; Valsala, R. and Annamalai, P. (2014). Antioxidant activity of *Euphorbia hirta* Linn leaves extracts. European J. Med. Plants, **27**(2):408-412.

Eftekhari, A.; Ameer Khusro, C.; Elham Ahmadian, D.; Solmaz Maleki Dizaj, E.; Amir Hasanzadeh, A. and Magali Cucchiarini, F. (2021). Phytochemical and nutra-pharmaceutical. Arab. J. Chem., **14**:103-106.

Foidl, N.; Makkar, H.P.S. and Becker, K. (2001). The potential use of *Moringa oleifera* for agriculture and industrial uses. Managua, Nicaragua: 2001. pp:1-20.

Gangwar, V.; Garg, A.; Lomore, K.; Korla, K.; Bhat, S.S.; Rao, R.P.; Rafiq, M.; Kumawath, R.; Uddagiri, B.V. and Kareenhalli, V.V. (2021). Immunomodulatory effects of a concoction of natural bioactive compounds-mechanistic insights. Biomedicines., **9**(11):1522.

Ghosh, P.; Ghosh, C. and Das, S. (2019). Botanical description, phytochemical constituents and pharmacological properties of *Euphorbia hirta* Linn: A review. Int. J. Health Sci. Res., **9**(3):273-286.

Gohil, K.J.; Patel, J.A. and Gajjar, A.K. (2010). Pharmacological review on *Centella asiatica*: A potential herbal cure-all. Indian J. Pharm. Sci., **72**(5):546-556.

Grandhi, A.; Mujumdar, A.M. and Patwardhan, B. (1994). A comparative pharmacological investigation of Ashwagandha and Ginseng. J. Ethnopharmacol., 44(3):131-135.

Gupta, P.; Nahata, A. and Dixit, V.K. (2011). An update on *Murraya koenigii* spreng: A multifunctional Ayurvedic herb reviews, **9**:824-833.

Gupta, S.; George, M.; Singhal, M.; Sharma, G.N. and Garg, V. (2010). Leaves extract of *Murraya koenigii* linn for anti-inflammatory and analgesic activity in animal models. J. Adv. Pharm. Technol. Res., **1**:68-77.

Handral, H.K.; Pandith, A. and Shruthi, S.D. (2012). A review on *Murraya koenigii*: Multipotential medicinal plant. Asian J. Pharm. Clin. Res., **5**:5-14.

Harun N.H.; Wan Amir W.; Ahmad N.W. and Suppian, R. (2021). Immunostimulatory effects of asiatic acid and madecassoside on the phagocytosis activities of macrophages cell line (J774A.1), J. App. Pharm. Sci., **11**(11):104-111.

Herro, E. and Jacob, S.E. (2010). *Mentha piperita* (peppermint). Dermatitis, 21(6):327-329.

Inoue, T.; Sugimoto, Y.; Masuda, H. and Kamei, C. (2002). Antiallergic effect of flavonoid glycosides obtained from *Mentha piperita* L. Biol. Pharm. Bull., **25**:256-259.

Jain, R.; Kachhwaha, S. and Kothari S.L. (2012). Phytochemistry, pharmacology, and biotechnology of *Withania somnifera* and *Withania coagulans*: A review, J. Med. Plant Res., **6**(41):5388-5399.

James, J. and Dubery, I. (2011). Identification and quantification of triterpenoid Centelloids in *Centella asiatica* (L.) Urban by densitometric TLC. Journal of Planar Chromatography-Modern Tlc **24**:82-87.

Joshi, V.C. and Khan, I.A. (2008). Morphological characterization of medicinal plant *Centella asiatica* (L.)Urb and detection of its possible substitutes. Planta Med., **74**:2.

Kasolo, J.N.; Bimenya, GS.; Ojok, L.; Ochieng, J. and Ogwal-okeng, J.W. (2010) Phytochemicals and uses of *Moringa oleifera* leaves in Ugandan rural communities, J. Med. Plants Res., **4**:753-757.

Kausar, J.; Muthumani, D.; Hedina A. and Anand V. (2016). Review of the phytochemical and pharmacological activities of *Euphorbia hirta* Linn. Pharmacognosy Journal, **8**(4):310-313.

Khare, C. (2007). Centella asiatica (Linn.) Urban.. In: Khare, C. (eds) Indian Medicinal Plants. Springer, New York, NY.

Khedkar, R. (2015). Curry leaf (*Murraya koenigii* L. Spreng) as a functional food. Food Sci. Res. J., **6**(1):135-141.

Kumar, M.; Sarma, D.K.; Shubham, S.; Kumawat, M.; Verma, V.; Nina, P.B.; Devraj, J.P.; Kumar, S.; Singh, B. and Tiwari, R.R. (2021). Futuristic non-antibiotic therapies to combat antibiotic resistance: A review. Front. Microbiol., **12**:609459.

Kumar, S.R.; Loveleena, D. and Godwin, S. (2013). The medicinal property of *Murraya koenigii*- a review, Int. Res. J. Biol., **2**(9):80-83.

Kumari, L. and Papiya, M. (2014). Evaluation of *in vitro* antioxidant activities of various extracts of *Murraya koenigii* (L.) Spreng leaves with special reference to their HPTLC fingerprinting profile. Guru drone J. Pharm. Res., **2**(2):1-11.

Maggini, S.; Pierre, A. and Calder, P.C. (2018). Immune function and micronutrient requirements change over the life course. Nutrients, **10**(10):1531.

Mali, G.R. and Hatapakki, C.B. (2022). An *in vitro* study of effect of *Centella asiatica* on phagocytosis by human neutrophils. Int. J.Pharm. Sci. Nanotechnol., **1**(3):297-302.

Maslow, J.N. (2017). Vaccine development for emerging virulent infectious diseases. Vaccine, **35**:5437-5443.

Mbikay, M. (2012). Therapeutic potential of *Moringa oleifera* leaves in chronic hyperglycemia and dyslipidemia: A review Front. Pharmacol., **3**:1-12

Nurain, I. (2015). Intake of powdered tea supplemented with *Moringa oleifera* leaf attenuates some hematological parameters in malnourished children. Biol. Chem. Res., **32**(2):892-901

Ogden, N.H.; AbdelMalik, P. and Pulliam, J. (2017). Emerging infectious diseases: Prediction and detection. Can. Commun. Dis. Rep., **43**(10):206-211.

Paul, S.; Bandyopadhyay, T.K. and Bhattacharyya, A. (2011). Immunomodulatory effect of leaf extract of *Murraya koenigii* in diabetic mice. Immunopharmacol. Immunotoxicol., **33**:691-699.

Prajapati, C.; Ankola, M.; Upadhyay, T.K.; Sharangi, A.B.; Alabdallah, N.M.; Al-Saeed, F.A.; Muzammil, K.; Saeed, M. (2022). *Moringa oleifera*: Miracle plant with a plethora of medicinal, therapeutic, and economic importance. Horticulturae, **8**:492.

Pratheepa, V. and Sukumaran, N. (2011). Specific and nonspecific immune stimulation study of *Euphorbia hirta* on *Pseudomonas fluorescens*-infected Cyprinus Carpio. Pharm. Biol., **49**(5):484-491.

Punturee, K.; Wild, C.P.; Kasinrerk, W. and Vinitketkumnuen, U. (2005). Immunomodulatory activities of *Centella asiatica* and *Rhinacanthus nasutus* extracts. Asian Pac. J. Cancer Prev., **6**(3):396-400.

Rahman, M.S.; Rana, S. and Islam, A.A.F. (2019). Antithrombotic and anti-inflammatory activities of leaf methanolic extract of *Euphorbia hirta* Lin. Int. J. Complement. Alt. Med., **12**(4):154-162.

Rendra, E.; Riabov, V.; Mossel, D.M.; Sevastyanova, T.; Harmsen, M.C. and Kzhyshkowska, J. (2019). Reactive oxygen species (ROS) in macrophage activation and function in diabetes. Immunobiology, **224**(2):242-253.

Rohloff, J. (1999). Monoterpene composition of essential oil from peppermint (*Mentha piperita* l.) with regard to leaf position using solid-phase microextraction and gas chromatography/mass spectrometry analysis. J. Agri Food Chem., **47**:3782-3786.

Rosenblum, M.G. and Donato, N.J. (1989). Tumor necrosis factor-a: A multifaceted peptide hormone. Crit. Rev. Immunol., **9**:21-44.

Sabin, N.S.; Calliope, A.S.; Simpson, S.V. Arima, H.; Ito, H.; Nishimura, T. and Yamamoto, T. (2020). Implications of human activities for emerging infectious diseases, including COVID-19. J. Physiol. Anthropol., **39**:29.

Saini, S.C.; Tyagi, M.K.; Amroha, D. and No, P.C. (2015). Studies about *Murraya koenigii* (quality estimation and antibacterial and antifungal properties) Int. J. Pharma. Sci. Inven., **4**:19-24.

Samuel, K.; Medikeri, A.; Pasha, T.; Ansari, M.F. and Saudagar, A. (2022) *Centella asiatica*: A traditional herbal medicine, World J. Adv. Res. Rev., **15**(01):512-524.

Sathaye, S.; Amin, P.; Mehta, V.; Zala, V.; Kulkarni, R.; Kaur, H. and Redkar. (2011). Immunomodulatory activity of aqueous extract of *Murraya koenigii*, L. in experimental animals. Int. J. Toxicol. Pharmacol. Res., **3**(4):7-12.

Sawian, J.T.; Jeeva, S.; Lyndem, F.G.; Mishra, B.P. and Laloo, R.C. (2007). Wild edible plants of Meghalaya, North Eastern India. Nat. Prod. Radiance, **6**(5):410-426

Shah, A.S.; Wakade, A.S. and Juvekar, A.R. (2008). Immunomodulatory activity of methanolic extract of *Murraya koenigii* (L.) Spreng. leaves. Indian J. Exp. Biol., **46**:505-509.

Sharangi, A. and Guha, S. (2013). Wonders of leafy spices: Medicinal properties ensuring human health. Sci. Int., **1**(9):312-317.

Sharma, M. and Gautam, D. (2022). Phytoconstituents and medicinal value of *Mentha piperita*. Modern Phytomorphology, **15**:156-160.

Sharma, N.; Minocha, N. and Kushwaha, N. (2020). A review on the activities of *Aloe vera* and curry leaves. Int. J. Recent Sci. Res., **11**:(11): 39985-39991.

Sharma, P.V. (1999). Ashwagandha, Dravyaguna Vijana, Chaukhambha Viashwabharti, Varanasi, pp:763-765.

Shih, M.; Cheng, Y.; Shen, C. and Cherng, J. (2010). A molecular pharmacology study into the anti-inflammatory actions of *Euphorbia hirta* L. on the LPS-induced RAW 264.7 cells through selective iNOS protein inhibition. J. Nat. Med., **64**:330-335.

Siddiqui, N.A.; Singh, S.; Siddiquei, M.M. and Khan, T.H. (2012). Immunomodulatory effect of *Withania somnifera*, *Asparagus racemosus*, and *Picrorhiza kurroa* roots. Int. J. Pharmacol., **8**:108-114.

Silalahi, M. (2021). Utilization of *Euphorbia hirta* L. for traditional medicine and its bioactivity. World J. Biol. Pharma Health Sci., **08**(01):053-058.

Singh, N.; Bhalla, M.; de Jager, P. and Gilca, M. (2011). An overview on ashwagandha: A Rasayana (Rejuvenator) of Ayurveda, Afr. J. Tradit. Complement. Altern. Med., **8**(S):208-213

Sivasankari, B.; Anandharaj, M. and Gunasekaran, P. (2014). An ethnobotanical study of indigenous knowledge on medicinal plants used by the village people, Thoppampatti, Dindigul district, Tamilnadu, India. J. Ethnopharmacol., **153**:408-423.

Somchit, M.N.; Sulaiman, M.R.; Zuraini, A.; Samsuddin, L.; Somchit, N.; Israf, D.A. and Moin, S. (2004). Antinociceptive and anti-inflammatory effects of *Centella asiatica*. Indian J. Pharmacol., **36**:377-380.

Sultan, R.A.; Mahmood, S.B.Z.; Azhar, I.; Ahmed, S.W. and Mahmood, Z.A. (2014). Biological activities assessment of *Centella asiatica* (Linn.). J. Herbsspices Med. Plants, **20**:319-327.

Sun, B.; Wu, L.; Wu, Y.; Zhang, C.; Qin, L.; Hayashi, M.; Kudo, M.; Gao, M. and Liu, T. (2020). Therapeutic Potential of *Centella asiatica* and Its Triterpenes: A review. Front Pharmacol., **4**:568032.

Sundari, S.; Kumarappan, C.T.; Jaswanth, A. and Valarmathy, R. (2004). Bronchodilator effect of alcoholic extract of *Euphorbia hirta*. Anc. Sci. Life, **23**:1-5.

Tharakan, A.; Shukla, H.; Benny, I.R.; Tharakan, M.; George, L. and Koshy, S. (2021). Immunomodulatory effect of *Withania somnifera* (Ashwagandha) extract-A randomized, double-blind, placebo controlled trial with an open label extension on healthy participants. J. Clin. Med., **10**(16):3644.

Tsai, M.; Wu, C.; Lin, T.; Lin, W.; Huang, Y. and Yang, C. (2013). Chemical composition and biological properties of essential oils of two mint species. Trop. J. Pharm. Res., **12**(4):577-582.

Ubeda, C. and Pamer, E.G. (2012). Antibiotics, microbiota, and immune defense. Trends Immunol., **33**(9):459-466.

Vijaya, K. and Padmavathi, K. (2010). Assessment of immunomodulatory activity of *Euphorbia hirta* L. Indian J. Pharm. Sci., pp:621-625.

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