

**A REVIEW ON HERBAL IMMUNITY BOOSTERS FOR IMPROVEMENT OF HUMAN HEALTH IN COVID-19**Surabhi Shakya¹, Padmini Shukla², Prabodh Shukla³¹Department of Pharmaceutical Sciences, Kumaun University, Nainital, Uttarakhand^{2,3} Faculty of Pharmacy, Uttar Pradesh University of Medical Sciences, Saifai, Etawah (U.P.)**Article Info: Received 25 August 2020; Accepted 20 September. 2020****DOI: <https://doi.org/10.32553/jbpr.v9i5.804>****Corresponding author: Surabhi Shakya****Conflict of interest statement: No conflict of interest****ABSTRACT:**

Herbal immunity boosters are the medicinal plants which increase the immunity of the human body and make the body able to fight with the various diseases. These immunity boosters are serving as a boon in the case of coronavirus disease. COVID-19 affects our respiratory system and lowers the immunity of the patient and the persons having weak immunity have the more chances to get affected with the diseases. Tulsi, garlic, ginger, giloy, coconut oil, turmeric, ashwagandha, amla, black pepper, aloe vera are the herbal immunity boosters. These herbal drugs used traditionally in medicines and also proved effective in scientific studies. The regular consumption of these boosters helps to treat the mild to moderate symptoms of diseases at home.

Keywords: Herbal immunity boosters, Coronavirus, COVID-19, Garlic, Tulsi, Ginger, Aloe vera**INTRODUCTION**

Human history recorded many pandemic diseases that not only affect the health of humans but also create many more problems. These diseases occurred after several years but the negative impacts created by them remain for many years and it takes time to recover from the losses. The world faced several unpredictable pandemics as cholera, plague, dengue, plague, influenza, AIDS, influenza, West Nile disease, tuberculosis, severe acute respiratory syndrome (SARS) [1]. Pandemic series in the last 20 years are Severe Acute Respiratory Syndrome (2003), Influenza A H₁N₅ (bird flu, 2007), H₁N₁ (swine flu, 2009), Middle East Respiratory Syndrome (MERS, 2012), Ebola (2014), COVID-19 (coronavirus, 2019) [2]. Nowadays, the whole world is facing the outbreak of COVID-19, and scientists of every corner of the world are working on this dreadful virus. Many approaches came forward for the treatment of this disease not only in allopath but also in Ayurveda but still full success not found. In this panic situation, a ray of hope is the herbal immunity boosters which strengthen our immune system and make our body capable of the fight against the virus. The significant role played by the medicinal plants in improving the quality of human life. Medicinal herbs provide many benefits from centuries and public interest towards medicinal plants increasing day by day due to changing lifestyles. The constituents present in the plants serve a major role in the cure of many vital diseases and boost the immune system [3]. Traditional knowledge passed through generations by traditional

health practitioners (THPs). For example, traditional healers of South Africa used a plant called "African Potato" (*Hypoxis hermerocallidea* Fish) as an immune booster [4]. Herbal tonics which having the properties of the immune-boosting has been used by the South Africans due to the high prevalence of HIV infections and the commercial one is Umakhonya®[5]. A traditionally used aromatic shrub i.e., Tulsi (*Ocimum sanctum*) provides many health benefits and also has its spiritual rituals. Tulsi serves as a boosting tonic that normalizes Vata and Kapha [6]. Another remarkable plant is Garlic, a strong immune modulator. The main constituent present in the garlic is sulfur combinations which are responsible for maintaining the homeostasis and therapeutic effects[7]. From traditional knowledge to modern science, medicinal plants occupied a prominent place in proceeding the human health. The constituents present in it play a major role in the pathway of immune modulation and help the immune system in removing or suppressing the toxins, allergens, or pathological microbes. T-cells of the immune system are responsible for distinguishing between self from nonself antigens. The cells of the human body infected by intracellular parasites and bacteria, viruses, and other pathogens are also recognized by cells of the immune system [8]. Neem (*Azadirachta indica*) increases the production of white blood cells by stimulating the lymphocytic system and boosts the macrophage activity of the body. Immuno-stimulant activity exhibit by the aqueous extract of bark of the neem tree and also possess by the neem oil which can activate the cell-

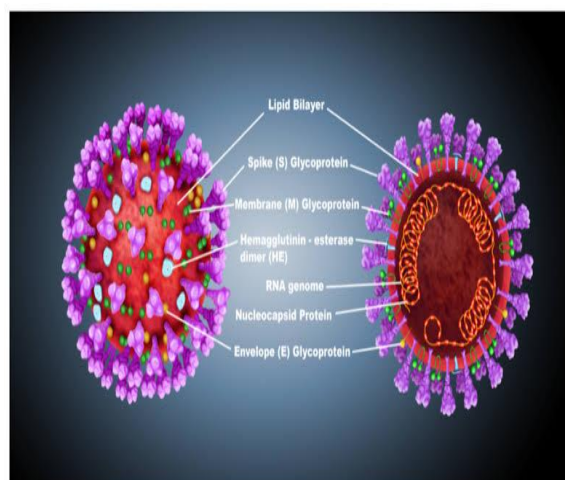
mediated immune response[9]. Some other medicinal plants having well-defined immunomodulation activity are *Zingiber officinale* (Ginger), *Andrographis paniculate* (Kalmegh), *Panax pseudoginseng*(Himalayan ginseng), *Curculigo orchioides*(Black muls), *Phoenix dactylifera* (Date palm), *Prunus amygdalus* (Almond), *Piper longam*(Long pepper) [10], *Bauhinia Variegata*(Orchid tree), *Tinospora cordifolia* (Giloy), *Ficus carica* (Common fig), *Hibiscus Rosa Sinensis* (China rose), *Aloe barbadensis* (Aloe vera), *Citrus*, *Allium sativum*(Garlic), *Curcuma longa*(Turmeric), *Asparagus racemosus* (Shatavari), *Withania somnifera* (Ashwagandha), *Emblica officinalis* (Indian Gooseberry), *Terminalia arjuna*(Arjun tree), *Eclipta alba* (Bhringraj)[11].

CORONAVIRUS

A newly discovered virus responsible for the highly infectious disease known as COVID-19 (Coronavirus disease). The international committee on the Coronavirus study group suggested the name of newly found coronavirus as SARS-CoV-2 (Severe Acute Respiratory Syndrome- Coronavirus-2) because it acts on the same receptor as SARS-CoV (ACE2) [12]. After getting infected by the virus, the person developed mild to moderate symptoms. But due to the changing behavior of the virus sometimes the symptoms remain hidden. Symptoms that commonly occurred are fever, a person feels tired and dry cough. Sometimes the other symptoms also occur but they are less common as aches in the body, headache, diarrhea, loss of taste, and smell. And when the condition becomes worse, the most serious symptoms occur as like chest pain or pressure, shortness of breath, or difficulty in breathing [13].

Structure and mechanism of Coronavirus

Highly contagious virus i.e., Coronavirus contains approximately 30,000 in its genome. Four structural proteins encoded by this virus are Envelop protein, Membrane protein, Spike protein, Nucleocapsid protein. It also encodes several non-structural proteins. The outer covering of the virus is a protein shell (capsid), the inner side of the capsid contains the single-strand RNA having the attachment with nuclear protein. This attachment plays a major role in the conversion of human cells into the infected one [14]. On the surface of human cells, angiotensin-converting enzyme-2(ACE2) is present, for the coronavirus these enzymes serve as receptors on which the virus gets attached with the help of its Spike protein and facilitate its entry into the host cell[15]. The shape of the virus envelop maintained by the membrane protein and remains in interaction with other structural proteins also [16]. Cellular proteases facilitate the entry of the corona virus into the cell that involves cathepsins, human airway trypsin-like protease (HAT), and transmembrane protease serine 2, cause penetration changes through the splitting of spike protein [17]



1. Garlic (*Allium sativum* L.)



Allium sativum L. belongs to the family Alliaceae. Mainly the organo-sulfur compounds are produced by the genus *Allium*. The main constituents present in garlic are Alliin (S-allyl- L-cysteine sulfoxide), MCSO (S-methyl cysteine-sulfoxide), DAS (Diallyl sulfide), DADS (Diallyl disulfide), E & Z Ajoene. An enzyme alliinase present in the garlic which converts alliin into allicin after getting crushed. The constituents present in the garlic responsible for many pharmacological activities and used since ancient times for the treatment of various diseases like respiratory infections, indigestion, urinary tract infections, heart problem [25]. For maintaining the homeostasis and immune function, garlic serves as a promising candidate. Differentiation and proliferation of the β -cells increases by the intake of garlic as a dietary source. Garlic enhanced T-cell proliferation which indirectly or directly affects the B-cells but more study required for understanding the mechanism of antibodies production. Allicin, the main constituent of garlic responsible for the maturation of dendritic cells (cells which cause the induction of primary immune response) [26]. Like BCG, garlic also enhances the activity of natural killer cell and lymphokine-activated killer cells. It also

increased the release of other immune cells like interleukin-2, phagocytes, macrophages, etc [27].

2. Ginger (*Zingiber officinale*)-



The rhizome of *Zingiber officinale* effective for the treatment of various diseases belongs to the family Zingiberaceae. The biggest producer of ginger is India and traditionally used by peoples of many countries as a home remedy. Numerous studies revealed that it has many efficient activities like anticancer, antidiabetic, antioxidant, immunomodulatory, anti-inflammatory, nephroprotective, hepatoprotective, analgesic, etc [28]. The main constituents present in rhizome are gingerol (responsible for its pungent nature), mono and sesquiterpenes present in volatile oil, shogaol (gingerol's dehydrated product), sesquiterpenoids present in essential oil with zingiberene as the main constituent. Protein, fatty oil, carbohydrates, ash, water, crude fiber are also present in dried rhizome. Other constituents are cineole, curcumin, borneol, terpineol, linalool, camphene, beta-sesquiphellandrene, α -zingiberene. Gingerdiols, paradols, gingerdiones, gingerenones are other pungent compounds present in ginger. Gingediacetates, methylgingediol, methylegingediacetates are present in minute quantity [29]. The constituents present in ginger showed an effective immune response through various mechanisms. Consumption of rhizome for the required duration results in the increment of different blood cells like white blood cells, red blood cells, neutrophils, hemoglobin, major histocompatibility complex (MHC) [30]. In the case of lung diseases or asthma, ginger helps to reduce the symptoms by relaxing the smooth muscles in the airway (as it acts on the calcium channels). The main constituents present in ginger like gingerol, shogaol cause the reduction of inflammatory cytokines and chemokines, etc. Ginger serves as a boosting remedy because it affects the various activities which directly or indirectly make the body healthy like it caused the inhibitory effect on lipoxigenase and COX-2 in

inflammation. The anti-oxidant activity of the ginger is due to the reduction of reactive oxygen species and enhancement in glutathione [31].

3. Tulsi (*Ocimum sanctum*)-



Tulsi is not only known for its aromaticity and medicinal properties but also for its connection with the Hindu religion that's why it is known as holy basil also which belongs to the family Lamiaceae. In Ayurveda, tulsi used for the cure of many diseases through 3000 years and has adequate healing power and called "Elixir of Life". Most of the beneficial constituent present in the leaves of the plant. The main constituents present in the leaves of tulsi are Ursolic acid, eugenol[32], methyl eugenol. Apigenin, isothymusin, circimaritin, cirsilineol are the phenolic compounds present in leaves and stem. Stearic acid, palmitic acid, linolenic acid, oleic acid, linoleic acid are the major fatty acids present in the plant. Other constituents that present in tulsi are tannins, calcium, flavonoid, vitamin C, beta carotene, camphor, etc[33]. Vitamins such as vit. A and vit. C present in tulsi which increases the production of antibodies upto 20%. In Ayurveda, extract of leaves used for the treatment of many diseases like malaria, epilepsy, fever, bronchitis, convulsions, cough and cold, etc. The pharmacological activities present in tulsi are anticancer, antidiabetic, antiviral, antimicrobial, antifungal, hepatoprotective, immunomodulator, anticoagulant, anthelmintic, antistress, antipyretic, radioprotectant, antihyperlipidemic [34]. The seed oil of this aromatic herb used for boosting immunity by mediating the GABAergic pathway and balances both humoral and cell-mediated immunity. The aqueous extract of leaves showed a superior response than the alcoholic extract haemagglutination titer. It acts on the different levels of the immune system and boosts immunity by increasing the antibodies production and during the inflammation, it causes the release of mediators also [35].

4. Giloy (*Tinosporacordifolia*)-



Climbing shrub of the family Menispermaceae used traditionally as a natural medicine and it also called Guduchi. *Tinosporacordifolia* is a deciduous shrub and climb vertically with several branches. Giloy is known for its medicinal properties due to the presence of many active constituents in it. The chemical constituents present in giloy are tinosporine, berberine, tembetarine, isocolumbin (alkaloids present in stem and root), tinocordiside, furanoidditerpene, palmatosides, cordifolioside, tinocordifolioside (glycosides present in stem part). Other constituents are tinocordifolin, furanolactone, tinosporides, beta-sitosterol, columbin, δ -sitosterol, clerodane derivatives [36]. Apart from these constituents, giloy is also rich in protein, carbohydrate, fiber, potassium, chromium, calcium, and iron.

Numerous experimentations proved that *Tinosporacordifolia* possesses varieties of activities like anticancer, anti-inflammatory, anti-oxidant, brain tonic, aphrodisiac, immunomodulatory [37], anti-microbial, anti-HIV, anti-toxic, anti-viral, vasorelaxant, anti-leprotic, anti-arthritis, anti-allergic. It is used in many forms like decoction, syrups, tincture, infusion, maceration, etc. The stem part of giloy is used for making the cold infusion and found to be effective in high fever [38]. Immunomodulatory and the cytotoxic effect of giloy is shown by the presence of its active constituents like magnoflorine, cordifolioside, tinocordiside, N-methyl-2-pyrrolidone, etc. These active components are responsible for boosting the immune system through the production of free radicals in neutrophils and stimulate the macrophage's phagocytic property. Production of immune cells and cytokines is also enhanced through the intake of its aqueous extract [39]. Polysaccharide i.e., Arabinogalactan found in giloy acts on the dendritic cells (immature) of bone marrow and induced its maturation. α -D-glucan activates the various lymphocytes (at concentration 100 μ g/ml) like T-cells, B-cells, Natural killer cells, etc [40].

5. Turmeric (*Curcuma longa*)-



Turmeric is known to be a very popular Indian spice and almost used on a daily basis in every Indian food. This medicinal plant belongs to the family Zingiberaceae (plant of the ginger family). Turmeric is used traditionally as herbal medicine because of its valuable activities. It shows various activities such as: anti-viral, anti-inflammatory, anti-microbial, anti-mutagenic, anti-cancer, anti-oxidant, anti-venom, anti-arthritis, anti-diabetic, wound healing activity [41]. Ayurveda mentioned turmeric's role as to provide warming and strengthening to the body. People use turmeric as a home remedy for the treatment of many problems such as acidity, to relieve menstruation, applied locally on cuts, burns, insect bites, increase the flow of bile, to provide relief in cough and asthma. It is also used as a dye and food colorant [42]. The main constituents present in turmeric are curcumin. Three compounds present in turmeric which are collectively known as curcuminoids are curcumin, bisdemethoxycurcumin, and demethoxycurcumin. Sesquiterpenes and monoterpenes present in the volatile oil are curcumenone, curcumenol, procurcumenol, epiprocurcumenol, bisacumol. Other constituents are terpinolene, α -phellandrene, α , and β turmerone. Curcumin is responsible for most of the pharmacological activities [43]. Curcumin shows its effect on immune cells by modulating the proliferation and activation of B-cells, T-cells, macrophages, and Natural killer cells. Different studies performed for curcumin on various models and showed beneficial results as- the proliferation of B-cells increases in the intestinal mucosa of mice by curcumin, curcumin acts on macrophages and decreases its ability to generate ROS, the study on mouse suggests that splenic lymphocyte proliferation increased at the low dose of curcumin and decreased at high dose [44].

6. Black pepper (*Piper nigrum* L.)-



Black pepper (*Piperaceae*- the family of *Piper nigrum* L.) also referred to as the king of spices because of its valuable properties. Other names of black pepper are Kali Mirch (in Hindi) and Pippali (in Sanskrit). Black pepper used all over the world as in various dishes, as a medicinal agent, and also in perfumery. Various studies revealed the presence of many phytochemicals in black pepper but piperine (pungent) found in many of the plants of the *Piperaceae* family. The phytoconstituents are piperamide, pipericide, piperolein, tricholein, sarmentine, sarmentosine, N-formylpiperidine. Chavine, Isochavicine, piperine, and isopiperine are the four isomers of piperine [45]. Piperine is known to have diverse pharmacological activities like anti-microbial, anti-inflammatory, anti-cancer, analgesic, hepatoprotective, anti-depressant, immunomodulatory, anti-diarrheal. In addition to this, piperine also known to enhance the bioavailability of various drugs (norfloxacin, ampicillin, amoxicillin) and natural compounds (curcumin) [46]. A study on piperine concluded that the combination of GABA (gamma-aminobutyric acid) with piperine cause the activation of JNK (Jun N-terminal kinase) and p38 MAPK (mitogen-activated protein kinase), which results in the NF- κ B (it stands for Nuclear Factor kappa-light-chain-enhancer of activated B-cells) and IL-10 (another name of IL-10 is human cytokine synthesis inhibitory factor) up-regulation through increasing the expression of EPO (erythropoietin) and EPO-R (erythropoietin receptor) [47].

7. Coconut Oil



The main product of the coconut (*Cocos nucifera*) is the coconut oil which has its multipurpose uses. It is used for skin moisturizing, for cooking food, for hair treatment, and also in folk medicines. Coconut oil obtained from the fruit of the coconut after the extraction process. Inside the fruit, kernel is present which is also called coconut's meat. The kernel is the main part of the fruit which through which different products are obtained like coconut oil, coconut milk, the dried form of coconut. Coconut oil is of two types- one is RBD (refined, bleached, and deodorized copra oil) and the other is VCO (virgin coconut oil). Both types of oil have the same triglycerides and fatty acids profile [48]. Virgin coconut oil is obtained from the fresh kernel by natural means without the treatment of heat and has a clear appearance like water. Virgin coconut oil contains both saturated and unsaturated fatty acids like palmitic acid, myristic acid, caproic acid, capric acid, stearic acid, oleic acid and linoleic acid. Other compounds present in VCO are tocopherols and phenolic compounds. The fatty acids present in virgin coconut oil play a major role in boosting immunity. The immune-stimulant property of VCO concluded through a study on chicken in which vaccine given to chickens against a variety of influenza viruses and VCO increases the Th-CD4 and lymphocytes in them. VCO acts on the viral membrane and disrupts it and shows an anti-viral property. The presence of fatty acids makes the oil effective against many lipid-coated viruses [49].

8. Amla (*Emblica officinalis*)-



It is also known as *Phyllanthus emblica* Linn. and locally known as amla or Indian gooseberry, belongs to the family *Euphorbiaceae*. It is one of the important traditionally used medicinal herb. Amla's fruit is known to exert many beneficial effects on human health such as tonic, laxative, digestive, antipyretic, diuretic, tonic, anti-inflammatory, cardioprotective, hepatoprotective, and many more. The fruit of amla shows prominent effects in the severe conditions of asthma, peptic ulcer, bronchitis, cough, etc. the phytoconstituents present in Amla are tannins (Emblicanin A and Emblicanin B are two hydrolyzable tannins), alkaloids (Phyllantidine,

Phyllembein), vitamins (vitamin C), flavonoids (quercetin, kaempferol), phenolic compounds (ellagic acid, gallic acid, methyl gallate), carbohydrates and citric acid. The fruit of amla contains a higher concentration of Vitamin C than other fruits like lemons, oranges, and tangerines. Amla also has immunity-boosting property [50]. The vitamin C presents in amla fruit is responsible for boosting immunity by improving the activity of natural killer cells. A study revealed the immunomodulatory effect of *Emblica officinalis* in the presence of chromium (IV) which is an immunosuppressive agent. Chromium induced the free radical production, *Emblica officinalis* inhibited the production and maintain the level of anti-oxidant also [51].

9. Ashwagandha (*Withaniasomnifera*):



It is a member of the Solanaceae family and commonly known as Indian Ginseng. The Rasayana form of Ashwagandha used in the traditional system for many years. Rasayana is in the form of an herbal preparation that improves mental and physical health. The constituents present in the ashwagandha exerts the immunomodulatory effect. The phytoconstituents present in ashwagandha are anaferine, withanolide, withaferin, sitoindosides VII-X, withasomniferin-A, isopelletierine [52]. The properties like immunomodulatory, analgesic, anti-inflammatory, antioxidant, anti-stress, anti-pyretic, and many more shown by the root extract of ashwagandha. The immuno-modulatory property of *Withaniasomnifera* confirmed by the test in which cyclophosphamide (immunosuppressive drug) given to the rats. Five days before the administration of cyclophosphamide, the aqueous extract of *Withaniasomnifera* administered to the rats for 10 days regularly. Due to the effect of ashwagandha, the immunity of rats increased and they showed a significant increase in the count of white blood cells and absolute lymphocyte count [53]. Ashwagandha stimulates the cell-mediated immunity. The pathogen killing power of immune cells increases because it enhanced the macrophage's nitric oxide synthetase activity. In mice, the root extract of ashwagandha

increases the level of interleukin-2 and granulocyte macrophage colony-stimulating factor [54].

10. Aloe vera (*Aloe barbadensis* Mill., *Aloe indica* Royle, *Aloe vulgaris* Lam)-



The family of Aloe vera is Asphodelaceae. In the 17th century, Aloe vera was introduced to India, China, and Southern Europe. The cactus-like plant has fleshy leaves and triangular. Leaves of aloe vera divided into two main parts one is latex and the other are the gel. "Aloe juice" which is referred as latex whose concentration is more in young leaves in comparison to the older ones. The inner part of the leaf is referred to as gel which is tasteless and consists of pulp or mucilage. The latex and gel both contain the pharmacologically active constituents like anthraquinones (aloin, emodin, aloe-emodin, barbaloin, aloe-emodin, anthranol), saccharides (glucomannan, mannose, glucose, cellulose, glucogalactomannan), vitamins (Vit C, B1, B2, B3, folic acid, α -tocopherol), enzymes (lipase, amylase, catalase, oxidase), and other constituents are steroids, triglycerides, cholesterol, uric acid, etc. Acemannan (polysaccharides) reported having different activities like immunostimulating, antibacterial, antiviral, and wound healing [55]. Aloe vera used as a general tonic for increasing immunity because of its ability to produce white blood cells or macrophages in conditions like cancer and HIV. Aloe vera is a medicinal plant which has enormous uses like blood purifier, removes constipation, helps to supply oxygen to the cells, control diabetes and provide relief to Asthma patients [56]. Aloe vera contains 23 polypeptides; these polypeptides play a major role in diseases related to the immune system. The consumption of aloe-vera regularly for 5 days increases the macrophages and total WBC count [57].

CONCLUSION:

Many of the medicinal plants used for centuries for their beneficial properties. In Ayurveda the herbal preparations, minerals and metals used for the treatment of diseases. Many scientific studies revealed

that herbal preparations showed beneficial results in boosting the immunity of the person through various mechanism. The constituents present in the medicinal plants play multiple roles and also show the synergistic effects with the drugs. Here we discussed only some of the medicinal plants but thousands of medicinal herbs are present in the world which showed the prominent effect in boosting immunity. These plants are easily available in our surroundings and can be consumed in various ways like decoction form, in dried form, powder, fresh leaves of some plants can also be consumed like tulsi. As the whole world is changing rapidly and today's lifestyle is the main reason for the generation of different and new diseases and COVID-19 is one of the examples. Regular consumption of these immunity boosters helps the body to protect itself from the attack of pathogens and viruses. The more scientific approach required in this field because the immunity-boosting activities of many of the plants are still unknown.

REFERENCES:

- Qui W., Rutherford S., Mao A., Chu C. (2016-2017). The Pandemic and its impact. Health, Culture, and Society, 9-10, 3-11.
- Ross A.G.P., Crowe S.M., Tyndall M.W. (2015). Planning for the Next Global Pandemic. International journal of infectious diseases, 38, 89-94.
- Craig W.J. (1999). Health-promoting properties of common herbs. The American journal of Clinical Nutrition, 70 (suppl), 491S-95S.
- Khumalo B.M., Qwebani-Ogunleye. T., Ejidike I.P., Mtunzi F.M., Pinkoane M. (2018). Evaluation of immune booster formulation by traditional health practitioners: phytochemical, antioxidant, and mineral elements studies. International Journal of Pharma and BioScience, 9(2), 29-37.
- Ngcobo M., Sibiyi N. (2016). Immunomodulatory effects of Umakhonya®: A South African commercial traditional immune booster. South African journal of botany, 102, 26-32.
- Cohen M.M. (2014). Tulsi- *Ocimum sanctum*: A herb for all reasons. Journal of Ayurveda and Integrative Medicine, 5(4), 251-259.
- Khodadadi S. (2015). Role of herbal medicine in boosting immunity system. Immunopathologia Persa, 1(1), 1-2.
- Chaplin D.D. (2010). Overview of Immune response. J. Allergy Clin Immunol, 125(2), S3-23.
- Kumar P.S., Mishra D., Ghosh G., Panda C.S. (2010). Biological action and medicinal properties of various constituents of *Azadirachtaindica*(Meliaceae): An Overview. Scholars Research library, 1(3), 24-34.
- Puri A., Srivastava A., Bhardwaj A., Tandon J.S., Saxena K.C. (2013). Immunostimulant activity of certain plants used in Indian traditional medicine. Journal of Medicinal Plants research, 7(44), 3242-3246.
- Patel R., Piyush G., Mohd T., Kumar S. (2012). Herbal plants used for Immunomodulatory action: a review. International journal of Research in Pharmacy and science, 2(3), 14-26.
- Guo Y.R., Cao Q.D., Hong Z.S., Tan Y.Y., Chen S.D., Jin H.J., Tan K.S., Wang D.Y., Yan Y. (2020). The origin, transmission, and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak-an update on the status. Military Medical Research, 7(11), 1-10.
- World Health Organization. Coronavirus overview. Available at: https://www.who.int/health-topics/coronavirus#tab=tab_1
- Boopathi S., Poma A.B., Kolandaivel P. (2020) Novel 2019 coronavirus structure, mechanism of action, antiviral drug promises and rule out against its treatment. Journal of biomolecular structure and dynamics, 1-10.
- Simmons G., Gosalia D.N., Rennekamp A.J., Reeves J.D., Diamond S.L., Bates P. (2005). Inhibitors of cathepsin L prevent severe acute respiratory syndrome coronavirus entry. PNAS, 102(33), 11876-11881.
- Schoeman D., Fielding B.C. (2019). Coronavirus envelop protein: current knowledge. Schoeman and Fielding Virology Journal, 16(69), 1-22.
- Shereen M.A., Khan S., Kazmi A., Basir N., Siddique R. (2020). COVID-19 infection: Origin, transmission and characteristics of human coronaviruses. Journal of advanced research, 24, 91-98.
- Hafeez A., Ahmad S., Siddiqui S.A., Ahmad M., Mishra S. (2020). A review on COVID-19 (Coronavirus Disease-2019) Diagnosis, Treatments and Prevention. Eurasian journal of Medicine and Oncology, 4(2), 116-125.
- Dong L., Hu S., Gao J. (2020). Discovering drugs to treat coronavirus disease 2019 (COVID-19). Drug Discoveries and Therapeutics, 14(1), 58-60.
- Cruvinel W.M., Junior D.M., Araujo J.A.P., Catelan T.T.T., Souza A.W.S.S., Silva N. P., Andrade L.E.C., (2010). Fundamentals of innate immunity with emphasis on molecular and cellular mechanisms of inflammatory response. Molecular and cellular aspects of innate immunity 50(4). 434-61.
- Schultz K.T., Grieder F. (1987). Structure and Function of the Immune System. Toxicologic Pathology, 15(3), 262-264.
- Zhong J., Tang J., Ye C., Dong L. (2020). The immunology of COVID-19: is immune modulation an option for treatment? Lancet Rheumatol. 2, e428-36.
- Sadeeq S., Nazifi A., Labbo A.M., Khalid G.M., Yahya A., Muhammad U., Haruna A.M. (2020). Mechanism of Antiviral Immune Response and COVID-19 Infection. Asian Journal of Immunology, 3(3), 1-8.
- Tripathi J.S., Singh R.H. (1999). The concept and practice of immunomodulation in Ayurveda and the role of Rasayanas as immunomodulators. Ancient science of life, 19 (1&2), 59-63.
- Batiha G. S., Beshbishy A.M., Wasef L.G., Elewa Y.H.A., Sagan A.A., El. Hack. A.A., Taha A.E., Elhakim Y.M.A., Devkota H.P. (2020). Chemical constituents and pharmacological activities of Garlic (*Allium sativum* L.): A review. 12(872), 1-21.
- Arreola R., Fabian S.Q., Roa R. I. L., Gutierrez E.O.F., Grajeda J.P.R., Quintanar L.C., Daniel O.S. (2015). Immunomodulation and anti-inflammatory effects of garlic compounds. Journal of Immunology research, 1-13.
- Bhandari P.R. (2012). Garlic (*Allium sativum* L.): a review of potential therapeutic applications. International journal of green pharmacy, 6, 118-129.
- Syafitri D.M., Levita J., Mutakin M., Diantini A. (2018). A review: Is ginger (*Zingiberofficinale var. Roscoe*) potential for future phytomedicine? I J A S, 8(1), 1-6.
- Banerjee S., Mullick H.I., Banerjee J. (2011). *Zingiberofficinale*: a natural gold. International journal of pharma and bio sciences, 2(1), 283-294.
- Singh R., Singh K. (2019). Zingiberofficinale: a spice with multiple roles. RJLBPCS, 5(2), 113-125.
- Aryaelan N., Tavakkoli H. (2015). Ginger and its effects on inflammatory diseases. Adv Food Technol Nutr Sci Open J, 1(4), 97-101S.
- Jamshidi N., Cohen M.M. (2017). The clinical efficacy and safety of tulsi in humans: a systemic review of the literature. Evidence based complementary and alternative medicine, 1-13.
- Tewari D., Sah A.N., H.K. Pandey., Meena H.S. (2012). A review on phytoconstituents of *Ocimum* (Tulsi). International journal of ayurvedic medicine, 3(1), 1-9.
- Bano N., Ahmed A., Tanveer M., Khan G.M., Ansari M.T. (2017). Pharmacological evaluation of *Ocimum sanctum*. Journal of bioequivalence and bioavailability, 9(3), 387-392.
- Vaghiasya J., Datani M., Nandkumar K., Malaviya S., Jivani N. (2010). Comparative evaluation of alcoholic and aqueous extracts of *Ocimum sanctum* for immunomodulatory activity.

- International journal on pharmaceutical and biological research, 1(1), 25-29.
- 36- Bharathi C., Reddy A.H., Nageswari G., Sri Lakshmi B., Soumya M., Vanisri D.S., Venkatappa B. (2018). A review on medicinal properties of *Tinosporacordifolia*. International journal of scientific research and review, 7(12), 585-598.
- 37- Kavva B., Kavva N., Ramarao N., Venkateshwarlu G. (2015). *Tinosporacordifolia* (willd.) miers.: nutritional, ethnomedical and therapeutic utility. International journal of research in Ayurveda and pharmacy, 6(2), 195-198.
- 38- Promila, Singh S., Devi P. (2017). Pharmacological potential of *Tinosporacordifolia* (Willd.) Miers ex hook. and Thooms, (Giloy): A review. Journal of pharmacognosy and phytochemistry, 6(6), 1644-1647.
- 39- Saeed M., Naveed M., Leskovec J., Kamboh A.A., Kakar I., Ullah K., Ahmad F., Sharif M., Javaid A., Rauf M., El-hack M.E.A., Latif M.A.A., Chao S. (2019). Using guduchi (*Tinosporacordifolia*) as an eco-friendly feed supplement in human and poultry nutrition. Poultry science, 99(2), 801-811.
- 40- Singh D., Chaudhuri P.K. (2017). Chemistry and pharmacology of *Tinosporacordifolia*. Natural product communications, 12(2), 299-308.
- 41- Rathore S., Mukim M., Sharma P., Devi S., Nagar J.C., Khalid M. (2020). Curcumin: a review for health benefits. International journal of research and review, 7(1), 273-290.
- 42- Bhowmik D., Chiranjib, Kumar K.P.S., Chandira M., Jayakar B. (2009). Turmeric: A herbal and traditional medicine. Scholars research library, 1(2), 86-108.
- 43- Niranjana A., Prakash D. (2008). Chemical constituents and biological activities of turmeric (*Curcuma longa L.*) - a review. Journal of food science and technology, 45(2), 109-116.
- 44- Jagetia G. C., Aggarwal B.B. (2007). Spicing up of the Immune system by curcumin. Journal of clinical immunology, 27(1), 19-35.
- 45- Damanhour Z.A., Ahmad A. (2014). A review on therapeutic potential of *Piper nigrum L.* (Black pepper): The king of spices. Medicinal and aromatic plants, 3(3), 1-6.
- 46- Shityakov S., Bigdelian E., Hussein A.A., Hussain M.B., Tripathi Y.C., Khan M.U., Shariati M.A. (2019). Phytochemical and pharmacological attributes of piperine: a bioactive ingredient of black pepper. European journal of medicinal chemistry, 1-13.
- 47- Radic Z.S., Pejic M., Dimitrijeic M., Aleksic A., Kumar N.V.A., Salehi B., Cho W.C., Rad J.S. (2019). Piperine- A major principle of black pepper: a review of its bioactivity and studies. Applied science, 9, 1-29.
- 48- Lima R. da S. L., Block J.M. (2019). Coconut oil: what do we really know about it so far? Food quality and safety, 20, 1-12.
- 49- Dumancas G.G., Viswanath L.C.K., Leon A.R., Ramasahayam S., Maples R., Koralege R.H., Perera U.D.N., Langford J., Shakir A., Castles S. (2016). Health benefits of virgin coconut oil, Nova science publishers, Inc., 6, 1-34.
- 50- Dasaraju S., Gottumukkala K.M. (2014). Current trends in the research of *Emblca officinalis* (Amla): A pharmacological perspective. International journal of pharmaceutical sciences review and research, 24(2), 150-159.
- 51- Bhandari P.R., Kamdod M.A. (2012). *Emblca officinalis* (Amla): A review of potential therapeutic applications. International journal of green pharmacy, 6, 257-269.
- 52- Singh N., Bhalla M., Jager P., Gilca M. (2011). An overview on ashwagandha: a rasayana (rejuvenator) on Ayurveda. Afr J Tradit complement altern med, 8(S), 208-213.
- 53- Ali M., Rizvi T.F., Alam S.P., Ali M.C., Kumar R., Kumar A. (2015). Immunomodulatory effect of *Withaniasomnifera* (Ashwagandha) on Cyclophosphamide induced toxicity in rats. American journal of pharmtech research, 5(3), 638-645.
- 54- Tiwari R., Chakraborty S., Saminathan M., Dhama K., Singh S.V. (2014). Ashwagandha (*Withaniasomnifera*): role in safeguarding health, immunomodulatory effects, combating infections and therapeutic applications: a review. Journal of biological sciences, 14(2), 77-94.
- 55- Christaki E.V., Paneri P.C.F. (2010). Aloe vera: a plant for many uses. Journal of food, agriculture and environment, 8(2), 245-249.
- 56- Kumar K.P.S., Bhowmik D., Chiranjib, Biswajit. (2010). Aloe vera: a potential herb and its medicinal importance. Journal of chemical and pharmaceutical research. 2(1), 21-29.
- 57- Nandal U., Bhardwaj R.L. (2012). Aloe vera: a valuable wonder plant for food, medicine and cosmetic use- a review. International journal of pharmaceutical sciences review and research, 13(1), 59-67.