



A review of traditional herbs used for antiviral therapy and their potential as a treatment for Covid-19.

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Abstract: The viral contamination related to SARS and COVID-19 has led to an assignment among healthcare providers to look for efficient antiviral medicines. International health agency (WHO) has declared the current epidemic as a worldwide disaster for human safety. That is why the studies on tablets are taken into consideration because of the cutting-edge emergency in several clinical laboratories. The vaccines for the disorder are nonetheless being examined in scientific trials to test for or her efficacy. It could take a while earlier than a safe and effective vaccine is made available for use to the global population that could specifically act towards those viruses. However other techniques for his or her treatment and prevention, along with the usage of medicinal plants, is to be had. Consequently, it's miles important to broaden a treatment routine the use of medicinal plant life and their phyto-parts as a capability exchange alternative till an effective vaccine is evolved to suppress the transmission of the virus. Based totally on current studies information to be had, this review summarises the medicinal flora with an antiviral hobby for the prevention of SARS and COVID-19.

Keywords: Viral infection, SARS, COVID-19, treatment, medicinal flora

Advent

Viral infections, each new and continual viruses are a growing fitness difficulty international. An international sickness due to viral infections, both extreme acute breathing syndrome (SARS) and coronavirus disease 2019 (COVID-19), has led to an emerging urgent want for novel and more green antiviral drugs. COVID-19 is a scientific situation synonymous with intense acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, the symptom involving a complex kind of respiratory condition varies from one to the opposite. Even as SARS-CoV-2 belongs to a comparable genus of beta-coronavirus much like the coronaviruses responsible for the severe acute respiratory syndrome (SARS) and the center East breathing syndrome (MERS), this new virus seems to be related to milder infections.¹ The maximum a hit strategies to combat virus contamination, particularly for COVID-19, are being investigated and advanced, among which Remdesivir has been encouraged for the therapeutic control of the sufferers. Currently, multiple scientific trials analyzing redeliver for the treatment of COVID-19 are in progress or underneath development. Early in the pandemic, as a result of the obvious effective effects of the first few sufferers, an aggregate of antiviral remedies and corticosteroids became delivered as an ordinary remedy in some international locations.² The greatest undertaking confronted in virus remedy is their fast drug-resistance tolerance and increase as well as the advent of contemporary hybrid viruses. Given the advances made in the development of immunization and medications, there may be a scarcity of preventive vaccinations and successful antiviral treatment plans. The identity of novel antiviral tablets is important and herbal medicinal merchandise are an exceptional source of these findings.³ Herbal cures had been gaining a growing

reputation inside the area of scientific studies over the last few years. The idea of natural drugs is common in the fashionable populace because of ease of getting entry to, fee-effectiveness, lack of aspect outcomes, and high tolerance.⁴ consumption of natural treatments is an increasing number of developing internationally as an effective therapy for a variety of ailments.⁵ Many scientific studies performed on medicinal plant life monitor proof of their benefits programs for the prevention of viral sicknesses and infections.⁶ the exact mechanism by means of which this flora act isn't always known. However, positive research discovered that phytochemicals have superimposed response pathways and their antiviral hobby may additionally include the inhibition of DNA or RNA formation and viral replication.⁷ inside this assessment, we summarise the recorded antiviral outcomes of many herbal products and natural drug treatments and the correlation of this to similarly deal with SARS and COVID-19.

Medicinal vegetation used in South India for the management of COVID-19

1. Ginger

Ginger (*Zingiber officinale*, circle of relatives: Zingiberaceae) is the most typically consumed natural supplement worldwide. Although regularly used for culinary motives, sufferers additionally use it as a remedy for numerous conditions.⁸ Ginger has validated first-rate antimicrobial interest and efficacy in combating many viral, bacterial, and fungal sicknesses.⁹ Oleoresin from ginger's rhizomes consists of a couple of bioactive components inclusive of 6-gingerol, the principle pungent detail known to carry out-diffusion of terrific pharmacological activities. Gingerols are the principal materials of clean ginger, at the same time as Shogaol is extra not unusual in dry ginger.¹⁰ It's been examined within the plaque reduction take a look at for antirhinoviral interest. Isolation of sesquiterpenes became carried out, among which beta-sesquiphellandrene changed into very powerful in inhibiting rhinovirus.¹¹ Ginger is an essential ingredient in traditional Chinese language medications acknowledged to have antiviral efficacy against the human respiratory syncytial virus (HRSV).¹²

2. Licorice or Liquorice

Licorice (*Glycyrrhiza glabra*, family: Fabaceae) is Another popular herb that has been for hundreds of years utilized in conventional Chinese remedies.¹³ Phytochemical research has proven that flavonoids and pentacyclic triterpene saponins, such as isoliquiritigenin, glabridin, glycyrrhizic acid, and glycyrrhizin are the primary chemical components of the licorice root.¹⁴

Glycyrrhizin was proven to be a lively antiviral agent towards SARS-CoV. It blocked the adsorption and penetration of the virus.¹⁵ The alkaline extract from the roots of licorice confirmed appropriate anti-HIV efficacy than the extract from aqueous solvents. Licorice root flavonoids, especially liquiritinapioside, isoliquiritinapioside, glucuronide, and isoliquiritin exhibited greater anti-HSV hobby than other polyphenol and flavonoid compounds.¹⁶ Animal studies carried out on *Glycyrrhiza* species stated reduced demise charge and viral pastime of pneumonia virus and herpes virus. In vitro research was additionally performed on the HIV virus, SARS-CoV, respiratory syncytial virus (RSV) and the consequences have been very promising.¹⁷

Three. Garlic

Garlic (*Allium sativum*, family: Amaryllidaceae) is considered an essential herb. Recent research has hooked up garlic's useful behavior on cardiovascular disorder and cancer. In reality, garlic has been shown to have immunomodulation, anti-inflammatory, antimicrobial, antioxidant, and antiviral results.¹⁸ Allicin (allyl 2-propenethiosulfinate or diallylthiosulfinate) is the most bioactive compound observed inside the garlic aqueous extract or the homogeneous raw garlic.¹⁹

One research advised a likely route to prevent the emerging pandemic SARS-CoV-2 with the usage of fundamental garlic oil. The phytoconstituents in the critical garlic oil inhibit the angiotensin-2 (ACE2) converting enzyme, resulting in the virus lacking the host receptor and concentrating on the SARS-CoV-2 principal protease, PDB6LU7. The records on docking stimulation showed that 17 of the 18 primary garlic oil compounds had the ability to inhibit the interaction between ACE2 and SARS-CoV-2.²⁰ The in vitro antiviral examination of the garlic extract changed into carried out towards herpes simplex virus and influenza B virus. The virus infectivity titer became discovered to be reduced Upon incubation of the garlic extract with both the viruses.²¹

Four. Ashwagandha

Withania somnifera (family: Solanaceae), domestically referred to as “Ashwagandha” is an Indian primary medicinal source for Ayurvedic and indigenous medicines and has been used for the treatment of various varieties of human illnesses.²² It includes alkaloids, steroidal lactones and flavonoids, such as somniferous, within, with alanine, pseudotropine, anaferine, choline, isopelletierine, withanolide, withanolide, withanonequercetine.²³

The foundation of the plant has been documented towards viruses together with herpes simplex, hepatitis, H1N1 influenza, HIV, coxsackievirus, their infections, and replications for its effective antiviral function. Ashwagandha’s antiviral characteristic, adaptogenic and immunomodulatory capacity turned into recorded. The findings of the simulation of in silico docking and the review of molecular dynamics advised that sure phytoconstituents together with withanoside, dihydro withaferin, withanolide and ashwagandanolide have the promise to inhibit the main viral proteins of SARS-CoV-2.²⁴

The Ashwagandha plant has been tested as an antiviral agent in opposition to virus replication of infectious bursal sickness. The hydroalcoholic extract of *Withania somnifera* roots showed virus inhibition in its maximum safe awareness, 25 µg/ml.²⁵

5. Pepper

Piper nigrum (family: Piperaceae) is the most outstanding species of this genus. As a result of its smelly element, piperine, it's miles regarded as the “father of spices”. It has beneficial fitness and ailment-stopping homes inclusive of antiviral, immunomodulatory, anti-inflammatory, antipyretic, and bioavailability enhancement.²⁶ Phytochemical work performed on its culmination indicated the existence of unstable oils and alkaloids consisting of piperine, piperidine, and piperidine analogs.²⁷ It turned into found that the natural drug piperine has a better affinity to bind towards spike glycoprotein and its mobile reaction ACE2 compared to hydroxychloroquine. As a result inhibiting the interplay of spike glycoprotein of SARS-CoV-2 and its cellular receptor ACE2.²⁸ The consequences from the molecular docking examination on the chemical parts of black pepper performed to locate the interaction with Covid-19, verified higher arrangement at the dynamic site.²⁹ Piperamides removed from the end result were tested for his or her antiviral houses against viruses displaying higher respiration tract infection and their multiplication in vascular easy muscle cells.²⁶

6. Gooseberry or Amla

Emblica Officinalis (family: Euphorbiaceae) is broadly discovered in ayurvedic medicines. *Emblica Officinalis* is also referred to as by the name *Phyllanthusemblica* or Indian gooseberry. It's far a wealthy source of vitamin C at the side of other citrus culmination.³⁰ Pentagalloyl glucose (PGG), in amla, can inhibit Influenza a plague replication.³¹ It greatly reduced the aggregation of a nucleoprotein by using the plasma membrane at the late level of the replication system. PGG greatly decreased the budding virus and the production of progeny from contaminated cells.³² It's also claimed to boom the white blood cells count number and reinforce immunity.³³

7. Tulsi

Ocimum sanctum (own family: Labiatae) is a medicinal herb used in the indigenous machine of drugs. The aqueous extract of the leaves contains chemical elements like eugenol, carvacrol, ursolic acid, rosmarinic acid, linalool, α & β -caryophyllene, eugenic acid, geraniol, ocimene, and β -elements.³⁴ The leaves extract includes beneficial secondary metabolites that were observed to have an antiviral pastime in opposition to numerous viruses.³⁵ The extracts from the plant and its critical oil had been observed to own inhibitory impact in opposition to the multiplication of viruses together with infectious pancreatic necrosis virus (IPNV), poliovirus type-three, hepatitis B virus, white spot syndrome virus (WSSV), coxsackievirus B1 (CVB1), adenoviruses (ADV), herpesviruses (HSV) and enterovirus 71(EV71).³⁶ The phytoconstituents found in tulsi, i.E., oleanolic acid, rosmarinic acid, methyl eugenol and ursolic acid were used to test their hobby in opposition to SARS-CoV-2 protein goals. Tulsi compounds can be successful inhibitors of SARS-CoV-2 via binding to the spike glycoprotein, RNA polymerase, and/ or its protease, both in their pure form or as an extract.³⁷

8. Guduchi

Tinospora cordifolia (circle of relatives: Menispermaceae) is the maximum widely used herbal supplement global. Its miles were identified by using numerous names together with giloy, Guduchi, Guduchi and amrutharasakinda.^{38,39} major ingredients like cardiac glycosides, alkaloids, flavonoids, saponins, lignans, steroids, terpenoids, tannins are present in it.^{40,41} The plant is also used in conventional ayurvedic remedies and has many clinical residences.^{42,43} Guduchi has demonstrated splendid immunomodulatory because of the presence of berberine and syringin.⁴⁴ it has been discovered that the plant extract has anti-HIV potential and inhibited HIV reverse transcriptase pastime.⁴⁵ The nanoparticles formula of the plant witnessed capacity antiviral movement towards the chikungunya virus. This confirmed elevated phagocytosis and intracellular killing assets which were accountable for mentioned antiviral interest.⁴⁶ The study was conducted on purified compounds from the plant, amongst which cordifolioside A and syringin were found to reveal a huge immunomodulatory pastime.⁴⁷

9. Clove

Syzygium aromaticum (circle of relatives: Myrtaceae) is one of the most famous historical spices. Cloves have an abundance of the following kinds of phytochemicals: monoterpenes, sesquiterpenes, phenolic compounds, and hydrocarbons. The most critical phytochemical in clove oil incorporates eugenol, eugenol acetate, and β -caryophyllene.⁴⁸ The aqueous clove extract changed into studied as a counterpart to human norovirus, as an antiviral agent towards tom cat calicivirus (FCV). The inactivation of FCV changed into located to be dose-based while the host cells have been dealt with clove extracts at concentrations equivalent to or below the suggested non-toxic concentrations.⁴⁹ Eugenol, critical oil from clove changed into examined for antiviral pastime towards Two stress of human syncytial viruses, which confirmed inhibition within the replication of those viruses. Floor application of the eugenol slowed down the development of herpes virus-brought on keratitis.⁵⁰

10. Neem

Azadirachta indica (circle of relatives: Meliaceae) usually called “Indian Lilac”, is part of the Meliaceae circle of relatives. It has been used by numerous civilizations for its pharmacological sports. Numerous compounds of the medicinal fee were proven to be present within the plant. ⁵¹ The neem tree carries chemical constituents like isoprenoids, tannins, polysaccharides, flavonoids, fatty acids, amino acids, dihydrochalcone, coumarins, aliphatic compounds, and many others.⁵² The exclusive components of the plant/tree have been reported to possess several pharmacological blessings together with antiviral sports.⁵³ Neem has shown its tested efficacy against coxsackie B institution of viruses. Evidence suggested that sure compounds inside the plant had been determined to be active in opposition to the virus as virucidal agents at sub-poisonous concentrations all through the early stage of replication.⁵⁴ Aqueous extract from the neem plant bark serves as a powerful inhibitor for access into natural target cells towards herpes simplex virus-1 contamination. Neem bark extract (NBE) treated goal cells also inhibited the development of HSV-1 glycoprotein-mediated cell–mobile fusion.⁵⁵ The polysaccharides obtained from the leaf of the plant and its sulfate derivatives tested that compound acted during the initial degree of viral replication and have been effective in inhibiting the multiplication of poliovirus.⁵⁶ Medicinal plant life with antiviral interest towards Covid-19

Research hole

Latest times have brought about a growing want for the treatment of COVID-19. In most viral infections, e.G., SARS-CoV, hepatitis B, dengue, and so on., there's no specific treatment. Currently, the therapeutic treatment used for COVID-19 is the equation that has been used for older viruses like MERS, SARS, and HIV. But this treatment is not unique for the unconventional coronavirus because they're extensive-spectrum. More modern antiviral capsules are still underneath medical trials, for which protection and effectiveness aren't shown. The pharmaceutical groups are under strain to broaden a safe and powerful vaccine and have additionally taken into consideration specializing in herbal product drug discovery.

Conclusion and destiny possibilities

The medicinal plant life studied inside the assessment had been used for centuries by indigenous human beings both in the mixture to convey a synergistic effect or in my view. The evidence supplied

on this overview altogether reinforces the idea that herbs have promising ability against contamination as a result of diverse viruses. The ability destiny implications could be to similarly analyze the right mechanism system against the brand-new pressure of viruses and to set up a drug transport device that actually works over an extended time at the target place.

References

1. Petrosillo N, Viceconte G, Ergonul O, Ippolito G, Petersen E. COVID-19, SARS and MERS: are they closely related? *Clinical Microbiology and Infection*. 2020 March 28.
2. Mousa HA-L. Prevention and treatment of influenza, influenza-like illness, and common cold by herbal, complementary, and natural therapies. *Journal of evidence-based complementary & alternative medicine*. 2017;22(1):166–74.
3. Lin L-T, Hsu W-C, Lin C-C. Antiviral natural products and herbal medicines. *Journal of traditional and complementary medicine*. 2014;4(1):24–35.
4. Sainhi H, Sirohiya R. A Review Article on Phytochemicals New Line of Treatment of Sars Covid-19. *IOSR-JPBS*. 2020;15(3):36-46.
5. Kaur J, Kaur S, Mahajan A. Herbal medicines: possible risks and benefits. *Am J Phytomed Clin Ther*. 2013;1(2):226–39.
6. Dhama K, Karthik K, Khandia R, Munjal A, Tiwari R, Rana R, et al. Medicinal and therapeutic potential of herbs and plant metabolites/ extracts countering viral pathogens-current knowledge and future prospects. *Current drug metabolism*. 2018;19(3):236–63.
7. Jassim SAA, Naji MA. Novel antiviral agents: a medicinal plant perspective. *Journal of applied microbiology*. 2003;95(3):412–27.
8. White B. Ginger: an overview. *American family physician*. 2007;75(11):1689–91.
9. Imo C, Za'aku JS. Medicinal Properties of Ginger and Garlic: A Review. *Curr Trends Biomedical Eng & Biosci*. 2019;18(2):1-6.
10. Jolad SD, Lantz RC, Chen GJ, Bates RB, Timmermann BN. Commercially processed dry ginger (*Zingiber officinale*): composition and effects on LPS-stimulated PGE2 production. *Phytochemistry*. 2005;66(13):1614–35.
11. Denyer CV, Jackson P, Loakes DM, Ellis MR, Young DA. Isolation of antirhinoviral sesquiterpenes from ginger (*Zingiber officinale*). *Journal of natural products*. 1994;57(5):658–62.
12. San Chang J, Wang KC, Yeh CF, Shieh DE, Chiang LC. Fresh ginger (*Zingiber officinale*) has anti-viral activity against human respiratory syncytial virus in human respiratory tract cell lines. *Journal of ethnopharmacology*. 2013;145(1):146–51.
13. Wang L, Yang R, Yuan B, Liu Y, Liu C. The antiviral and antimicrobial activities of licorice, a widely-used Chinese herb. *Acta Pharmaceutica Sinica B*. 2015;5(4):310–5.
14. Kamei J, Nakamura R, Ichiki H, Kubo M. Antitussive principles of *Glycyrrhizae radix*, a main component of the Kampo preparations Bakumondo-to (Mai-men-dong-tang). *European journal of pharmacology*. 2003;469(1–3):159– 63.
15. Cinatl J, Morgenstern B, Bauer G, Chandra P, Rabenau H, Doerr HW. Glycyrrhizin, an active component of liquorice roots, and replication of SARS-associated coronavirus. *The Lancet*. 2003;361(9374):2045–6.
16. Fukuchi K, Okudaira N, Adachi K, Odai-Ide R, Watanabe S, Ohno H, et al. Antiviral and antitumor activity of licorice root extracts. *in vivo*. 2016;30(6):777–85.
17. Fiore C, Eisenhut M, Krausse R, Ragazzi E, Pellati D, Armanini D, et al. Antiviral effects of *Glycyrrhiza* species. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*. 2008;22(2):141– 8.

18. Cheng B, Li T. Discovery of alliin as a putative inhibitor of the main protease of SARS-CoV-2 by molecular docking. *BioTechniques*. 2020 May.
19. Bayan L, Koulivand PH, Gorji A. Garlic: a review of potential therapeutic effects. *Avicenna journal of phytomedicine*. 2014;4(1):1.
20. Thuy BTP, My TTA, Hai NTT, Hieu LT, Hoa TT, Thi Phuong Loan H, et al. Investigation into SARS-CoV-2 resistance of compounds in garlic essential oil. *ACS omega*. 2020;5(14):8312–20.
21. Tsai Y, Cole LL, Davis LE, Lockwood SJ, Simmons V, Wild GC. Antiviral properties of garlic: in vitro effects on influenza B, herpes simplex and coxsackie viruses. *Planta medica*. 1985;51(05):460–1.
22. Gurav SS, Gurav NS. *Indian herbal drug microscopy*. Springer; 2014; 9-14.
23. Abraham A, Kirson I, Glotter E, Lavie D. A chemotaxonomic study of *Withania somnifera* (L.) dun. *Phytochemistry*. 1968;7(6):957–62.
24. Chikhale RV, Gurav SS, Patil RB, Sinha SK, Prasad SK, Shakya A, et al. Sars-cov-2 host entry and replication inhibitors from Indian ginseng: an in-silico approach. *Journal of Biomolecular Structure and Dynamics*. 2020;1–12.
25. Pant M, Ambwani T, Umapathi V. Antiviral activity of Ashwagandha extract on infectious bursal disease virus replication. *Indian J Sci Technol*. 2012;5(5):2750–1.
26. Mair CE, Liu R, Atanasov AG, Schmidtke M, Dirsch VM, Rollinger JM. Antiviral and anti-proliferative in vitro activities of piperamides from black pepper. *Planta Medica*. 2016;82(S 01):P807.
27. Khawas S, Nosálová G, Majee SK, Ghosh K, Raja W, Sivová V, et al. In vivo cough suppressive activity of pectic polysaccharide with arabinogalactan type II side chains of *Piper nigrum* fruits and its synergistic effect with piperine. *International journal of biological macromolecules*. 2017;99:335–42.
28. Maurya VK, Kumar S, Prasad AK, Bhatt ML, Saxena SK. Structure-based drug designing for potential antiviral activity of selected natural products from Ayurveda against SARS-CoV-2 spike glycoprotein and its cellular receptor. *VirusDisease*. 2020;1–15.
29. Rajagopal K, Byran G, Jupudi S, Vadivelan R. Activity of phytochemical constituents of black pepper, ginger, and garlic against coronavirus (COVID-19): An in silico approach. *International Journal of Health & Allied Sciences*. 2020;9(5):43.
30. Variya BC, Bakrania AK, Patel SS. *Emblca officinalis* (Amla): A review for its phytochemistry, ethnomedicinal uses and medicinal potentials with respect to molecular mechanisms. *Pharmacological research*. 2016;111:180–200.
31. Gangal N, Nagle V, Pawar Y, Dasgupta S. Reconsidering Traditional Medicinal Plants to Combat COVID-19. *AJIR Preprints*. 2020;
32. Tai DY. Pharmacologic treatment of SARS: current knowledge and recommendations. *ANNALS-ACADEMY OF MEDICINE SINGAPORE*. 2007;36(6):438.
33. Dasaroju S, Gottumukkala KM. Current trends in the research of *Emblca officinalis* (Amla): A pharmacological perspective. *Int J Pharm Sci Rev Res*. 2014;24(2):150–9.
34. Verma S. Chemical constituents and pharmacological action of *Ocimum sanctum* (Indian holy basil-Tulsi). *The Journal of Phytopharmacology*. 2016;5(5):205–7.
35. Mohan L, Amberkar MV, Kumari M. *Ocimum sanctum* Linn (Tulsi)—an overview. *Int J Pharm Sci Rev Res*. 2011;7(1):51–3.
36. Raghav P, Saini M. Antimicrobial Properties of Tulsi (*Ocimum sanctum*) in Relation to Shelf Life Enhancement of Fruits & Vegetables. *IJGHC*. 7(1):20–32.
37. Kumar A. Molecular docking of natural compounds from tulsi (*Ocimum sanctum*) and neem (*Azadirachta indica*) against SARS-CoV-2 protein targets. 2020, "in process".
38. Leonti M, Casu L. Soma, food of the immortals according to the Bower Manuscript (Kashmir, 6th century AD). *Journal of ethnopharmacology*. 2014;155(1):373–86.

39. Chi S, She G, Han D, Wang W, Liu Z, Liu B. Genus *Tinospora*: ethnopharmacology, phytochemistry, and pharmacology. Evidence- Based Complementary and Alternative Medicine. 2016;2016.
40. Sannegowda KM, Venkatesha SH, Moudgil KD. *Tinospora cordifolia* inhibits autoimmune arthritis by regulating key immune mediators of inflammation and bone damage. International Journal of Immunopathology and Pharmacology. 2015;28(4):521–31.
41. Sonkamble VV, Kamble LH. Antidiabetic potential and identification of phytochemicals from *Tinospora cordifolia*. American Journal of Phytomedicine and Clinical Therapeutics. 2015;3(1):097–110.
42. Dhama K, Sachan S, Khandia R, Munjal A, MN Iqbal H, K Latheef S, et al. Medicinal and beneficial health applications of *Tinospora cordifolia* (Guduchi): a miraculous herb countering various diseases/disorders and its Immunomodulatory effects. Recent Patents on Endocrine, Metabolic & Immune Drug Discovery. 2016;10(2):96–111.
43. Dhama K, Tiwari R, Chakraborty S, Saminathan M, Kumar A, Karthik K, et al. Evidence based antibacterial potentials of medicinal plants and herbs countering bacterial pathogens especially in the era of emerging drug resistance: An integrated update. Int J pharmacol. 2014;10(1):1– 43.
44. Sharma U, Bala M, Kumar N, Singh B, Munshi RK, Bhalerao S. Immunomodulatory active compounds from *Tinospora cordifolia*. Journal of ethnopharmacology. 2012;141(3):918–26.
45. Estari M, Venkanna L, Reddy AS. In vitro anti-HIV activity of crude extracts from *Tinospora cordifolia*. BMC Infectious Diseases. 2012;12(1):1–1.
46. Sharma V, Kaushik S, Pandit P, Dhull D, Yadav JP, Kaushik S. Green synthesis of silver nanoparticles from medicinal plants and evaluation of their antiviral potential against chikungunya virus. Applied microbiology and biotechnology. 2019;103(2):881–91.
47. Upadhyay UPPDD, Ewam PCVV, Ewam UPCVV, Sansthan G-A. Immunomodulatory and Therapeutic Potentials of Herbal, Traditional/ Indigenous and Ethnoveterinary Medicines” Mahima, “Anu Rahal,” Rajib Deb, “Shyma K. Latheef,” Hari Abdul Samad. Pakistan Journal of Biological Sciences. 2012;15(16):754–74.
48. Chaieb K, Hajlaoui H, Zmantar T, Kahla-Nakbi AB, Rouabhia M, Mahdouani K, et al. The chemical composition and biological activity of clove essential oil, *Eugenia caryophyllata* (*Syzygium aromaticum* L. Myrtaceae): a short review. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 2007;21(6):501–6.
49. Aboubakr HA, Nauertz A, Luong NT, Agrawal S, El-Sohaimy SA, Youssef MM, et al. In vitro antiviral activity of clove and ginger aqueous extracts against feline calicivirus, a surrogate for human norovirus. Journal of food protection. 2016;79(6):1001–12.
50. Benencia F, Courreges MC. In vitro and in vivo activity of eugenol on human herpesvirus. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 2000;14(7):495–500.
51. Bijauliya RK, Alok S, Chanchal DK, Sabharwal M, Yadav RD. An updated review of pharmacological studies on *Azadirachta indica* (neem). Int J Pharm Sci Res. 2018;9(7):2645–55.
52. Maithani A, Parcha V, Pant G, Dhulia I, Kumar D. *Azadirachta indica* (neem) leaf: A review. Journal of Pharmacy Research. 2011;4(6):1824–7.
53. Atawodi SE, Atawodi JC. *Azadirachta indica* (neem): a plant of multiple biological and pharmacological activities. Phytochemistry Reviews. 2009;8(3):601–20.
54. Badam L, Joshi SP, Bedekar SS. 'In vitro' antiviral activity of neem (*Azadirachta indica*. A. Juss) leaf extract against group B coxsackieviruses. The Journal of communicable diseases. 1999;31(2):79–90.

55. Tiwari V, Darmani NA, Yue BY, Shukla D. In vitro antiviral activity of neem (*Azadirachta indica* L.) bark extract against herpes simplex virus type-1 infection. *Phytotherapy Research*. 2010;24(8):1132–40.
56. Faccin-Galhardi LC, Yamamoto KA, Ray S, Ray B, Linhares REC, Nozawa C. The in vitro antiviral property of *Azadirachta indica* polysaccharides for poliovirus. *Journal of Ethnopharmacology*. 2012;142(1):86–90.

