

PHYTO FUNGICIDAL ACTIVITIES

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ABSTRACT

Plants have been sources of medicines for decades. From the beginning, plants have been a leading source of effective and safe medicines. Phytochemistry of numerous plant species has indicated that the phytochemicals may be a higher supply of medication compared to synthetically produced drugs. In this review plant natural products have been found to elicit anti-Candida effects based on inhibition of germination and biofilm formation, cellular metabolism, cell wall integrity, cell membrane plasticity, and induction of apoptosis.

Key words: Phytochemistry, Antimicrobial activity, Anti-Candida activity, Herbal medicine.

INTRODUCTION:

Phytochemicals (from the Greek word phyto, meaning plant) are natural, biologically active chemical compounds found in plants that provide human health benefits beyond those of macronutrients and micronutrients.

They protect plants from diseases and damage and contribute to the color, aroma, and flavor of the plant. In general, plant chemicals that protect plant cells from environmental hazards such as pollution, stress, drought, UV exposure, and pathogens are referred to as phytochemicals⁽¹⁾.

Recently, it is well known that they play a role in protecting human health when their food intake is significant. More than 4,000 phytochemicals have been cataloged and classified according to the protective function, physical properties, and chemical properties and about 150 phytochemicals have been studied in detail⁽²⁾.

Medicinal plants are a gift from nature to humans to lead a healthy and disease-free life. It plays an important role in maintaining our health. India is one of the most culturally diverse medicinal countries in the world, where the medicinal plant industry is part of a time-honored tradition that is still respected today. Traditional medicines derive their scientific heritage from the rich experiences of ancient civilizations. Therefore, it is not surprising that the claim of traditional medicines applies to several "difficult-to-cure" diseases (Satyavati, 1982). India is known for its rich traditional medicine systems ie Siddha, Ayurveda, Unani, and Amchi (Tibetan) as well as for a vast reservoir of living traditions in ethnomedicine. The oldest mention of the use of plants in medicine is found in the Rigveda, which is written between 4500 and 1600 BC. was written. During the British era, our traditional natural healing arts disappeared due to western culture. Now it is making a comeback due to the recognition of its importance in curing diseases without side effects.

The Phytochemicals from various sources have dual functions,

- (i) they can be used as a cosmetic skin care product, and
- (ii) botanicals impart biological activity to the skin, and provide beneficial nutrients to the skin or body⁽³⁾

Many of today's synthetic drugs originated from the plant country but, historically, medicinal herbalism went into decline while pharmacology hooked up itself as a main and powerful department of scientific therapeutics. In a great deal of the English-speaking global, herbalism virtually vanished from the healing map of drugs in the course of the closing a part of the nineteenth and early a part of the twentieth century. However, in lots of 0.33 global international locations diverse paperwork of ethnic herbalism be triumphant to the prevailing day (e.g., Ayurvedic medicinal drug in India, Kampo medicinal drug in Japan and Chinese herbalism in China). In a few advanced international locations (e.g. Germany and France), scientific herbalism maintains to coexist with present day pharmacology, albeit on an increasingly decrease key⁽⁴⁾.

Advantages of herbal over synthetic⁽⁵⁾:

- Strengthen the immune system
- Detoxification

- Enhance physical and mental well-being
- They do not cause allergic reactions. And it has no negative side effects.
- They works easily into skin and hair.
- The plant extract reduces the volume property of cosmetics and provides corresponding pharmacological effects.
- Stimulating the internal organs
- Providing antioxidants to the body
- Boosting energy levels and invigorating the body

Phytomedicine For Treatment of Skin Aliments:

Skin diseases are a common condition and affect people of all ages, from newborns to the elderly, and cause damage in a variety of ways. There are over a thousand conditions that can affect the skin⁽⁶⁾.

Medicinal plants are of great importance for the health of individuals and communities, and their importance lies in the chemical substances that produce a specific physiological effect on the human body. Many of the currently available pharmaceuticals have a long history of use as herbal medicines, including opium, aspirin, digitalis, and quinine, while their purification and quantification make them more predictable, and the processing of chemicals sometimes reduces their effects into Wishes can change ways. Herbal remedies typically have a more complex and subtle blend of chemicals and can sometimes provide access to drugs or combinations of drugs that have not been exploited by the pharmaceutical industry. These natural compounds formed the basis for the discovery of Modern Drugs^(6,7).

SL NO	Botanical name	Family	Bioactive components	The chemical constituent for Fungicidal activity
1.	<i>Artemisia vulgaris</i>	Asteraceae	Alkaloids, carotene, ascorbic acid	<i>Artemisia</i> L. have the ability to neutralize individual determinants of antibiotic resistance and thereby restore the susceptibility of resistant strains ⁽⁸⁾
2.	<i>Ajania fruticulosa</i>	Asteraceae	Guaianolides	Axillarin, centaureidin, santin and 5,7,40-trihydroxy-3,30 -dimethoxyavone were inhibitory to the growth of <i>Candida albicans</i> ⁽⁹⁾
3.	<i>Aegle marmelos</i>	Rutaceae	Alkaloid-aegelenine and aegeline	Aegelenine and aegeline are responsible to inhibit dermatophytic fungi like <i>Trichophyton mentagrophytes</i> , <i>Trichophyton rubrum</i> , <i>Microsporum canis</i> , <i>Microsporum gypseum</i> and <i>Epidermophyton floccosum</i> ⁽¹⁰⁾
4.	<i>Bacopa monnieri</i>	Scrophulariaceae	Alkaloid, brahmi, nicotine, herpestin, bacosides A and B, saponins A, B and C	Bacoside A chemical constituent of <i>B. monnieri</i> showed more prominent antimicrobial activity against <i>Staphylococcus aureus</i> i.e. gram positive bacteria ⁽¹¹⁾ .

5.	<i>Berberis vulgaris</i>	Berberiaceae	Berlambine Hydrocyanine, Isocorydine, (-) Tejedine, Lupeol, Oleanolic acid	Berberine had potent antidermatophytic effects against <i>T. mentagrophytes</i> , <i>T. rubrum</i> , <i>M. canis</i> , and <i>M. gypseum</i> as pathogenic dermatophyte strains ⁽¹²⁾
6.	<i>Blumea balsamifera</i>	Asteraceae	Monoterpene, sesquiterpens,diterpenes, flavonoids	<i>B. balsamifera</i> to have a minimum inhibitory concentration against <i>Bacillus cereus</i> , <i>S. aureus</i> and <i>Candida albicans</i> ⁽¹³⁾
7.	<i>Calendula officinalis</i>	Asteraceae	Sesquiterpene,hydrocarb ons and sesquiterpeols . δ -cadinene α -cadinol	<i>C. officinalis</i> flower oil produced inhibition zones against candida species ⁽¹⁴⁾ .
8.	<i>Carica papaya</i>	Caricaceae	Papain, chymopapaincarpain, carpasemine	Efficiently inhibited mycelialgrowth in <i>C.gloeosporioides</i> and <i>Fusarium</i> spp ⁽¹⁵⁾
9.	<i>Cinchona</i>	Cinchonaceae	Quinine, quinidine, cinchonine and cinchonidine, quinicine, cinchonicine hydroquinine, hydrocinchonidine	Quinoline ,quinine is a potent antimalarial compound that has been shown to have inhibit antibacterial and antifungal properties, albeit at high concentrations ⁽¹⁶⁾
10.	<i>Citrus lemon</i>	Rutuaceae	limonene ,pinene, γ - terpinene,sabinene ,myrc ene	Inhibiting activity against gram negative bacteria : <i>Salmonella typhimurium</i> , <i>Shigella</i> , <i>Helicobacter pylori</i> and <i>Candida albicans</i> . ⁽¹⁷⁾ .
11.	<i>Curcuma longa</i>	Zingiberaceae	Curcumin, demethoxycurcumin, and bisdemethoxycurcumin	Antifungal activities of curcumin The most significant activity was found against <i>Candida</i> species and <i>Paracoccidioides brasiliensis</i> , although curcumin showed fungicidal activity against several fungi ⁽¹⁸⁾
12.	<i>Digitalis lanata</i>	Plantaginaceae	Digitoxin, gitoxin,digoxin.Lanatoside A, B, C, D & E	Digitoxincontrol the synthesis of bioactive compounds that can be transferred during prolonged symbiosis between endophytic fungi and the host ⁽¹⁹⁾

13.	<i>Datura stramonium</i>	Solanaceae	Tropane alkaloids, scopoline, saponins, tannins	The extracts were screened for potential antimicrobial activity against <i>Staphylococcus aureus</i> , <i>Bacillus subtilis</i> , <i>Escherichia coli</i> , <i>Klebsiella pneumoniae</i> , <i>Micrococcus luteus</i> and <i>Candida albicans</i> ⁽²⁰⁾ .
14.	<i>Epinetrum villosum</i>	Menispermaceae	Bisbenzylisoquinoline, Coccine alkaloid	Coccoline, a bisbenzylisoquinoline alkaloid from the <i>Epinetrum villosum</i> displayed antifungal activities ⁽²¹⁾
15.	<i>Ginkgo biloba</i> ,	Ginkgoaceae	Flavonoids and terpenoids	The flavonoids can combine with proteins and shows antibacterial activities ⁽²²⁾ .
16.	<i>Glycyrrhiza glabra</i>	Leguminosae	Glabrol isoflavonoids chalcones	<i>Glycyrrhiza glabra</i> extracts have shown significant fungicidal activity against fungi, which has mainly been attributed to the presence of phenolic compounds such as flavonoids, isoflavonoids and chalcones ⁽²³⁾
17.	<i>Hydrastis canadensis</i>	Ranunculaceae	Berberine, hydrastine	<i>H. canadensis</i> has antimicrobial activity against a number of bacterial pathogens, and this activity has primarily been attributed to the alkaloid berberine ⁽²⁴⁾
18.	<i>Hildegaria barteri</i>	Malvaceae	Flavanoids	An isoflavone, 2-hydroxy maackiain was observed to have antifungal activity ⁽²⁵⁾
19.	<i>Isolona cauliflores</i>	Annonaceae	Dimeric prenylindoles caulindole	Some of the prenylindoles had antifungal and antimalarial activities ⁽²⁶⁾
20.	<i>Justica adhatoda</i>	Acanthaceae	Alkaloids, tannins, saponins, phenolics and flavonoids	The presence of alkaloids in the extracts were active against both bacteria and fungi ⁽²⁷⁾
21.	<i>Jaminum officinale</i>	Oleaceae	Linalool geranyl linalool	The antibacterial activity of Jasmine (<i>Jasminum sambac</i> L.) flower hydro steam distilled essential oil, components was assessed against <i>Escherichia coli</i> ⁽²⁸⁾

22.	<i>Krameria triandra</i>	Krameriaceae	Oligomeric proanthocyanidins propelagonidin:procyanidin	Proanthocyanidins were active against both bacteria and fungi ⁽²⁹⁾
23.	<i>Lycium chinense</i>	Solanaceae	Nferu loyloctopamine, trans-N caffeoyltyramine	Dihydro-N-caffeoyltyramine, trans-Nferu loyloctopamine, trans-N caffeoyltyramine, and cis-N-caffeoyltyramine reported to have antifungal activity ⁽³⁰⁾
24.	<i>Melia azedarach</i>	Meliaceae	Quercetin spathulenol benzyl 3-O-β-D-glucopyranosyl-7-hydroxybenzoate	Hydroxycoumarin scopoletin reported to be antifungal against <i>Fusarium verticillioides</i> ⁽³¹⁾
25.	<i>Nigella sativa</i>	Ranunculaceae	Thymoquinone, carvacrol, t-anethole and 4-terpineol	The seed of various extracts and oil have antibacterial, antifungal ⁽³²⁾
26.	<i>Olea europaea</i>	Oleaceae	Tocopherols, squalene, carotenoids, sterols	Phenolic compounds and flavonoids such as <i>Ole</i> , hydroxytyrosol have antifungal properties ⁽³³⁾ .
27.	<i>Piper solmsianum</i>	Solanaceae	β-caryophyllene, eupomatenoid-3, eupomatenoid-5,	The four compounds eupomatenoid-3, eupomatenoid-5, conocarpan, and orientin exhibited antifungal action against all the dermatophytes tested ⁽³⁴⁾
28.	<i>Rosmarinus officinalis</i>	Lamiaceae	Osmarinic acid, camphor, caffeic acid, ursolic acid, betulinic acid, carnosic acid and carnosol	betulinic acid, carnosic acid and carnosol responsible for fungal activity ⁽³⁵⁾
29.	<i>Syzygium aromaticum</i>	Myrtaceae	Acetyl eugenol, β-caryophyllene, vanillin, crategolic acid, tannins, such as bicornin,	Eugenol, crategolic acid, tannins acts against dermal infection ⁽³⁶⁾
30.	<i>Trigonella foenum-graecum</i>	Fabaceae	Alkaloid - trigonelline and coumarins cinnamic acid and scopoletin	Trigonelline shown great potential of antibacterial activity against gram positive and gram negative bacteria ⁽³⁷⁾ .

31.	<i>Viburnum tinus</i>	Adoxaceae	Flavonoids, tannins, anthocyanins, phenolic acids	Phenolic acids shows antibacterial activity against Gram-positive bacteria ⁽³⁸⁾ .
32.	<i>Withania somnifera</i>	<u>Solanaceae</u>	Withanolides—which are triterpene lactoes WithaferinA, alkaloids, steroidal lactones, tropine, and cuscohygrine.	<i>W. somnifera</i> was very effective in inhibiting the test pathogens including methicillin resistant <i>Staphylococcus aureus</i> and <i>Enterococcus</i> spp ⁽³⁹⁾
33.	<i>Zingiber officinale</i>	Zingiberaceae	Zingiberene, zingerone, shogaols and gingerols.	The antimicrobial effect is achieved mainly to several phytochemicals such as camphene, phellandrene, zingiberene and zingerone. ⁽⁴⁰⁾

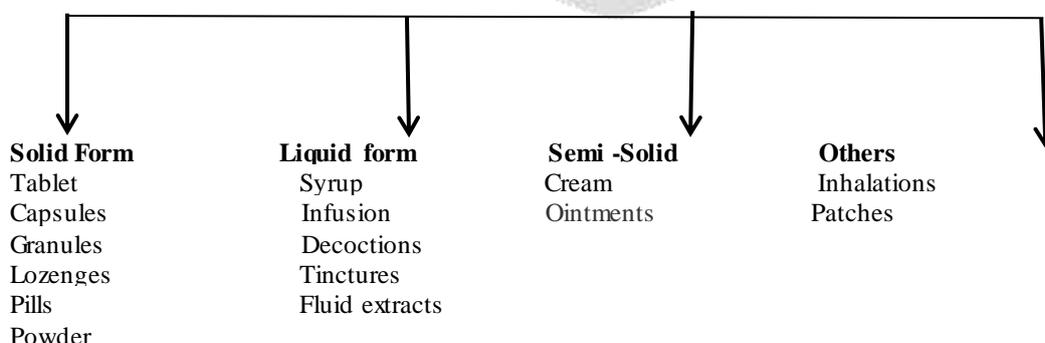
VARIOUS FORMS OF PHYTOMEDICINES :

Commonly available herbal dosage forms include decoctions, herbal teas, tinctures, glycerites, ointments, and herbal soaps, herbal tablets, herbal capsules, herbal **creams**, and ointments. **Plant and herbal extracts differ in terms of** the solvent used for extraction, **temperature** and extraction **time** and include alcoholic extracts, vinegars, hot water **extracts**, **long-boiled extracts** of roots or bark (decoctions), and cold **infusions** of plants.⁽⁴¹⁾

Dosage forms are how drug molecules or parts **of plants** are delivered to sites of action **in** the body. **Routes of administration** of herbal dosage include oral, rectal, **topical**, parenteral, respiratory, nasal, **ophthalmic**.

Herbal medicines **could** contain excipients in addition to the active ingredients. Medicines containing plant materials combined with **with chemicals outlined** active substances, **as well as** chemically defined, isolated constituents of plants, **aren't thought-about** to be **flavourer** medicines.

Types of Herbal formulations⁽⁴²⁾



Solid Form :Solid oral dose forms represent the preferred class of product for orally administered drugs. Advantages being unit dosage form, simple to handle and transport, convenient and safe

1. Herbal tablets : Tablet is defined as a compressed stable dosage shape containing medicaments without or with excipients. They range in form and differ greatly in size and weight, depending on the number of medicinal substances and the intended mode of administration.. Herbal tablets are usually designed for oral use with various natural substances included for a specific healing effect the usage of excipients . Pandey et al developed *Pueraria tuberosa* tablets by using different excipients, it has shown nephroprotection against cisplatin-induced kidney damage⁽⁴³⁾.

2. Herbal Capsules : Capsules are defined as solid unit dosage forms of drugs, available as small gelatin containers (envelopes) containing precisely measured drug substances. The herbal capsules, incorporation of the the herbal material is also through with the finely pulverized and sifted stuff or extracts from the plant materials victimization varied solvents that are appropriate for oral use . Sarisuta et al. developed herbal capsule containing oleoresin of *Zingiber Officinale* extract for anti-microbial and other purpose⁽⁴⁴⁾.

3. Herbal lozenges: Lozenges can be organized with the aid of using the powdered herbs collectively with excipients which include sugar and honey to offer the candy taste, gums (Acacia and tragacanth) and the white of an egg in a few instances . The lozenges usually can be used to soothe pain withinside the throat, in addition, in addition to assisting withinside the remedy of throat infections. Okorie et al. formulated lozenges from the root bark extract of *Zinthoxylum Tessmannii* ,remedies for mouth and throat infections, particularly tonsillitis and oral thrush.⁽⁴⁵⁾

4. Herbal Granules: Granules are defined as a dosage form composed of dry aggregates of powder particles that may contain one or more APIs, with or without other ingredients. They may be swallowed as such, dispersed in food, or dissolved in water. Amruta Avalaskar et al. Formulated Oral granules of dried aqueous extract of *Justicia adhatoda* for Asthma, especially in paediatric patients⁽⁴⁶⁾.

II) Liquid form : Oral liquids are homogeneous liquid preparations usually containing a solution, emulsion or suspension of one or more active ingredients in a suitable liquid base. They are prepared either as such or after dilution for oral administration. They can contain other substances such as dispersants, solubilizers, wetting agents, emulsifiers, stabilizers, suspending agents, thickeners and antimicrobial substances suitable for preservation.

1. Herbal Syrup: A syrup is a viscous oral liquid containing one or more active ingredients in a solution. The base usually contains large amounts of sucrose or other sugars to which sorbitol can be added to inhibit crystallization or to modify the solubilization, flavor, and other properties of the base. Sugar-free syrups may contain other sweeteners like saccharin and thickeners. Saini Tanishk et al. evaluate the anthelmintic activity of an herbal formulation. The resins of *Fenula asafoetida* and volatile oil composition of *Eugenia caryophyllus* are responsible for the anthelmintic potential of the herbal syrup⁽⁴⁷⁾.

2. Herbal Decoction : Decoctions are made by boiling the herb in water for a period to extract the soluble components. Water decoction of a mixture of 2-10 herbal materials is the most common traditional herbal dosage form. Decoctions are usually intended for immediate use, ideally within 24 hours, with a maximum limit of 72 hours if stored in a very cool place. Ivanova et al. [2005] examined the antioxidant activity (TEAC) of teas and herbal tea infusions and determined a higher activity in green and black tea as compared to peppermint⁽⁴⁸⁾.

3. Herbal Tinctures : Tinctures extract the chemical constituents in alcohol, vinegar, or vegetable glycerin. Alcohol is most effective and therefore most commonly used. Vinegar or vegetable glycerin can be used where there is a reason not to use alcohol, such as for children. Tinctures are invaluable, as water will retrieve only some of the medicinal properties.. Natalia Hudzet al. Phytochemical Evaluation of Tinctures and Essential Oil Obtained from *Satureja montana* herb were developed by different methods of maceration. It was revealed that the determination of the total phenolic and flavonoid contents could be used for the quality evaluation of tinctures from the *S. montana* herb⁽⁴⁸⁾.

III) Semi -solid - Semi-solid pharmaceutical preparations can be defined as topical products intended to be applied to the skin or accessible mucous membranes to provide local and sometimes systemic effects at the site of application. In general, semi-solid dosage forms are complex formulations with complex structural elements. They often consist of two phases (oil and water), one being a continuous (outer) phase and the other being a dispersed (inner) phase. The active ingredient in is often dissolved in one or both phases, creating a three-phase system.

1. Herbal cream: Creams are semi-solid emulsions, and the mixtures of oil and water are (hydrophilic). Herbal creams typically contain the herb material either in a finely sieved form or incorporated as an extract. Creams typically contain antimicrobial preservatives due to the presence of water in the base and can have a relatively shorter shelf life compared to ointments. **A. Dahlan et al.** examined the anti-bacterial properties of *A. paniculata* towards *S. aureus* and formulated *A. paniculata* into cream to determine its anti-bacterial properties⁽⁴⁹⁾.

2. Herbal Ointments : Ointments are semi-solid, greasy preparations for application to the skin, rectum, or nasal mucosa. The base is normally anhydrous (hydrophobic) and immiscible with skin secretions. Ointments can be used as an emollient or to apply suspended or dissolved medication to the skin. Herbal ointments typically have the plant material(s) either in a finely sieved or extracted form incorporated into the base. Herbal ointments should not be used on deep wounds. Ointments are relatively stable compared to other liquid dosage forms. **Aravinda et al.** formulated and evaluated the ointment of garlic bulb extract for anti-microbial activity, it shows more zone of inhibition against *Bacillus*⁽⁵⁰⁾.

IV)Others :

1. Herbal patch : A transdermal patch is defined as an adhesive medicated patch that is applied to the skin to deliver a specified dose of drug at a predetermined release rate through the skin to reach the bloodstream. **Chauhan and Vashish**^(51,52) formulated and evaluated the Transdermal Drug Delivery System of an antidiabetic herbal drug. Herbal drugs such as neem & karela extracts are used in formulating transdermal patches due to the appropriate concentration of release of drug from the formulations using this novel approach.

2. Inhalations: Inhalation therapy used for the treatment of respiratory disease has been used for over 4000 years. Inhalation is any drug or solution of drugs administered by the nasal or oral respiratory route. Acharya Charaka (200 BC) also mentioned several Vamaka yogas involving inhalation of drug powder.

Inhaled medication is preferred as this route minimizes systemic absorption and thus improves the balance between therapeutic benefits and potential side effects. Tamaka Shvasa (~Bronchial asthma) is a disorder which is manifested due to the vitiation of humor Prana Vata. Being a disease which requires an emergency management, an effort is put forth to give an immediate relief through administering Bhargimoola Arka nebulization⁽⁵³⁾.

CONCLUSION : Plants have endless ability to synthesize Alkaloids, Flavonoids, Phenols, terpenoids, Tannins, etc. These substances serve as defense mechanisms and provide protection of microorganisms. Microbial resistance to synthetic medicines making infections harder to treat and increasing the risk of disease spread, severe illness and death. The plant life preserve amazing promise as a supply of novel antimicrobial agents. They are conveniently available, reasonably-priced and also, almost; do not no longer have any side effects. Plant spinoff compounds which include phytochemicals have even been used to deal with diverse infectious disorders and feature proven thrilling antimicrobial activity in opposition to numerous human pathogens.

REFERENCE:

1. Sivanandham, Velavan. (2015). PHYTOCHEMICAL TECHNIQUES - A REVIEW. World Journal of Science and Research. 1. 80-91
2. Saxena, Mamta & Jyoti, S. & Nema, Rajeev & Dharmendra, Swarnah & Abhishek, G. (2013). Phytochemistry of Medicinal Plants. J Pharm Phytochem. 1. 168-182.
3. Karimi A, Majlesi M, Rafieian-Kopaei M. Herbal versus synthetic drugs; beliefs and facts. *J Nephroarmacol.* 2015;4(1):27-30. Published 2015 Jan 1.
4. TP, Aneesh & Sekhar, Sonal & Varghese, K. & Vasudaven, Deepa & Revikumar, KG. (2008). Herbalism: A Phenomenon of New Age in Medicine. Internet Journal of Pharmacology. 6.
5. Karimi, Ali & Majlesi, Maedeh & Rafieian-kopaei, Mahmoud. (2015). Herbal versus synthetic drugs; beliefs and facts. Journal of nephroarmacology. 4. 27-30.
6. Rath CC, Devi S, Dash SK, Mishra RK. Antibacterial potential assessment of jasmine essential oil against *E. Coli*. *Indian J Pharm Sci.* 2008;70(2):238-241. doi:10.4103/0250-474X.41465
7. European Pharmacopoeia. Vol. 1. Herbal drug preparations; 2005.
8. Hrytsyk RA, Kutsyk RV, Yurchyshyn OI, Struk OA, Kireev IV, Grytsyk AR (2021) The investigation of antimicrobial and antifungal activity of some *Artemisia L.* species. *Pharmacia* 68(1): 93–100. <https://doi.org/10.3897/pharmacia.68.47521>
9. Meng, J C et al. "Antifungal highly oxygenated guaianolides and other constituents from *Ajania fruticulosa*." *Phytochemistry* vol. 58,7 (2001): 1141-5. doi:10.1016/s0031-9422(01)00389-2

10. Balakumar S, Rajan S, Thirunalasundari T, Jeeva S. Antifungal activity of *Aegle marmelos* (L.) Correa (Rutaceae) leaf extract on dermatophytes. *Asian Pac J Trop Biomed.* 2011;1(4):309-312. doi:10.1016/S2221-1691(11)60049-X
11. Arpita Roy. A Review on Pharmaceutically Important Medicinal plant: *Bacopa monnieri* J. Nat. Prod. Plant Resour., 2017, 7 (4):11-17
12. Mahmoudvand H, Ayatollahi Mousavi SA, Sepahvand A, Sharififar F, Ezatpour B, Gorohi F, Saedi Dezaki E, Jahanbakhsh S. Antifungal, Antileishmanial, and Cytotoxicity Activities of Various Extracts of *Berberis vulgaris* (Berberidaceae) and Its Active Principle Berberine. *ISRN Pharmacol.* 2014 Mar 10;2014:602436. doi: 10.1155/2014/602436. PMID: 24977052; PMCID: PMC3964876.
13. Pang Y, Wang D, Fan Z, et al. *Blumea balsamifera*--a phytochemical and pharmacological review. *Molecules.* 2014;19(7):9453-9477. Published 2014 Jul 3. doi:10.3390/molecules19079453
14. Gazim ZC, Rezende CM, Fraga SR, Svidzinski TI, Cortez DA. Antifungal activity of the essential oil from *Calendula officinalis* L. (asteraceae) growing in Brazil. *Braz J Microbiol.* 2008;39(1):61-63. doi:10.1590/S1517-838220080001000015
15. Chávez-Quintal P, González-Flores T, Rodríguez-Buenfil I, Gallegos-Tintoré S. Antifungal Activity in Ethanolic Extracts of *Carica papaya* L. cv. Maradol Leaves and Seeds. *Indian J Microbiol.* 2011;51(1):54-60. doi:10.1007/s12088-011-0086-5
16. Leanse LG, Goh XS, Dai T. Quinine Improves the Fungicidal Effects of Antimicrobial Blue Light: Implications for the Treatment of Cutaneous Candidiasis. *Lasers Surg Med.* 2020;52(6):569-575. doi:10.1002/lsm.23180
17. Klimek-Szczykutowicz M, Szopa A, Ekiert H. *Citrus limon* (Lemon) Phenomenon--A Review of the Chemistry, Pharmacological Properties, Applications in the Modern Pharmaceutical, Food, and Cosmetics Industries, and Biotechnological Studies. *Plants (Basel).* 2020;9(1):119. Published 2020 Jan 17. doi:10.3390/plants9010119
18. Moghadamtousi SZ, Kadir HA, Hassandarvish P, Tajik H, Abubakar S, Zandi K. A review on antibacterial, antiviral, and antifungal activity of curcumin. *Biomed Res Int.* 2014;2014:186864. doi:10.1155/2014/186864
19. P. K. Lai and J. Roy, "Antimicrobial and chemopreventive properties of herbs and spices," *Current Medicinal Chemistry*, vol. 11, no. 11, pp. 1451–1460, 2004.
20. Banso A, Adeyemo S. Phytochemical screening and antimicrobial assessment of *Abutilon mauritianum*, *Bacopa monnifera* and *Datura stramonium*. *Biokem.* 2006;18(1):39–44.
21. Otshudi, A & Apers, Sandra & Pieters, Luc & Claeys, Magda & Pannecouque, Christophe & Clercq, E & Zeebroeck, A & Lauwers, Sabine & Frederich, Michel & Foriers, Andre. (2005). Biologically active bisbenzylisoquinoline alkaloids from the root bark of *Epinetrum villosum*. *Journal of ethnopharmacology.* 102. 89-94. 10.1016/j.jep.2005.05.021.
22. Chen, Gang & Zhang, Min & Zhao, Jingrui & Zhou, Rui & Meng, Zuchao & Zhang, Jie. (2013). Investigation of Ginkgo biloba leaf extracts as corrosion and Oil field microorganism inhibitors. *Chemistry Central journal.* 7. 83. 10.1186/1752-153X-7-83.
23. Li, Anping et al. "Fungicidal Activity and Mechanism of Action of Glabridin from *Glycyrrhiza glabra* L." *International journal of molecular sciences* vol. 22,20 10966. 11 Oct. 2021, doi:10.3390/ijms222010966
24. Cech NB, Junio HA, Ackermann LW, Kavanaugh JS, Horswill AR. Quorum quenching and antimicrobial activity of goldenseal (*Hydrastis canadensis*) against methicillin resistant *Staphylococcus aureus*.
25. Balogun, Olaoye & Ajayi, Olukayode & Adeleke, Ayansola. (2017). Hexahydrofarnesyl Acetone-Rich Extractives from *Hildegardia barteri*. *Journal of Herbs, Spices & Medicinal Plants.* 23. 1-8. 10.1080/10496475.2017.1350614.
26. Makangara, John J et al. "The caulindoles: dimeric prenylindoles from *Isolona cauliflora*." *Phytochemistry* vol. 65,2 (2004): 227-32. doi:10.1016/j.phytochem.2003.10.010
27. Khan, Ibrar et al. "Pharmacological activities of *Justicia adhatoda*." *Pakistan journal of pharmaceutical sciences* vol. 31,2 (2018): 371-377.
28. Rath CC, Devi S, Dash SK, Mishra RK. Antibacterial potential assessment of jasmine essential oil against *e. Coli*. *Indian J Pharm Sci.* 2008;70(2):238-241. doi:10.4103/0250-474X.41465
29. Scholz, E, and H Rimpler. "Proanthocyanidins from *Krameria triandra* root." *Planta medica* vol. 55,4 (1989): 379-84. doi:10.1055/s-2006-962032
30. Mocan A, Vlase L, Vodnar DC, et al. Polyphenolic content, antioxidant and antimicrobial activities of *Lycium barbarum* L. and *Lycium chinense* Mill. leaves. *Molecules.* 2014;19(7):10056-10073. Published 2014 Jul 10. doi:10.3390/molecules190710056
31. Jabeen, Khajista et al. "Antifungal compounds from *Melia azedarach* leaves for management of *Ascochyta rabiei*, the cause of chickpea blight." *Natural product research* vol. 25,3 (2011): 264-76. doi:10.1080/14786411003754298

32. Mahmoudvand, H et al. "Evaluation of antifungal activities of the essential oil and various extracts of *Nigella sativa* and its main component, thymoquinone against pathogenic dermatophyte strains." *Journal de mycologie medicale* vol. 24,4 (2014): e155-61. doi:10.1016/j.mycmed.2014.06.048
33. Bianco A. D., Muzzalupo I., Piperno A., Romeo G., Uccella N. (1999). Bioactive derivatives of oleuropein from olive fruits. *J. Agric. Food Chem.* 47 3531–3534. 10.1021/jf981240p
34. De Campos, Marina Pereira et al. "Evaluation of antifungal activity of *Piper solmsianum* C. DC. var. *solmsianum* (Piperaceae)." *Biological & pharmaceutical bulletin* vol. 28,8 (2005): 1527-30. doi:10.1248/bpb.28.1527
35. Wang W, Li N, Luo M, Zu Y, Efferth T. Antibacterial activity and anticancer activity of *Rosmarinus officinalis* L. essential oil compared to that of its main components. *Molecules.* 2012;17(3):2704–2713
36. Rana IS, Rana AS, Rajak RC. Evaluation of antifungal activity in essential oil of the *Syzygium aromaticum* (L.) by extraction, purification and analysis of its main component eugenol. *Braz J Microbiol.* 2011;42(4):1269-1277. doi:10.1590/S1517-83822011000400004
37. Abdel-Massih R, Abdou E, Baydoun E, Daoud Z. Antibacterial activity of the extracts obtained from *Rosmarinus officinalis*, *Origanum majorana*, and *Trigonella foenum-graecum* on highly drug-resistant gram-negative bacilli. *J Bot* 2010.
38. Eryılmaz, Müjde & M., Eryılmaz & Ozbilgin, Serkan & Ergene, Burçin & Yılmaz, Betül & Altun, Mehmet & Çitoğlu, Gülçin. (2013). Antimicrobial Activity of Turkish *Viburnum* Species. *Bangladesh Journal of Botany.* 42. 355-360. 10.3329/bjb.v42i2.18044.
39. Owais M, Sharad KS, Shehbaz A, Saleemuddin M. Antibacterial efficacy of *Withania somnifera* (*Ashwagandha*) an indigenous medicinal plant against experimental murine salmonellosis.
40. Bag A., Chattopadhyay R. R. (2015). Evaluation of synergistic antibacterial and antioxidant efficacy of essential oils of spices and herbs in combination. *PLoS One* 10:e0131321. 10.1371/journal.pone.0131321
41. Gafner S, Bergeron C. The challenges of chemical stability testing of herbal extracts in finished products using state-of-the-art analytical methodologies. *Curr Pharm Anal* 2005;1:203-15.
42. European Pharmacopoeia. Vol. 1. Herbal drug preparations; 2005.
43. Pandey, Harsh & Srivastava, Shivani & Mishra, Brahmeshwar & Saxena, Riden & Tripathi, Yamini Bhusan. (2018). Development and evaluation of Herbal Tablet loaded with *Pueraria tuberosa* water extract with use of different Excipients. *Asian Journal of Pharmaceutics.* 12. 786-793. 10.22377/ajp.v12i02.2493.
44. Amolnat Turkishkongkon et al. Formulation development of herbal capsule containing oleoresin of *Zingiber officinale* extract. *Int J Pharm Pharm Sci*, Vol 5, Issue 4, 439-445
45. OkorieCO O, Esimone Evaluation of lozenges formulated from the root bark extract of *ZinthoxylumTessmannii* (2009) *Journal of pharmaceutical and allied sciences* Vol. 6 No. 4 (2009)
46. AmrutaAvalaskar, Khandelwal, P., Shah, P.J., & RashmiJadhav (2016). FORMULATION AND EVALUATION OF ORAL HERBAL GRANULES FOR ASTHMA.
47. Saini Tanishk. Formulation and evaluation of anthelmintic herbal formulations. *Int. J. Res. Ayurveda Pharm.* 2018;9(3):205-208 <http://dx.doi.org/10.7897/2277-4343.09394>
48. Ivanova D., Gerova D., Chervenkov T., Yankova T.I., Polypheno-nols and antioxidant capacity of Bulgarian medicinal plants. *J. Ethnopharmacol.*, 2005, 96, 145–150
49. Nataliia Hudz, Ewa Makowicz, Mariia Shanida Phytochemical Evaluation of Tinctures and Essential Oil Obtained from *Satureja montana* Herb
50. Dahlan A, Yip WS and Pin KY: Formulation and characterization of an anti-bacterial cream using *Hempedu bumi* (*Andrographis paniculata*). *Int J Pharm Sci & Res* 2014; 5(9): 3633-40. doi: 10.13040/IJPSR.0975-8232.5(9).3633-40
51. Aravinda Nalla, Krishna Mohan Chinnala: Formulation and Evaluation of Herbal Ointment for anti-microbial activity. *wjpmr*, 2017,3(7), 113-117.
52. Chauhan L, Vashisht S. Formulation and evaluation of novel herbal antidiabetic transdermal patch. *Innov Pharm Pharmacother* 2018;6(4):61-64
53. Dwivedi, Satyadhar & Dwivedi, Dr. Sumeet & Dwivedi, Dr. (2015). Herbal Remedies for Respiratory Diseases among the Natives of Madhya Pradesh, India. *American Journal of Life Science Researches.* 3. 158-162.