



ANTIFUNGAL ACTIVITY OF MEDICINAL PLANTS

¹Mr. Swapnil Bawne, ²Mrs. Pooja Bhonde, ³Dr. Gajanan Sanap, ⁴Mr. Sudarshan Chavan

¹Student, ²Assistant Professor, ³Principal, ⁴Student

¹Department of Pharmacy,

¹Late Bhagirathi Yashwantrao Pathrikar College of Pharmacy, Pathri, Aurangabad, 431001. Maharashtra, India.

Abstract: The epidemiological information propose that the occurrence and incidence of great mycoses is still a public fitness problem. The expanded use of antifungal retailers has resulted withinside the improvement of resistance to those drugs. The unfold of multidrug-resistant traces of fungus and the decreased range of medication to be had make it vital to find out new training of antifungals from herbal merchandise together with medicinal plant life. Historically, herbs and spices have loved a wealthy culture of use for his or her medicinal homes and offer limitless possibilities for brand new drug leads due to the big chemical diversity. Assays of bioactive compounds were stated with true antifungal homes in vitro or in vivo. It is sort of not possible to speak about the diverse traits of those plant life which include mode of motion and extraction of energetic compounds in a unmarried review. Therefore, we've focussed right here specially at the antifungal plant extracts, their use in opposition to pathogeinc and drug resistant fungi. The diverse training of compounds which include phenolics, terpenoids, saponins, and alkaloids, etc., are mentioned in detail. The new rising training of antifungal proteins and peptides also are reviewed briefly. In this chapter, we additionally describe the technical components associated with the method for screening and identity of antifungal compounds. The technical components concerning using dependable method of extraction, screening, bioautography, and identity of natural compounds from crude extracts and fractions also are mentioned right here.

Keywords – Antifungal, Medicinal Plants, Aloe, Glycyrrhiza, Ginger, Alkaloids, Flavonoids, Saponins.

I. INTRODUCTION

The pills used to deal with fungal infections are referred to as antifungal marketers.[3] Systemic mycotic infections and some cutaneous or sub contagious mitosis are handled with oral or parenteral marketers. The wide variety of invasive fungal infections has a dramatically multiplied in each evolved and growing countries.[1,2] An antifungal drug is a remedy used to deal with fungal infections which include athlete's food , ringworm, candidiasis (thrush), critical systemic infections which include cryptococcal meningitis and others, such pills are generally acquired with the aid of using medical doctors prescriptions or bought over the counter. But use of this sort of pills utilized in big approaches makes the unusable because of resistance to antibiotics and with the toxicity in the course of extended treatment. There are big wide variety downside in synthetic pills so humans greater closer to natural pills that is greater safe. Yeasts of the genus candida (particularly sea. Albicans) and of the species cryptococcusneo for mans are the fungal marketers maximum regularly concerned in the etiology of infectious techniques in topics tormented by AIDS. Many research investigating the antifungal susceptibility of medical tendencies of candida species. Have been done with style of consequences and this research factor to the emergency of the brand new resistant strains. Disseminated cryptococcus, however influences a greater restrained percent of the patients, (6-8%) is a critical lifestyles threatening conditions. In the existing scenaria, an emergency of a couple of pills resistance in human pathogenic fungi and a small wide variety of antifungal classes to be had inspired studies directed closer to the invention of novel antifungal agent from different sources, which include medicinal plants. [4]

II. BACKGROUND

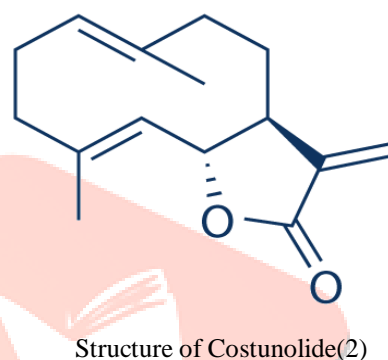
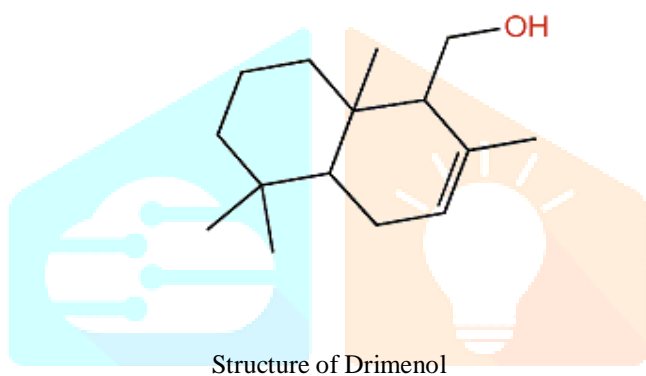
Candida species are the maximum distinguished retailers of fungal infections in human beings and animals. These infections are greater not unusualplace in sufferers with this kind of predispose elements as a cancer, leukemia, diabetes mellitus, long time antibiotics and corticosteroid therapy, AIDS, pregnancy, burn injurious and organ transplantation. The spectrum of those infections diverse from mucosal clonization to invasive and fungal infections. Cutaneous and mucosal candidiasis is greater not unusualplace than different medical candida infections. Vaginal candidiasis, thrush and any chomycosis are the maximum not unusualplace kinds of mucosal and cutaneous candidiasis. In addition, candida albicans are the maximum normal agent of candida infections among candida species.[5]

III. CLASSES OF COMPOUNDS AND THEIR ANTIFUNGAL ACTIVITY

Several papers and opinions had been posted at the incidence of antifungal compounds in relation to their function in plant resistance [6]. However, literature and systematic opinions at the herbal merchandise as an opportunity to antifungal capsules are nevertheless scanty. The distribution of antifungal compounds can be defined both on the premise in their taxonomic distribution or on the premise of their chemical instructions. indicates the antifungal herbal merchandise belonging to all major instructions of secondary metabolites consisting of phenolic, alkaloids, terpenoids, saponins, flavonoids, proteins, and peptides, etc. The significance of those groups of compounds in opposition to pathogenic/nonpathogenic fungi is defined below.

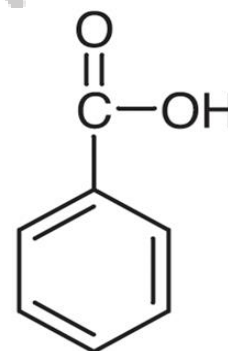
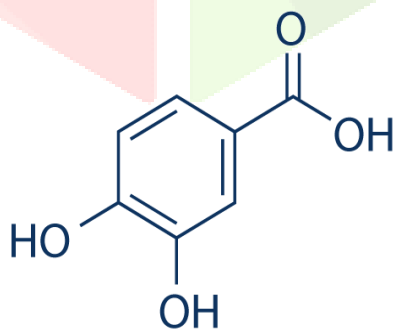
1. Terpenoids

Terpenoids (or isoprenoids), a subclass of the prenylipids (terpenes, prenylquinones and sterols), constitute the oldest organization of small molecular merchandise synthesized via way of means of vegetation and are likely the maximum huge organization of herbal merchandise. It has been pronounced withinside the literature that aglycones of terpenoids are greater stable and energetic in comparison to the glycosides. For example 4 nonglycosidic iridioids have been determined in Aliertial macrophylla and of the 1a and 1b hydroxydihydrocornin aglycones confirmed fungitoxicity in opposition to a selection of Clostridium and Aspergillus species .[7] Some consultant systems of this organization are proven in (formidable numbers 1 to eight in brackets underneath seek advice from these). Six antifungal sesquiterpenes [5- and 7-hydroxycalamenene, drimenol (1), drimenal, viridiflorol, gymnomitrol, and chloroisopiagiochin D] have been remoted via way of means.[8] from a dichloromethane and methanol extract of the liverwort *Bazzania trilobata* (L.). These compounds confirmed antifungal hobby in opposition to numerous fungi consisting of *Botrytis cinerea*, *Cladosporium cucumerinum*, *Phythophthora infestans*, *Pyricularia oryzae*, and *Septoria tritici*. Similarly polygodial, a sesquiterpene remoted from *Polygonum punctatum* (Polygonaceae), wasfound to show off a fungicidal hobby in opposition to meals spoilage yeast, *Zygosaccharomyces bailii*. [9]



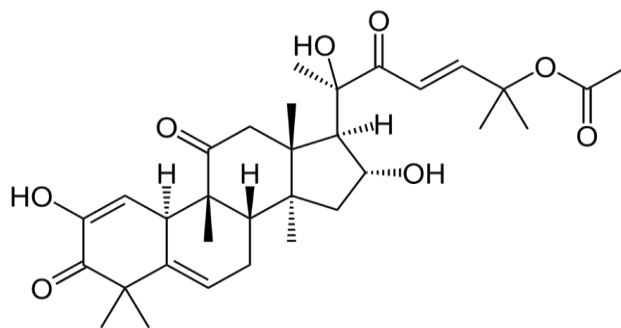
2. Phenolic Compounds

In current years, a huge range of research were posted on antimicrobial hobby of the phenolics compounds of herbal origin. In many cases, those materials function plant protection mechanisms against microorganisms and insects, etc. Some flowers supply their odors like terpenoids, how ever others (quinones and tannins) are accountable for plant pigment. A huge range of fragrant flowers display antibacterial and frequently antifungal hobby. These compounds consist of easy and alkylated phenols, phenolic acid ,phenyl phenyl propanoids, coumaine, quinines ,anthaquinones, and xanthones,etc [10]



3. Saponins

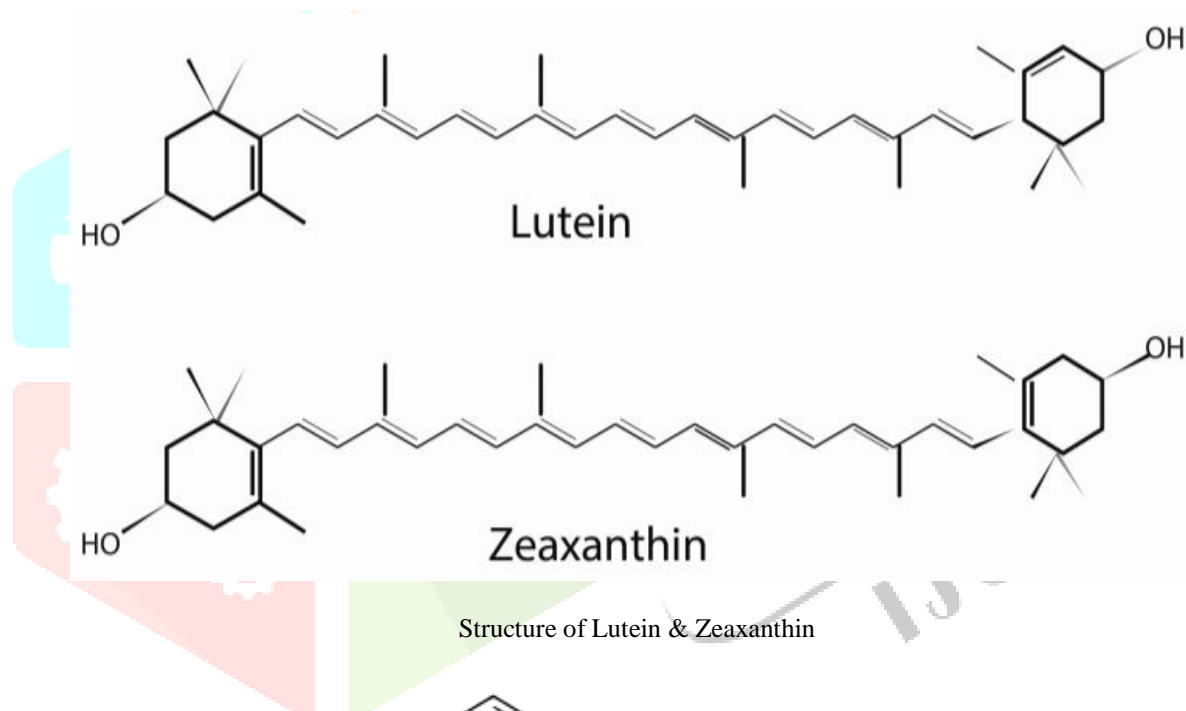
An critical supply of constitutive antifungals is the saponins. Shows of these (formidable numbers in brackets 9 and 10 below). Saponins are natural detergents which are powerful antimicrobial, cholesterol lowering anticancer compounds. These compounds chemically associated with the triterpenoid organization such as triterpene saponins, collectively with steroidal saponins, have been additionally remoted as antifungal constituents.[11]



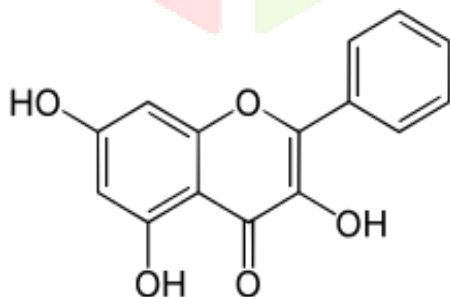
Structure of Cucurbitacin(5)

4. Flavones, Flavonoids and Flavonols

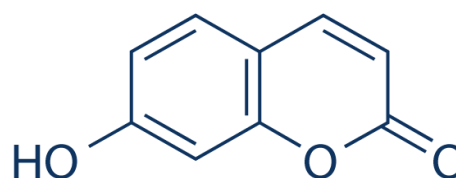
Flavones are phenolic systems containing one carbonyl group. The addition of a 3- hydroxyl group yields a flavonol, and flavonoids also are hydroxylated phenolic materials however arise as a C6-C3 unit connected to an fragrant ring. Since they're recognised to be synthesized with the aid of using flora in reaction to microbial infection, it need to now no longer be unexpected that they've been located in vitro to be powerful antimicrobial materials in opposition to a big range of microorganisms [12] . In the flavonoid group, reviews on antifungal compounds from medicinal flora especially problem the ones remoted from species of the fabaceae and moraceae households. However, reviews at the antifungal hobby of flavonoids of numerous medicinal flora belonging to different botanical households have additionally been located withinside the literature. [13]



Structure of Lutein & Zeaxanthin



Structure of Galangin(6)



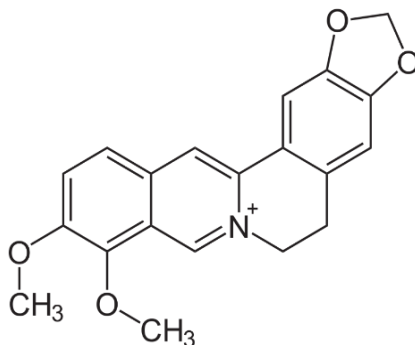
Structure of Umbelliferon(7)

5. Coumarins

Various coumarins remoted from the historically used medicinal vegetation in Brazil confirmed that the remoted coumarins are lively both by myself or in mixture towards some of fungi, *C. neoformans*, *M. gypseum*, *T. rubrum*, and *T. mentagrophyt* Ojala [14]. examined six industrial coumarins, bergaptin (17), coumarin (18), herniarin (19), umbelliferone (20), xanthotoxin (21), and scopoletin (22), and discovered that they're lively towards *F. culmorum* Tithoniamarin is a brand new isocoumarin dimer remoted from *Tithonia diversifolia* (Hemsl) Gray (Asteraceae). Preliminary research confirmed that tithoniamarin has antifungal and herbicidal sports towards *Microboviolaceum* and *Chlorella fusca*. [15] Alizarin (23) and emodin (24), anthraquinone aglycone of *Rubia tinctorum*, has proven antifungal activity. [16]

6. Alkaloids

Alkaloids are obviously happening chemicals containing fundamental nitrogen atoms. There are many reviews on alkaloids displaying pastime towards human pathogens, for example, the isoquinoline alkaloid jatrorrhizine, a number of peptide alkaloids, the quinolizidine alkaloid dietamine and the pyrrolizidine alkaloids, etc., (Harborne and Baxter 1993).[17] Berberine (25), a famous alkaloid, has been said for its sturdy antifungal pastime towards some of organisms such as human pathogenic fungi *C. albicans*, *T. mentagrophytes*, *M. canis*, *T. rubrum*, *E. floccosum*, and *M. gypseum*. Freile et al. 2006). Similarly, tomatine (26) from tomato and α -solanine from potato are examples of steroidal glycoalkaloids and feature very sturdy antifungal pastime.[19]



Berberine(9)

7. Proteins and Peptides

There are loads of antifungal peptides and proteins known, with extra being determined nearly daily. They are produced with the aid of using a mess of organisms together with leguminous flowering plants, nonleguminous flowering plants, gymnosperms, fungi, bacteria, insects, and mammals. In the final decade alone, many reviews were posted on antifungal proteins and peptides.[20]

IV. MEDICINAL PLANTS HAVING ANTIFUNGAL PROPERTIES

Following are some of the medicinal plants which having Antifungal properties.

1. Allium Sativum

The antifungal pastime of six fractions derived from garlic changed into investigated in an in vitro system. Ajoene had the most powerful pastime in those fractions. The boom of each *Aspergillus niger* and *Candida albicans* changed into inhibited with the aid of using ajoene at much less than 20 micrograms/ml. Scientific research have proven garlic to be a very powerful remedy for athlete's foot and different fungal infections. Soaking the inflamed foot in a bath of heat water containing numerous cloves of garlic normally relieves itching and burning. Garlic also can be steeped in olive oil and implemented immediately to the place of contamination a couple of times daily.[21-A, 21-B]

- Kingdom :- Plantae
- Clade :- Tracheophytes
- Clade :- Angiosperms
- Clade :- Monocots
- Order :- Asparagales
- Family :- Amaryllidaceae
- Subfamily :- Allioideae
- Genus :- Allium
- Species :- A. Sativum



2. Zingiber Officinalis

Ginger consists of the compound caprylic acid, which has robust antifungal properties. Simmer approximately an ounce of ginger root in a cup of boiling water after which observe it without delay to the affected region of the foot at [22-A, 22-B] least two times a day.

- Scientific Name :- Zingiber officinalis
- Common Name :- Adarak
- Family :- Zingiberaceae
- Kingdom :- Plantae
- Genus :- Zingiber
- Species :- Z. Officinalis



3. Glycyrrhiza Glabra

Chinese practitioners had been the use of licorice to deal with fungal infections, maximum considerably ringworm, for a very lengthy time. This is due to the fact licorice includes the finest wide variety of antifungal compounds of any of the herbs. You can both upload a few licorice for your garlic footbath, or boil six to seven teaspoons of dried licorice and follow it immediately to the affected area. [23]

- Scientific Name :- Glycyrrhiza Glabra
- Common Name :- Liquorice
- Family :- Leguminosae
- Kingdom :- Plantae
- Genus :- Glycyrrhiza
- Species :- G. Glabra



4. Curcuma longa

Turmeric oil and curcumin, remoted from Curcuma longa L., have been studied towards fifteen isolates of dermatophytes.[24]

- Scientific name :- Curcuma longa
- Common name :- Turmeric
- Family :- Zingiberaceae
- Kingdom :- Plantae
- Genus :- Curcuma
- Species :- C. Longa



5. Mentha Piperita

The composition and antifungal results of Mentha piperita oil on Fusarium oxysporum f. sp. ciceri., Macrophomina phaseolina, and Dreschlera oryzae on the premise of agar dilution method. The take a look at was caried out with factorial experiments primarily based totally at the random whole block layout with triplicates. Essential oil evaluation with GS/MS discovered that essential compounds of oil encompass menthol (19.76%), menthan-3-one (19.31%), menthofuran+isomenthone (9.12%), 1, 8-cineole+beta phellandrene (8.8%) and menthol acetate (5.63%). [25]

- Scientific Name :- Mentha Piperita
- Common Name :- Peppermint
- Family :- Lamiaceae
- Kingdom :- Plantae
- Genus :- Mentha
- Species :- M. Piperita



6. Azadirachta Indica

Evaluation of the pastime of the bloodless expeller neem oil(Azadirachta indica A. Juss.) and the fractions derived thru solvent partitioning, against Drechlera oryzae, Fusarium oxysporum and Alternaria tenuis confirmed that the lively antifungal fraction is a aggregate of tetra nor tri terpenoids. Further, testing the triterpenoidal aggregate derived from the 90% methanol (MeOH) extract of neem oil towards 13 phytopathogenic fungi found out that numerous species have been inhibited to one-of-a-kind degrees. Direct preparative High Performance Liquid Chromatography (HPLC) of the lively fractions and subsequent bioassay of the semi-natural fractions indicated that the lively fractions contained main compounds such as 6- deacetylnimbin, azadiradione, nimbin, salannin and epoxyazadiradione. Pure azadiradione, nimbin, salannin and epoxy-azadiradione did now no longer have considerable pastime. However, whilst those terpenoids have been combined and bioassayed, they confirmed antifungal pastime, indicating viable additive/synergistic effects.[26-A, 26-B]

- Scientific Name :- Azadirachta indica
- Comman Name :- Neem
- Family :- Meliaceae
- Kingdom :- Plantae
- Genus :- Azadirachta
- Species :- A. Indica



7. Withania Somnifera

The antifungal pastime of W.somnifera root extract (at 0.5,1.0,2.0and 2.5g) turned into investigated against Fusarium solani the usage of clorimazole(1%)as reference and clear out out disc with out the extract because the control .The extract had better inhibitory impact at the boom of F. solani than clotirmazole.[27] 26-B]

- Scientific Name :- Withania Somnifera
- Common :- Ashwagandha
- Family :- Solanaceae
- Kingdom :- Plantae
- Genus :- withania
- Species :- W. Somnifere



8. Acorus Calamus

The rhizome extract of *A. calamus* exhibited maximum antifungal pastime inhibiting the mycelial growth completely (100%) towards all of the 6 check pathogens.[28]

- Scientific Name :- Acorus calamus
- Common Name :- Sweet flag
- Family :- Acoraceae
- Kingdom :- Plantae
- Genus :- Acorus
- Species :- A. Calamus



9. Piper Betel

P. betel exhibited more than 50% inhibition against all the test pathogens except *M. phaseolina*. The ethanolic extract of several higher plants could be used as alternative source of antifungal agents for protection of plants or crops against fungal infection. [29]

- Scientific Name :- Piper betel
- Common Name :- Betel vine
- Family :- Piperaceae
- Kingdom :- Plantae
- Genus :- Piper
- Species :- P. Betel



10. Adhatoda Vasica (Basuti or Vasa)

Leaves are pronounced for use for the remedy of diverse illnesses and disorders, mainly for the respiration tract ailments. It's miles a robust antifungal marketer for diverse infections such as ring worm, athlete foot. [30]

- Scientific Name :- Adhatoda Vasica
- Common Name :- Vasaka
- Family :- Acanthaceae
- Kingdom :- Plantae
- Genus :- Adhatoda
- Species :- A. Vasica



11. Solanum Xanthocarpum

The Indian night shade, which grows abundantly in arid areas of the country is known to have pest repellent properties. The research showed that the methanolic extract have potent antifungal properties. The antifungal activity are carried by microbroth dilution, percent spore germination inhibition and disc diffusion methods. [31-A,31-B].

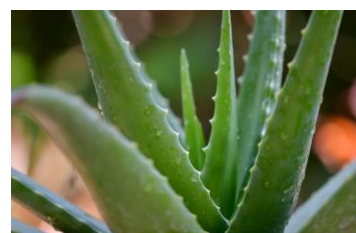
- Scientific Name :- Solanum Xanthocarpus
- Common Name :- Kantkari
- Family :- Solanaceae
- Kingdom :- Plantae
- Genus :- Solanum
- Species :- S. Xanthocarpus



12. Aloe Vera

Aloe Vera confirmed an inhibitory zeffect of the pulp of *A. Vera* on *F. oxysporum* at and over a protracted period. For the 2 styles of Aloe fractions the sports have been similar. Besides the liquid fraction decreased the rate of colony increase at a attention of a hundred and five il 1-1 in *R. solani*, *F. oxysporum*, and *C. coccodes*. [32]

- Scientific Name :- Aloe Vera
- Common Name :- Aloe
- Family :- Asphodelaceae
- Kingdom :- Plantae
- Genus :- Aloe
- Species :- A. Vera



13. Ocimum Sanctum

The antifungal pastime of six fractions derived from garlic changed into investigated in an in vitro system. Ajoene had the most powerful pastime in those fractions. The boom of each *Aspergillus niger* and *Candida albicans* changed into inhibited with the aid of using ajoene at much less than 20 micrograms/ml. Scientific research have proven garlic to be a very powerful remedy for athlete's foot and different fungal infections. Soaking the inflamed foot in a bath of heat water containing numerous cloves of garlic normally relieves itching and burning. Garlic also can be steeped in olive oil and implemented immediately to the place of contamination a couple of times daily.[21-A, 21-B]

- Scientific Name : - Ocimum Sanctum
- Common Name : - Holy Basil
- Family : - Lamiaceae
- Kingdom : - Plantae
- Genus : - Ocimum
- Species : - O. Sanctum



V. MECHANISM OF ACTION OF ANTIFUNGAL MEDICINAL PLANTS

The specific mechanism of action of vital oil unstable on fungi stays unclear however, various of consequences and speculation had been reported. this consists of inhibition of sporulation, distribution of a cell wall and membrane germination and hyphal elongation. Not surprisingly, because of the special effet found particular fungi of man or woman oils, it's far cautioned that the mechanism of motion of vital oils volatiles can also additionally range singificantly from that of oils introduced at once in to the increase medium. In general, the majority of reports agree that vital oil volatiles results in giant morphological adjustments to the huphae, pretty a reduction in hyphal diamater and hyphal wall thickness. [33-36] It is doubtful how the unstable are inhibiting fungal increase, with a few reviews demonstraping that the volatiles are appearing on fungal increase circuitously via way of means of being absorbed into the increase medium and diffusing through to the mycelia. Other authors believe that it is mixture of the that bring about the demonstrated.

Antifungal activity of critical oil volatiles, whilst others endorse the mode of movement is at once associated with the quantity of every compound absorbed to stable section additives and that during low doses, fungicidal hobby is at once associated with the character of the character compound, whilst at excessive concentration, compound from critical oil are fungicidal through not unusualplace mechanism for example, it's been validated that oil unstable are preferentially absorbed directly to the lipophilic floor through mycelia and that the extra the floor place of mycelia the more potent inhibitor impact of unstable oils. Others speculation that compound in the critical unstable oil erreversibly move link with additives withinside the fungal cell membrane inflicting the leakage of intracellular additives. It is likewise feasible that respiration suppression of aerial mycelia involve. Oil volatiles has been validated to inhibiting sporulation of fungi. It has been counseled that this inhibition of sporulation, as with mobileular wall harm is likewise related to alteration to the mobileular harm, is additionally related to alteration to the mobileular membrane or mobileular wall harm main to increased permeability and next lack of cytoplasmic content. Based on evaluation of the antispore activity of *M gypseum* of extract whose foremost components became lapachol, it's been proposed that this inhibition is because of additives both harm the mobileular wall or changing the membrane permeability of the microconidia, which bring about lack of cytoplasm, which result in mobileular death.[37-39]

VI. CONCLUSION

In this study, primarily based totally on exhaustive literature assessment we've diagnosed seven antifungal compound which display impact in opposition to fungal contamination and 13 extraordinary medicinal plant species that have fungicidal activity. There isn't anyt any doubt that vital unstable oil have first-rate capacity to be used in fungal manage and remedy which acquired from plant fabric through extraction process. In this undertaking discovered that drug utilized in huge manner make the unusable because of resistance to antibiotics and with the toxicity during extended remedy because of which natural tablets which can be secure in opposition to artificial tablets.

VII. REFERENCES

- [1] Meena AK, Kaur R, Singh B, Yadav AK, Singh U, Sachan A, Pal B, Rao MM. Review on antifungal activities of Ayurvedic medicinal plants. *Drug Invent Today*. 2010 Feb 1;2(2):146-8.
- [2] Ahmad I, Zahin M, Aqil F, Hasan S, Khan MS, Owais M. Bioactive compounds from *Punica granatum*, *Curcuma longa* and *Zingiber officinale* and their therapeutic potential. *Drugs of the Future*. 2008 Apr 1;33(4):329.
- [3] Prasad R, Shah AH, Rawal MK. Antifungals: mechanism of action and drug resistance. *Yeast Membrane Transport*. 2016:327-49.
- [4] Khan MS, Ahmad I. Antifungal activity of essential oils and their synergy with fluconazole against drug-resistant strains of *Aspergillus fumigatus* and *Trichophyton rubrum*. *Applied microbiology and biotechnology*. 2011 May;90(3):1083-94. Rajendra Prasad, Abdul Haseeb Shah, and Manpreet kaur Rawal, Springer International publication switzerland 2016 page no 327.
- [5] Scher JM, Speakman JB, Zapp J, Becker H. Bioactivity guided isolation of antifungal compounds from the liverwort *Bazzania trilobata* (L.) SF Gray. *Phytochemistry*. 2004 Sep 1;65(18):2583-8.
- [6] Fujita KI, Kubo I. Naturally occurring antifungal agents against *Zygosaccharomyces bailii* and their synergism. *Journal of agricultural and food chemistry*. 2005 Jun 29;53(13):5187-91.
- [7] Mishra N, Kaushal K, Mishra RC, Sharma AK. An ayurvedic herb: *Encostemma littorale* blume-A review article. *Journal of Medicinal Plants Studies*. 2017;5(1):78-82.
- [8] Nagata T, Tsushida T, Hamaya E, Enoki N, Manabe S, Nishino C. Camellidins, antifungal saponins isolated from *Camellia japonica*. *Agricultural and biological chemistry*. 1985 Apr 1;49(4):1181-6.
- [9] Tahara S, Ingham JL, Nakahara S, Mizutani J, Harborne JB. Fungitoxic dihydrofuranisoflavones and related compounds in white lupin, *Lupinus albus*. *Phytochemistry*. 1984 Aug 21;23(9):1889-900.

- [10] Cowan MM. Plant products as antimicrobial agents. *Clinical microbiology reviews*. 1999 Oct 1;12(4):564-82.
- [11] Abad MJ, Ansuategui M, Bermejo P. Active antifungal substances from natural sources. *Arkivoc*. 2007 Jan 1;7(11):6-145.
- [12] Stein AC, Alvarez S, Avancini C, Zacchino S, von Poser G. Antifungal activity of some coumarins obtained from species of *Pterocaulon* (Asteraceae). *Journal of ethnopharmacology*. 2006 Aug 11;107(1):95-8.
- [13] Yemele Bouberte M, Krohn K, Hussain H, Dongo E, Schulz B, Hu Q. Tithoniamarin and tithoniamide: a structurally unique isocoumarin dimer and a new ceramide from *Tithonia diversifolia*. *Natural Product Research*. 2006 Jul 20;20(9):842-9.
- [14] Manojlovic NT, Solujic S, Sukdolak S, Milosev M. Antifungal activity of *Rubia tinctorum*, *Rhamnus frangula* and *Caloplaca cerina*. *Fitoterapia*. 2005 Mar 1;76(2):244-6.
- [15] Pengelly A, Bone K. *The constituents of medicinal plants: an introduction to the chemistry and therapeutics of herbal medicine*. Routledge; 2020 Aug 4.
- [16] Greathouse GA, Watkins GM. Berberine as a factor in the resistance of *Mahonia trifoliolata* and *M. swaseyi* to *Phymatotrichum* root rot. *American Journal of Botany*. 1938 Dec 1:743-8.
- [17] Grayer RJ, Harborne JB. A survey of antifungal compounds from higher plants, 1982–1993. *Phytochemistry*. 1994 Jan 1;37(1):19-42.
- [18] Wong JH, Ng TB. Vulgarinin, a broad-spectrum antifungal peptide from haricot beans (*Phaseolus vulgaris*). *The international journal of biochemistry & cell biology*. 2005 Aug 1;37(8):1626-32.
- [19] Esquenazi D, Alviano CS, de Souza W, Rozental S. The influence of surface carbohydrates during in vitro infection of mammalian cells by the dermatophyte *Trichophyton rubrum*. *Research in microbiology*. 2004 Apr 1;155(3):144-53.
- [20] Yoshida S, Kasuga S, Hayashi NO, Ushiroguchi T, Matsuura H, Nakagawa S. Antifungal activity of ajoene derived from garlic. *Applied and Environmental Microbiology*. 1987 Mar;53(3):615-7.
- [21] Pai ST, Platt MW. Antifungal effects of *Allium sativum* (garlic) extract against the *Aspergillus* species involved in otomycosis. *Letters in applied microbiology*. 1995 Jan;20(1):14-8.
- [22] Ficker C, Smith ML, Akpagana K, Gbeassor M, Zhang J, Durst T, Assabgui R, Arnason JT. Bioassay-guided isolation and identification of antifungal compounds from ginger. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*. 2003 Sep;17(8):897-902.
- [23] Wang H, Ng TB. An antifungal protein from ginger rhizomes. *Biochemical and Biophysical Research Communications*. 2005 Oct 14;336(1):100-4.
- [24] Hojo Hiroshi et al, Antifungal Activity of Licorice (*Glycyrrhiza Glabra*) and Potential Applications in Beverage, Foods & Food Ingrid J Jpn2002 ;203:27-33
- [25] Apisariyakul A, Vanittanakom N, Buddhasukh D. Antifungal activity of turmeric oil extracted from *Curcuma longa* (Zingiberaceae). *Journal of ethnopharmacology*. 1995 Dec 15;49(3):163-9.
- [26] Masilamani S. et al, Identification of antifungal compounds from the seed oil of *Azadirachta Indica*, *Phytoparasitica* Publisher Springer Netherlands, 1998;26(2):109-116.
- [27] Govindachari TR, Suresh G, Gopalakrishnan G, Banumathy B, Masilamani S. Identification of antifungal compounds from the seed oil of *Azadirachta Indica*. *Phytoparasitica*. 1998 Jun;26(2):109-16.
- [28] Punetha H, Singh S, Gaur AK. Antifungal and antibacterial activities of crude withanolides extract from the roots of *Withania somnifera*(L.) Dunal(Ashwagandha). *Environment Conservation Journal*. 2010;11(1-2):65-9.
- [29] Begum J, Yusuf M, Chowdhury JU, Khan S, Anwar MN. Antifungal activity of forty higher plants against phytopathogenic fungi. *Bangladesh Journal of Microbiology*. 2007;24(1):76-8.
- [30] Anwar MN, Singha P, Begum J, Chowdhury JU. Antifungal activity of some selected plant extracts on phytopathogenic fungi. *Bangladesh J. Life Sci*. 1994;6(2):23-6.
- [31] Claeson UP, Malmfors T, Wikman G, Bruhn JG. *Adhatoda vasica*: a critical review of ethnopharmacological and toxicological data. *Journal of ethnopharmacology*. 2000 Sep 1;72(1-2):1-20.
- [32] Sharma GL. Studies on antimycotic properties of *Datura metel*. *Journal of ethnopharmacology*. 2002 May 1;80(2-3):193-7.
- [33] Qureshi S, Rai MK, Agrawal SC. In vitro evaluation of inhibitory nature of extracts of 18-plant species of Chhindwara against 3-keratinophilic fungi. *Hindustan Antibiotics Bulletin*. 1997 Feb 1;39(1-4):56-60.
- [34] De Rodriguez DJ, Hernández-Castillo D, Rodríguez-García R, Angulo-Sánchez JL. Antifungal activity in vitro of *Aloe vera* pulp and liquid fraction against plant pathogenic fungi. *Industrial Crops and Products*. 2005 Jan 1;21(1):81-7.
- [35] Singh TJ, Dasgupta P, Khan SY, Mishra KC. Preliminary pharmacological investigations of *Ocimum sanctum* Linn. *Indian J pharmacy*. 1970;32:92.
- [36] Manoorkar VB, Gachande BD. Full Length Article Evaluation of antifungal activity of some medicinal plant extracts against some storage seed-borne fungi of Groundnut.
- [37] Inouye S, Uchida K, Yamaguchi H. In-vitro and in-vivo anti-*Trichophyton* activity of essential oils by vapour contact. *Mycoses*. 2001 Apr;44(3-4):99-107.
- [38] Inouye S, Takizawa T, Yamaguchi H. Antibacterial activity of essential oils and their major constituents against respiratory tract pathogens by gaseous contact. *Journal of antimicrobial chemotherapy*. 2001 May 1;47(5):565-73.
- [39] Alvarez-Castellanos PP, Bishop CD, Pascual-Villalobos MJ. Antifungal activity of the essential oil of flowerheads of garland chrysanthemum (*Chrysanthemum coronarium*) against agricultural pathogens. *Phytochemistry*. 2001 May 1;57(1):99-102.