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Iraqi Medicinal Plants with Antifungal Effect- A Review

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Abstract: Medicinal plant possessed antifungal effects by many mechanisms, they caused membrane disturbance resulting in the loss of membrane integrity, inhibited DNA transcription and reduced the cell populations, inhibited the activity of fungal antioxidant enzymes and inhibited fungal biofilm formation[6-14]. The current review discussed the antifungal effects of medicinal plants.

Keywords: medicinal plant, pharmacology, antifungal

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I. INTRODUCTION

Traditional medicine is based on beliefs and practices that existed before the development of so-called modern medicine or scientific drug therapy. However, the recent pharmacological studies showed that the medicinal plants exerted many pharmacological effects, among these, the antifungal properties against dermatophytes and yeasts as a single treatment or combined with other antifungal agents, and some clinical trials showed that medicinal plants can be applied as an alternative antifungal agents for fungal diseases caused by traditional drugs- resistant fungal species [1-5]. Medicinal plant possessed antifungal effects by many mechanisms, they caused membrane disturbance resulting in the loss of membrane integrity, inhibited DNA transcription and reduced the cell populations, inhibited the activity of fungal antioxidant enzymes and inhibited fungal biofilm formation[6-16]. The current review will highlight the antifungal effects of medicinal plants.

II. MEDICINAL PLANTS WITH ANTIFUNGAL EFFECTS, THEIR SPECTRUM AND ANTIFUNGAL MECHANISMS:

Adiantum capillus-veneris

The water extracts and extracted phenols from gametophytes of *Adiantum capillus-veneris* showed antifungal activity against *Aspergillus niger* and *Rhizopus stolonifer* [17-18].

Alhagi maurorum

The antifungal effects of Alhagi maurorum was examined against Aspergillus flavus, Alternaria alternate, Fusarium oxysporum, Fusarium solani, Bipolaris oryzae, Rhizoctnia solani, Pythium ultimum, Chetomium, Rhizopus and Mucor. The result showed that the methanol extract of the plant exerted antifungal activity against some pathogenic fungi at 23 mg/ml concentration Aspergillus flavus, Alternaria alternate, Fusarium oxysporum, Fusarium solani, Bipolaris oryzae, Chetomium and Mucor, with a percentage of growth inhibition of 33.4, 89.4, 89.3, 94.6, 91.7, 59.0 and 94.1% [19-20].

Allium porrum

Spirostanol saponins isolated from *Allium porrum* showed antifungal activity [21].

Allium sativum

The effect of aqueous garlic extract on the macromolecular synthesis of *Candida albicans* was studied. Protein and nucleic acid syntheses were inhibited to the same extent as growth, but lipid synthesis was completely arrested. Blockage of lipid synthesis is likely an important component of the anticandidal activity of garlic [22]. A successful treatment of *Cryptococcal meningitis* was achieved by oral, muscular, and intravenous administration of garlic [23]. The antifungal activity in human serum against seven species of Candida and two species of Cryptococcus was detected after ingestion of garlic. Garlic extract showed potent antifungal activity against three different isolates of *Cryptococcus neoformans*. The minimum inhibitory concentration was 6 to 12 μg/mL. It also showed synergistic fungistatic activity with amphotericin B [24]. Pure allicin was also effective against *Candida*, *Cryptococcus*, *Trichophyton*, *Epidermophyton*, and *Microsporum* with MIC between 1.57 and 6.25 μg/mL. It inhibited germination of spores and growth of hyphae [25-26].

Alpinia galangal

It has been shown that essential oils from both fresh and dried rhizomes of galangal have antimicrobial activities against bacteria, fungi, yeast and parasite. Terpinen-4-ol, one of the monoterpenes in the essential oil from fresh galangal rhizomes, contains an antifungal activity against *Trichophyton mentagrophytes*. Acetoxychavicol acetate , a compound isolated from an n-pentane/diethyl ether-soluble extract of dried rhizomes, was active against some bacteria and many dermatophyte species [27-28]. *A. galanga* have antifungal activity against fungi resist the common antifungal products like amphotericin B and ketoconazole [29]. It exerted a concentration-dependent inhibition of the growth of zoonotic dermatophytes and the yeast-like *Candida albicans* [30]. Ethanolic extract of *A. galanga* posses phytotoxic activity against *Lemna minor* and significant antifungal activity against *Trichophyton longifusus* [31]. It also showed significant antifungal activity against *Candida albicans* and phytopathogenic fungi, *Colletotrichum musae* and *Fusarium oxysporum*, at a concentration of 10mg/ml [32]. 14 mg/ml of 1'- Acetoxychavicol acetate exerted antifungal activity against *Trichophyton mentagrophytes, Trichophyton rubrum, Trichophyton concentricum*, *Rhizopus stolonifer* and *Aspergillus niger* [28, 33].

Ammi majus

Acetone and 95% ethanol extract of *Ammi majus* inhibited the growth of the *Neurospora crassa* fungi *in vitro* [34-35].

Anchusa strigosa

The aqueous extract of *Anchusa strigosa* (15 mg ml−1 medium) produced antifungal activity , the means of percentage of mycelial inhibition against M. canis T. mentagrophytes and T. violaceum were l50.1±9.84 , 36.7±3.80 , and 71.7±1.91 respectively [36-37].

Apium graveolens

The methanolic extract of all the examined celery showed positive antibacterial activity against all strains. Similarly, antifungal potential of the celery was determined against *Trichphyton longifuss, Candida albicans, Aspergillus flavus, Microsporum canis, Fusarium solani and Candida glabrata* in concentration 200 µg/ml of dimethyl sulphoxide [38-39].

Arachis hypogaea

Peanut stilbenoids appear to play roles in plant defense mechanisms, they exerted antifungal effects when evaluated against economically important plant pathogenic fungi of the genera Colletotrichum, Botrytis, Fusarium, and Phomopsis [40-43].

Arundo donax

Arundo donax also exerted antifungal activity against four Basidiomycetes (*Trametes versicolor* CTB 863A , *Coniophora puteana* BAM Ebw.15, *Gloephyllum trabeum* BAM Ebw. 109, and *Postia placenta* FPRL 280) [44-45].

Asclepias curassavica

The crude extract of methanol was effective against *Clavibacter michiganense* than other extracts. The chloroform extract showed inhibition zone of 13mm, 19mm and 13mm against *Helminthosporium oryzae, Aspergillus niger* and *Fusarium oxysporum* respectively, whereas petroleum ether extract and methanol extract did not show any inhibition zone [46]. Ethanol and aceton extracts showed good anticandidal effect [47]. The latex sap terpens, cardenolids and glucanases also exerted antifungal activity. Fungi were deformed and emptied the cytoplasm. The sap exerted its effects on cell wall [48-49].

Asparagus officinalis

The saponin fraction of the *Asparagus officinalis* exerted antifungal activity [50-52].

Asphodelus fistulosus

Asphodelus fistulosus showed antifungal activity against *Trichophyton violaceum* [53].

Avena sativa

A protein fraction (P fraction) rich in Cys/Gly residues was extracted from oat (*Avena sativa*) seeds. Quantitative amino acid analysis and MS of the P fraction indicated that it contains a series of heterogeneous Cys/Gly-rich proteins with molecular masses of 3.6-4.0 kDa. Preliminary results showed that these proteins possessed weak to moderate antifungal properties to some fungal strains [54-55].

Ballota nigra

The essential oils from the aerial parts of *Ballota nigra* L. ssp foetida (Lamiaceae) collected at flowering and fruiting times, showed antifungal activity against nine plant pathogenic fungi [56]. Root and stem flavonoids, terpenes and phenols present in ethanol, chloroform, and ethyl acetate soluble fraction; these were found to be the most active inhibiting fractions against all the tested strains of bacteria, fungi, and leishmania. While in leaves flavonoids, terpenes, and phenols were present in ethanol, chloroform, and n-butanol fractions which were the most active fractions against both types of microbes and protozoan (leishmania) in in vitro study [57-58].

Bellis perenni

Bellis perenni extract showed *in vitro* and *in vivo* antifungal activity. Triterpenoid glycosides obtained from *Bellis perennis* inhibited the growth of human pathogenic yeasts (Candida and Cryptococcus species). The intensity of growth inhibition is influenced particularly by the carbohydrate chains of the glycosides. Monodesmosidic as well as bisdesmosidic glycosides of polygalacic acid exert fungicidic effects [59-60].

Benincasa hispida

The antifungal activity of *Benincasa hispida* was studied against *Candida albicans* and *Aspergillus niger*. The methanolic extract of *Benincasa hispida* showed significant zone of inhibition against *Candida albicans* at the concentration of 30 mg/ml, while, it caused no inhibition against *Aspergillus Niger* [61-62].

Betula alba

Betulinic acid showed an inhibitory effects against *Candida albicans* secreted aspartic proteases (SAP) with IC50 values of 6.5 μg/ml [63-64].

Brassica rapa

The susceptibility of six microorganisms covering gram positive bacteria, gram negative bacteria and two fungi to the extracts and fractions of *Brassica rapa* was measured using cut plug method and the results compared with standard antibiotic gentamycin and the standard antifungal fluconazole. All the tested fractions and crude extracts revealed positive inhibitory effects against *Candida albicans*. Light petroleum fraction of roots showed somewhat strong antifungal activity against *Candida albicans* with MIC calculated as 12.5 mg/ml [65]. An 9.4-kDa antifungal peptide designated as campesin was isolated from seeds of the plant. It exerted an inhibitory action on mycelial growth including *Fusarium oxysporum* and *Mycosphaerella arachidicola*, with an IC_{50} of 5.1 microM and 4.4 microM, respectively. It also inhibited and the activity of HIV-1 reverse transcriptase with an IC50 of 3.2 microM. It demonstrated lysolecithin binding activity [66]. It was also known that arvelexin, one of the phytoalexins extracted from *Brassica rapa* possessed antifungal activity [67]. *Brassica rapa* was separated in seeds, stems-leaves, and roots, and then macerated with ethanol. *F. oxysporum* was seeded on PDA medium separately supplemented with each extract and radial growth was assessed after 6 days. All *Brassica rapa* extracts exhibited dose dependent antifungal activity at different levels. Root-derived extract showed inhibition percentages above 45% between 10 – 0.1 μg/μL. Stem-leaf and seed-derived extracts also showed reasonable inhibition (> 30% and > 35%, respectively) in the same concentration range [68-69].

Caesalpinia crista

The compound, α-(2-hydroxy-2-methylpropyl)-ω- (2-hydroxy-3-methylbut-2-en-1-yl) polymethylene, isolated from ethyl acetate leaf extract of *Caesalpinia crista* was evaluated against *Candida albicans* and *Rhodotorula sp.* using agar diffusion method. The compound exerted a concentration-dependent activity against tested yeast strains comparable to standards fluconazole and griseofulvin for *Candida albicans* and *Rhodotorula sp.* The inhibition zones was (IZ >20 mm) for *C. albicans* and *Rhodotorula sp* [70-71].

Calamintha graveolens

The essential oil (in 1:10 dilution, w/v mg/μl) exerted antifungal effects. A significant reduction in the Candida albicans growth was recorded (with antifungal zone measuring 20mm). The antifungal effects could be attributed to its hydrocarbon sesquiterpenes , germacrene and bicycle-germacrene contents [72].

Calendula officinalis

Both methanol and ethanol extracts of *Calendula officinalis* showed excellent antifungal activity against tested strains of fungi [73-75]. The essential oil of the flowers showed good potential antifungal activity (at 15 μl/disc) when tested against *Candida albicans* (ATCC64548), *Candida dubliniensis* (ATCC777), *Candida parapsilosis* (ATCC22019), *Candida glabrata* (ATCC90030), *Candida krusei* (ATCC6258), and yeast isolated from humans [76-77].

Calotropis procera

Antifungal and antibacterial activity of solvent extracts of *Calotropis procera* growing wild in Saudi Arabia were evaluated against *Candida albicans*. A bioassay-guided fractionation of the crude flavonoid fraction (Cf3) of methanol extract which showed the highest antimicrobial activity led to the isolation of four flavonoid glycosides as the bioactive constituents. Most of the isolated extracts showed antimicrobial activity against the test microorganisms, where the crude flavonoid fraction was the most active, diameter of inhibition zones ranged between 15.5 and 28.5 mm against the tested bacterial strains, while reached 30 mm against *Candida albicans* [78]. The differential antimycoses activities of chloroform, methanol and ethyl acetate extracts of *Calotropis procera* (50,100 and 150 mg/ml) were studied against *Trichophyton rubrum, Trichophyton tonsurans, Trichophyton mentagrophyte, Epidermophyton floccosum* and *Aspergillus.* Ethyl lactate extract produced the potent activity followed by chloroform extract, while methanol extract had no antifungal activity in all concentrations used in the study [79]. The osmotin purified from *Calotropis procera* latex, inhibited the spore germination of *Fusarium solani*. Osmotin interacted with the negatively charged large unilamellar vesicles (LUVs) of 1-palmitoyl-2-oleoyl-sn-glycero-3-phospho-rac-1-glycerol (POPG), inducing vesicle permeabilization by the leakage of calcein. Osmotin induced the membrane permeabilization of spores and hyphae from *Fusarium solani*, allowing for propidium iodide uptake [80-81].

Capparis spinosa

The antifungal activities of ethanolic extract of (*Capparis spinosa* L.) was investigated *in vitro* against *Alternaria alternata, Fusarium oxysporum, Phoma destructiva, Rhizoctonia solani,* and *Sclerotium rolfsii* at concentrations of 0, 3, 6, and 9% (v/v). It produced concentration dependent fungal growth inhibition [82]. A monomeric protein with molecular mass of 38 kDa was purified from *C. spinosa* seeds. It inhibited HIV- 1 reverse transcriptase and fungal mycelia growth without having hemogglutinating, ribonuclease, mitogenic or protease inhibitor properties. A novel dimeric 62-kDa lectin was also extracted from caper (*C. spinosa*) seeds, it also inhibited HIV-1 reverse trans-criptase and proliferation of both hepatoma HepG2 and breast cancer MCF-7 cells [83-84].

Capsella bursa-pastoris

Two novel antimicrobial peptides were isolated and characterized from the roots of shepherd's purse, *Capsella bursa-pastoris*. These antimicrobial peptides, named shepherin I and shepherin II, consist of 28 and 38 amino acids, respectively, and are glycine- and histidine-rich peptides. Shepherin I and shepherin II have 67.9% and 65.8% (mol/mol) glycine, respectively, and 28.6% and 21.1% (mol/mol) histidine, respectively. Both shepherins have a Gly-Gly-His motif. These antimicrobial peptides exhibit antimicrobial activity against Gram-negative bacteria and fungi [85-86].

Capsicum annum

The extracts of *Capsicum annum* showed antifungal activity against *A. niger* and *C. albicans* with inhibition zone diameter range of 10-16 mm/15*M*l [87-88].

Carum carvi

The antifungal screening of the essential oil of *Carum carvi* showed 100% inhibition of radial mycelial growth of all the test fungi at 100 ppm. The MIC and minimum fungicidal concentration (MFC) values were found to vary from 50-300 ppm and 200-400 ppm respectively [89-90].

Cassia occidentalis

Crude extracts of different parts (leaf, seed and pod) of *Cassia occidentalis* was examined for their antifungal activity against three fungi viz. *Candida albicans,Aspergillus clavatus* and *Aspergillus niger*. Antifungal activity of different plant parts in terms of minimal inhibitory concentration ranged between 200-1000 µg/ml. The extracts performed as good as or even better than the standard drugs nystatin and greseofulvin with exception of activity of leaf extracts against Aspergilli [91-92].

Chenopodium album

Antifungal activity of methanol and n-hexane leaf, stem, root and inflorescence extracts of *Chenopodium album* (1, 2, 3 and 4% w/v) was investigated against *Macrophomina phaseolina*, a soil-borne fungal plant pathogen that has a broad host range and wide geographical distribution. The n-hexane extracts of *Chenopodium album* reduced fungal biomass by 60- 94% [88]. The zone of growth inhibition of methanol and ethyl acetate extracts of the plant was 18.3mm against *Candida albicans* ATCC 18804 [93-95].

Chrozophora tinctoria

The crude methanol extract of the plant was tested against seven fungal strains (*Fusarium moniliformes, Fusarium solani, Aspergillus niger, Aspergillus fumigatus, Aspergillus flavus, Alternaria* sp. and *Mucor* sp.). The plant extracts showed low antifungal activity against all the seven fungal strains. The percentage inhibition in linear growth was 22.08± 2.2, 2.89± 2.61, 32.73±1, 23.48±2, 18.33± 3.3, 7.14± 3.3 and 28.26± 5.6 respectivily [96]. However, aqueous and methanolic extracts of *Chrozophora tinctoria* showed no antifungal activity against *Rhizoctonia solani, Fusarium oxysporum* and *Cochliobolus sativus* [97-98].

Chrysanthemum cinerariaefolium

The diameter of the growth inhibition of *Chrysanthemum cinerariaefolium* leaf extract against five strains of the Candida species [*Candida tropicalis* (B- 1389/09), *Candida albicans* (CAGMC6), *Candida albicans* (B- 1622/09), *Candida parapsilosis* (B1597/09) and *Candida cruzei* (ATCC- 6258)] were 4-7mm for methanolic extract (10µl) and 4-15mm for ethanolic extract (10µl) [99].

Cicer arietinum

Several proteins, including a glucanase, a chitinase, an antifungal cyclophyllin-like protein, and three antifungal peptides designated cicerin, arietin, and cicearin were isolated from the chickpea (*Cicer arietinum* L) [100-101].

Two antifungal peptides with novel N-terminal sequences were isolated from chickpea. Although the two chickpea peptides, cicerin and arietin, were similar in molecular weight (5-8 kDa), they differed somewhat in antifungal activity. Arietin was more potent against *M. arachidicola*, *B. cinerea*, and *F. oxysporum* while cicerin exhibited a higher cell-free translation-inhibiting activity than arietin [102]. An antifungal protein, was isolated from *Cicer arietinum* and purified by gel filtration and tesred using agar diffusion method against human pathogenic fungi of ATCC strains and against clinical isolates of *Candida krusei*, *Candida tropicalis* and *Candida parapsilosis*. MIC values were varied from 1.56 to 12.5 µg/ml. Protein isolated from *Cicer arietinum* also inhibited the growth of fungal strains which are resistant to fluconazole [103]. The crude water extract of *Cicer arietinum* showed most significant antifungal activity against *Drechslera tetramera* even at lower concentration of 5%. In dichloromethane fraction, the inhibitory effect was found to be proportional with the applied concentration [104].

Cichorium intybus

Antifungal activity of *Cichorium intybus* seeds extract/fractions was very low against A. *flavus* and *A. niger* and mild against *R. solani* [105]. The ethyl acetate extract of chicory root had antifungal effect against *Aspergillus niger* and *Sachharomyces cerevisiae* [106]. Guaianolides-rich root extracts of *Cichorium intybus* have shown antifungal properties against anthropophilic fungi *Trichophyton tonsurans*, *T. rubrum*, and *T. violaceum* [107-108].

Cistanche tubulosa

The extracts of the aerial parts *Cistanche tubulosa* showed mild antifungal effects against *Aspergilus niger* and *Aspergilus* fumigates[93]. Phenylethanoid glycosides, Campneosid I and Campneosid II, isolated from *Cistanche tubulosa*, have high antifungal activity [109].

Citrullus colocynthis

MIC and MBC/MFC were determined for plant organs at different maturation stages. Aqueous and diluted acetone extracts (from the plant's roots, stems, leaves and three maturation stages of its fruit and seeds) were screened for activity against various *Candida* spp. (*Candida glabrata*, *Candida albicans*, *Candida parapsilosis* and *Candida kreusei*). All extracts showed activity against all strains. The highest MICs and MBCs/MFCs were obtained from the fruit aqueous extracts (MIC 0.10 mg/ml against *C. albicans* and *C. glabrata*), the lowest anticandidal activity was recorded for the root extracts of *Citrullus colocynthis* Schrad [110-111]. The antifungal and antimycotoxigenic power of methanolic and aqueous extracts of *Citrullus colocynthis* seeds were studied *in vitro*. The antifungal and antimycotoxigenic activity of methanolic and aqueous extracts were screened against *Aspergillus ochraceus* and *Aspergillus flavus.* The results suggest that the extracts showed a very good antifungal activity against *A. ochraceus*, but not against *A. flavus.* The extracts have good antiochratoxigenic power in liquid medium [112].

Citrus species

The antifungal potency of *Citrus aurantifolia* was studied against *Aspergilus niger* and *Candida albicans*,, in the different forms [juice of the fruit, burnt rind of the fruit commonly known as (epa-ijebu) in the Yoruba dialect, and the oil obtained from steam distillation of the fruit]. Only the oil extract was potent against

A. niger, while *Candida albicans* was susceptible to all the extracts with MIC ranging from 256mg/ml-512mg/ml [113]. The antifungal efficacy of leaf extract of *Citrus aurantifolia* Linn (CA) was studied against *Aspergillus niger, Aspergillus fumigates, Mucor Spp* and *Pencillium Spp*. 100 µl of 10 mg CA were assessed. The study demonstrated that the hydroalcoholic extract of CA leaf exhibited antifungal activity against *Aspergillus niger, Aspergillus fumigates* and *Mucor* species [114]. The effects of *Citrus limonum* essential oils (EO) compared to 0.2% chlorhexidine (CHX) and 1% sodium hypochlorite (NaOCl) was studied in multispecies biofilms formed by *Candida albicans*. The biofilms were grown in acrylic disks immersed in broth, inoculated with microbial suspension (106 cells/ml) and incubated at 37°C /48 h. After the biofilms were formed, they were exposed for 5 minutes to the solutions: *Citrus limonum* EO, 0.2% CHX, 1% NaOCl or sterile saline solution. The discs were placed in sterile 0.9% NaCl and sonicated to disperse the biofilms. Tenfold serial dilutions were performed and the aliquots were seeded onto selective agar and incubated at 37C / 48 h. Next, the number of colony-forming units per milliliter was counted and analyzed statistically (Tukey test, $p < 0.05$). *Citrus limonum* EO promoted a 100% reduction of *C. albicans*. CHX was less effective against *C. albicans* yielding a reduction of 68.8%. *Citrus limonum* EO was effective in controlling multi-species biofilms; the microbial reductions achieved by EO were not only similar to those of NaOCl, but even higher than those achieved by CHX, in some cases [115]. Antimicrobial activity of fruit juice and ethanolic extracts of root, leaf, bark, peel and pulp of *Citrus medica* were examined against two fungi (*Aspergillus flavus* and *A. niger*) and a yeast *Candida albicans* of clinical origin. Antifungal activity was shown by only root extract and fruit juice against *Aspergillus* Spp while C. albicans was resistant to all tested samples [116]. The antifungal activity against selected fungi was observed for the alcoholic extract of *Citrus medica*, it was active against *Candida albicans*, *Aspergillus niger* and *Aspergillus flavus*. The maximum antifungal activity was shown against *A. niger (*6.3 mm) and minimum activity was recorded against *A. flavus* (3 mm) [117]. The results of antifungal activity of peel essential oil of *Citrus limetta* var. Mitha against different against fungi showed that the essential oil possessed antifungal activity after 48 and 96 h [118]. Peels of *Citrus lemon, Citrus sinensis* and *Citrus limetta* were dried and extracted by cold water, hot water, methanol, ethanol, ethyl acetate and acetone. Extracts were subjected to antifungal susceptibility assay against (*Trichophyton mentagrophytes, Microsporum canis* and *Candida albicans*). Methanol extract was effective against fungal pathogens showing a zone of inhibition of 18 mm. Water and ethyl acetate extracts of *Citrus limetta* were also effective against fungal pathogens giving a zone of inhibition of 17mm and 15 mm respectively [119]. The antifungal activity of methanolic extract of *C. sinensis* fruit peel was tested against two fungal strains using turbidimetric or tube dilution method and paper disc diffusion method. *C. sinensis* fruit peel methanolic extract exhibited appreciable antifungal activity with minimum inhibitory concentration of 12.5 µg/ml [120]. The antimicrobial activity of petroleum ether extract of the peels of *Citrus sinensis* was studied against fungal strains (*Aspergillus niger, and Candida albicans*). The extract showed various levels of antifungal activity on the tested microorganisms. It was more effective against *Candida albicans*, while it possessed no activity against *Bacillus subtilis* and *Aspergillus niger* [121-122].

Clerodendrum inerme

The antimicrobial activities of different extracts (ethanol, benzene and aqueous) of *Clerodendrum inerme* plant parts were evaluated *in vitro* by disc diffusion method against fungal strains *Aspergillus niger* (ATCC 16404), *Aspergillus flavus* (ATCC 9807), *Candida albicans* (ATCC5027) and *Candida glabrata* (ATCC 66032). The methanol leaves extract exhibited highest zone of inhibition against *A. niger* (15.0±0.0 mm) with low MIC values (0.78 mg/ml) [123]. screened for antifungal activity. The tested fungi were included clinical isolates of dermatophytes such as *pidermophyton floccosum, Trichophyton mentagrophytes, Trichophyton rubrum* and *Trichophyton tonsurans*, and plant pathogens such as *Aspergillus niger, Aspergillus flavus, Curvularia lunata, Botrytis cinerea* and *Fusarium oxysporum*. Leaf hexane extract (1 mg/ml) of *C. inerme* inhibited the plant pathogenic fungi better than the human dermatophytes [124-125].

Clitoria ternatea

The crude extract from seeds of *C. ternatea* showed strong antifungal activity on the test fungus *Aspergillus niger* and *Aspergillus ochraceous* (NCIM 1140) [126]. The antimicrobial activities of the methanol extracts of the leaf, stems, flower, seed and roots of *Clitoria ternatea* were tested *in vitro* against 2 yeast species, and 3 filamentous fungi by the agar diffusion and broth dilution methods. The leaf and root extracts were found to be most effective against all of the tested organisms ($p<0.05$). The MFC (minimum fungicidal activity) values of *C. ternatea* extracts ranged from 0.3 mg/ml to 100.00 mg/ml [127-128]. An antifungal protein with a molecular mass of 14.3 kDa was isolated from the seeds of *Clitoria ternatea*. The protein showed broad-spectrum, fungicidal activity, particularly against the most clinically relevant yeasts, such as *Cryptococcus neoformans, Cryptococcus albidus, Cryptococcus laurentii, Candida albicans* and *Candida parapsilosis*. It also exerted an inhibitory activity on mycelial growth in several mould species including *Curvularia* sp., *Alternaria*

sp., *Cladosporium* sp., *Aspergillus flavus, Aspergillus fumigatus, Aspergillus niger, Rhizopus* sp., and *Sclerotium* sp [129]. *Clitoria ternatea* leaf extract showed a favorable antifungal activity against *A. niger*, the minimum inhibition concentration was 0.8 mg/ml and minimum fungicidal concentration was 1.6 mg/ml, respectively. The leaf extract exhibited considerable antifungal activity against filamentous fungi in a dose-dependent manner with 0.4 mg/ml IC_{50} value on hyphal growth of *A. niger*. The main changes observed under scanning electron microscopy after *Clitoria ternatea* extract treatment were loss of cytoplasm in fungal hyphae and the hyphal wall became markedly thinner, distorted, and resulted in cell wall disruption. In addition, conidiophore alterations were also observed when *A. niger* was treated with *Clitoria ternatea* leaf extract [130]. A single protein (finotin), was obtained from seeds of *Clitoria ternatea*. The protein finotin showed broad and potent inhibitory effect on the growth of various important fungal pathogens of plants (*Rhizoctonia solani, Fusarium solani, Colletotrichum lindemuthianum, Lasiodiplodia theobromae, Pyricularia grisea, Bipolaris oryzae* and *Colletotrichum gloeosporioides*) [131].

Corchorus aestuans

The antimicrobial activity of various solvent extracts of *Corchorus aestuans* was evaluated against *Aspergillus niger, Candida albicans, Candida tropicalis, Candida kefyr* and *Cryptococcus neoformans*. It was appeared that ethanol, methanol, ethyl acetate, acetone, chloroform, petroleum ether, hexane and aqueous extracts showed antifungal activity. Hot water extract of *Corchorus aestuans* showed more activity against *Candida kefyr*, zone of diameter 12.20±0.20mm and *Cryptococcus neoformans*, zone of diameter 11.17±0.29mm, when compared to other solvent extracts. Hot water extract showed more inhibition to the growth of tested organism, than ethanol, methanol and acetone extracts [132]. The leaf, capsule and root extracts of *Corchorus aestuans* were tested for antifungal activity against *Aspergillusniger, Rhizopusstolonifer, Saccharomyces cervisiae*, the methanolic extracts showed moderate activity. The chloroform and methanolic *Corchorus aestuans* leaf, capsule and root extracts showed potent antifungal activity [133].

Corchorus capsularis

Disc diffusion method was used to determine the activity of the crude methanolic extract of *Corchorus capsularis* (leaves) against yeast and fungi (*Candida albicans, Saccharomyces cerevisiae* and *Bacillus megaterium*). *Corchorus capsularis* extracts possessed antifrungal and anti-yeast activity. N-hexane fraction of methanolic extract of leaves of *Corchorus capsularis* showed the highest acivities against fungi with a zone of inhibition 0.9-1.5mm, followed by hexane extract [134-135].

Coriandrum sativum

Essential oils from commercial samples of coriander were assayed for their antifungal activities. Against *Aspergillus niger*. The essential oils showed a high antifungal activity[136-137]. The antifungal activity of ethanol, methanol, acetone, chloroform, hexane and petroleum ether extracts of *Coriandrum sativum* was investigated against *Aspergillus niger, Candida albicans, Candida kefyr* and *Candida tropicalis* using agar well diffusion method. The methanol extract of *Coriandrum sativum* showed antibacterial activity against *Candida albicans* (zone of diameter 14.20±0.20mm) and *Aspergillus niger* (10.10±0.10mm). It appeared that methanol extract showed a varying degree of antifungal effects more than ethanol, acetone, chloroform, hexane and petroleum ether extracts [138]. The antibacterial potential of two commercial essential oils (EOs) from *Coriandrum sativum* was studied against vaginal clinical strains of yeast. It showed low fungicidal activity [139]. The antifungal activity of essential oil from *Coriandrum sativum* fruits was evaluated against *Microsporum canis* and *Candida* spp. by the agar-well diffusion method and the minimum inhibitory concentration (MIC) and the minimum fungicidal concentration (MFC) were established by the broth microdilution method. The essential oil induced growth inhibition zones of 28 ± 5.42 and 9.25 ± 0.5mm for *M. canis* and *Candida* spp. respectively. The MICs and MFCs for M. canis strains ranged from 78 to 620 and 150 to 1.250 µg/ml, and the MICs and MFCs for *Candida* spp strains ranged from 310 to 620 and 620 to 1.250 µg/ml, respectively [140]. The antifungal activity of coriander essential oil was studied on germ tube formation, and the potential synergism with amphotericin B were also studied. Coriander essential oil has a fungicidal activity against the *Candida* strains tested, with MLC values equal to the MIC value and ranging from 0.05 to 0.4% (v/v). Flow cytometric evaluation of BOX, PI and DRAQ5 staining indicated that the fungicidal effect was a result of cytoplasmic membrane damage and subsequent leakage of intracellular components such as DNA. Also, concentrations bellow the MIC value caused a marked reduction in the percentage of germ tube formation for *C. albicans* strains. A synergetic effect between coriander oil and amphotericin B was also recorded against *C. albicans* strains, while for *C. tropicalis* strain only an additive effect was observed [141]. The antifungal activity and mode of action of the essential oils (EO) from *Coriandrum sativum* leaves were evaluated against Candida spp. In addition, the molecular targets affected in whole-genome expression in human cells was also studied. The EO showed anticandidal effects. *Coriandrum sativum* EO may bind to membrane ergosterol,

increasing ionic permeability and causing membrane damage leading to cell death, but it did not act on cell wall biosynthesis-related pathways. The EO also inhibited Candida biofilm adherence to a polystyrene substrate at low concentrations, and decreased the proteolytic activity of *Candida albicans* at the minimum inhibitory concentration. In addition, the EO and its selected active fraction had low cytotoxicity on human cells [142]. *Coriandrum sativum* essential oil possessed antifungal activity against *Candida* species isolates from the oral cavity of patients with periodontal disease. 2-hexen-1-ol, 3-hexen-1-ol and cyclodecane were determined as the active constituents in the oil [143]. The efficacy and tolerability of 6% coriander oil was tested in unguentum leniens in the treatment of interdigital tinea pedis. The study was performed on 40 participants. 6% coriander oil showed highly significant improvement of the clinical signs in unguentum leniens ($p < 0.0001$) during the entire observation period. The number of positive fungal cultures also decreased ($p = 0.0654$). The tolerability of the tested substances was good [144].

Cressa cretica

The antifungal effect of the different fractions (hexane, ethylacetate and methanol) of the whole methanolic extract of Cressa cretica were studied against five fungi: Candida albicans, Candida tropicalis, Aspergillus fumigatus, Aspergillus niger and Fusarium oxysporum by agar disc diffusion method. Cressa cretica showed higher inhibitory activity against the Aspergillus fumigates, Aspergillus niger (zone of inhibition diameter was found to be 26 and 22mm, respectively) than the Candida albicans and Candida tropicalis and, the least activity was recorded against Fusarium oxysporum [145-146].

The antifungal activity of methanolic extract of *Cressa cretica* was studied by cup plate method against *albicans.* 200-800µg/ml of the ethanolic extract showed dose dependent antifungal activity, the diameter of zone of growth inhibition (mm) was 20-25 against *C. albican* [147].

Antifungal activity was exerted by ethanol extract of *Cressa cretica* against *Penicillium citrinum* (32.2 mm) and *Candida albicans* (25.7 mm) [148].

The antifungal activity of crude solvent extract of *Cressa cretica* against the dermatophytic fungi *Aspergillus niger, Aspergillus flavus, Paecilomyces varioti, Microsporum gypseum* and *Trichophyton rubrum* was investigated. The various crude solvent extracts were found to be effective against the test organisms, the chloroform and aqueous extracts appeared to be the most effective antifungal extracts, compared to the ethanol, methanol and ethyl acetate extracts [149].

Crotalaria juncea

Moderate antifungal activity has been reported in the methylene chloride and methanol extract of aerial parts of *Crotalaria juncea* of Indonesian origin [15-151].

Cyminum cuminum

All essential oils, and cuminic aldehyde, were tested, using agar diffusion and serial dilution methods, against three different *Candida albicans* isolates. All cumin oils and cuminic aldehyde exhibited a considerable inhibitory effect against all the tested organisms [152].

The essential oil of Bulgarian *Cuminum cyminum* was active against *Aspergillus niger, Saccharomyces cerevisiae* and *Candida albicans* [153].

The essential oils from seeds of *Cuminum cyminum,* exerted antifungal activity against *Aspergillus flavus* [154].

Antimicrobial testing showed high activity of the essential *Cuminum cyminum* oil against *Candida albicans*, *Aspergillus niger*, as well as the yeast (*Saccharomyces cerevisiae*) [155].

Cuminum cyminum essential oils possessed antifungal activity against *Botrytis cinerea, Rhizopus stolonifer* and *Aspergillus niger*. The incorporation of 750 µl/1 from *Cuminum cyminum* oils to PDA medium was completely inhibited the growth of *B. cinerea*, *R. stolonifer* and *A. niger* [156].

The fungicidal activities of p-isopropyl benzaldehyde and p-isopropyl benzoic acid extracted from *Cuminum cyminum* were studied against *Alternaria solani*, *Verticillium dahliae*, *Rhizoctonia cerealis*, *Alternaria alternata*, *Gaeumannomyces graminis*, *Sclerotinia sclerotiorum*, *Phytophthora capsici*, *Thanatephorus cucumeris*, *Blumeria graminis* [*Erysiphe graminis*] and *Botrytis cinerea*. The bioassay results showed that both compounds had fungicidal activities *in vivo* and *in vitro*. P-isopropyl benzaldehyde and p-isopropyl benzoic acid had better inhibitory effects against *Sclerotinia sclerotiorum*, and their EC_{50} were 2.1 and 7.3 mg/l respectively. In a concentration of 1000 mg/l, the protective effects of p-isopropyl benzaldehyde and p-isopropyl benzoic acid treatments were higher than 50% against *Blumeria graminis*. At the same concentration, the control effect of p-isopropyl benzoic acid treatment was 57.52% against *Sclerotinia sclerotiorum*, which was comparable to sumilex treatment [157].

The antifungal activities of the essential oils obtained from *Hyssopus officinalis*, *Cuminum cyminum*, *Thymus vulgaris* and cones of *Cupressus arizonica* were evaluated against *Aspergillus flavus*. Different

concentrations of the essential oils on conidial germination and germ tube elongation were determined *in vitro*. Essential oils were applied in 5 levels (0, 0.125, 0.25, 0.375 and 0.5%). The results showed that the essential oil of *Cuminum cyminum* was more effective in comparison with others [158].

The storage life of the strawberry fruits was increased by the use of Cumin (*Cuminum cyminum*) essential oils significantly, because they inhibited the fungi (*Botrytis cinerea*) [159].

The antifungal activity of the volatile parts (at doses from 5 to 20 microl) of the essential oil of fruits of *Cuminum cyminum* was tested on dermatophytes and phytopathogens, fungi, yeasts and some new *Aspergilli*. Antifungal testing showed that *Cuminum cyminum* was active on all fungi but in particular on the dermatophytes, where *Trichophyton rubrum* was the most inhibited fungus at the lowest dose of 5 µl. Phytopathogens were less sensitive to the treatment [160].

The antimicrobial effects of garlic, bay, black pepper, origanum, orange, thyme, tea tree, mint, clove, and cumin essential oils were studied against *Saccharomyces uvarum* UUFE 16732, *Kloeckera apiculata* UUFE 10628, *Candida albicans* ATCC 10231, *Candida oleophila* UUPP 94365, and *Metschnikowia fructicola* UUPP 23067. Thyme, origanum, clove, orange, cumin, tea tree, and mint oils inhibited the fungi and yeasts actively [161].

The effects of the essential oils (EOs) of *Cuminum cyminum* on growth and aflatoxins production by *A. parasiticus* was evaluated. Minimal inhibitory concentrations (MICs) and minimal fungicidal concentrations (MFCs) of the EOs were determined. Determination of aflatoxin (AFB1, AFB2, AFG1, and AFG2) production was performed by immunoaffinity column extraction using reverse phase-high performance liquid chromatography. *Cuminum cyminum* oil exhibited strong activity (MIC_{90}: 1.6; MFC: 3.5 mg/ml) against *A. parasiticus*. Aflatoxin production was inhibited at 0.25 mg/ml of *Cuminum cyminum* [162].

The potential of *Cuminum cyminum* (cumin) seed essential oil (EO) (as a plant based shelf life enhancer) was studied against fungal and aflatoxin contamination and lipid peroxidation. The EO showed efficacy as a preservative in food systems (stored wheat and chickpeas). The minimum inhibitory concentration and minimum aflatoxin inhibitory concentration of EO were 0.6 and 0.5 µl/ml respectively. The EO showed toxicity against a broad spectrum of food borne fungi. The antifungal action of EO on ergosterol content in the plasma membrane of *A. flavus* was determined. As a fumigant in food systems, the EO provided sufficient protection of food samples against fungal association without affecting seed germination. In view of the antifungal and antiaflatoxigenic nature, free radical scavenging potential and efficacy in food system, cumin seed EO may be able to provide protection of food commodities against quantitative and qualitative losses, thereby enhancing their shelf life [163].

The *in vitro* antifungal activities of essential oil from *Cuminum cyminum* were studied against *C. albicans* ATCC 14053, *C. dubliniensis* ATCC CD60, *C. glabrata* ATCC 90030, *C. krusei* ATCC 6258 and *C. parapsilosis* ATCC 22019. *Cuminum cyminum* oil had a broad-spectrum antifungal activity against different pathogenic Candida species. Inhibition zone values were ranged from 7 to 50mm against the tested organisms. The best minimal inhibitory concentration (MIC) of *Cuminum cyminum* oil was recorded against *C. albicans* and *C. dubliniensis* (289 mg/l) [164].

The antifungal activity of cumin oil was evaluated on mycelia growth of 90 fungal isolates (eighty-seven species and 3 species varieties belonging to 32 genera). The agar-well diffusion method was used to evaluate fungal growth inhibition at a concentration of 100%. Cumin oil was highly effective against all the isolates of tested fungi. It was completely inhibited mycelial growth of all fungi when added to solid medium [165-166].

Cupressus sempervirens

The antifungal activities of water and chloroform extracts of *Cupressus sempervirens* were carried out against *Aspergillus niger* and *Candida albicans*. However, water extract showed no activity against fungi and chloroform extract showed mild activity against *Candida albicans* (3mm) [167].

The antimicrobial activity of *Cupressus sempervirens* essential oil was studied against *Aspergillus niger, Candida albicans* and *Trichoderma reesei*. The results revealed that the oil of *Cupressus sempervirens* inhibited the growth of susceptible filamentous fungi and yeasts. MIC/MCC ratio confirmed a fungicidal activity of the essential oil [168].

The zone of inhibition of 2 and 4 µl/disc of essential oil of *Cupressus sempervirens* against the tested microorganisms were (respectively): *Saccharomyces cerevisiae* 9 and 10; and *Klyveromyces fragilis* 15 and 17 mm [169].

The essential oil of *Cupressus sempervirens* was tested against seven fungi *(A. niger, A. flavous, A. fumigatus, F. solani, F. oxysporium, P. digitatum,* and *C. terus*). The zone of inhibition of essential oils after 96 hr incubation was 5.7 mm against *F. solani* to 29 mm against *P. digitatum* [170].

The *in vitro* antifungal activity of the essential oil samples of *Cupressus sempervirens* were evaluated against 8 cultivated crop fungi (*Fusarium culmorum*, *Fusarium oxysporum*, *Fusarium equisiti*, *Fusarium*

verticillioides, Fusarium nygamai, Botrytis cinerea, Microdochium nivale var. nivale and *Alternaria* sp), and all samples of essential oil of *Cupressus sempervirens* have shown a significant antifungal activity against all tested fungi [171].

Essential oils isolated from *Cupressus sempervirens* var. *dupreziana* leaves were tested for antifungal activity against 10 agricultural fungal species (*Gibberella avenacea, Fusarium culmorum, Fusarium oxysporum, Fusarium subglutinans, Fusarium verticillioides, Fusarium nygamai, Rhizoctonia solani, Microdochium nivale, Alternaria alternate*n and *Fusarium culmorum*). Results of *in vitro* antifungal test assays showed that oils significantly inhibited the growth of 10 plant pathogenic fungi [172-173].

Cydonia oblonga

The antifungal effects of ethanolic and acetonic extracts of *Cydonia oblonga* leaves were studied against *Aspergillus niger*. The results showed that the *Cydonia oblonga* extracts inhibited the growth of A. niger and ethanolic extract was more effective than acetonic extracts [174-175].

Cymbopogon schoenanthus

The antimicrobial activity of *Cymbopogon schoenanthus* was evaluated against five common fungal species (*A. flavus, A. niger, C. spicifer, F. dimerum, M. circinelloides*), four crop threatening pathogenic fungi, (*Alternaria alternata, Cochliobolous spicifer, Stachybotrys atra* var microspora, and *Ulocladium botrytis*), as well as dermatophytic fungi (*Candida albicans, Candida tropicalis, Candida krusei, Epidermophyton floccosum, Trichophyton rubrum, Trichophyton mentagrophytes, Trichophyton verrucosum* and *Microsporium canis*). The aqueous extract of *Cymbopogon schoenanthus* showed antimicrobial activity against the tested fungi, while *F. dimerum, U. botrytis, C. albicans, C. tropicalis, E. floccosum* and *M. canis* tolerated the aqueous extracts. The organic extracts (methanol, ethylacetate and n-butanol) were more effective than the aqueous extract, they showed higher antifungal activity against the tested fungi, but *A. flavus, F. dimerum, S. atra var. microspora, C. albicans, C. tropicalis, C. krusei, E. floccosum, M. canis, T. rubrum* and *T. verrucosum* tolerated these extracts [176-177].

Cynodon dactylon

The antimicrobial activity of ethanol, methanol, acetone, chloroform, hexane and petroleum ether extract of *Cynodon dactylon* was tested against fungi (*Aspergillus niger, Candida albicans, Candida kefyr* and *Candida tropicalis*) using the agar well diffusion method. It was observed that ethanol, methanol, acetone, chloroform, hexane and petroleum ether showed activity against fungi. The ethanol extract of *Cynodon dactylon* showed more activity against *Aspergillus niger* (zone of diameter 12.23±0.21mm) and *Candida albicans* (zone of diameter 11.0±0.20mm), when compared to other solvent extracts [178-179].

Cyperus rotuntdus

The oil of *Cyperus rotundus* was tested against various fungal strains (*Candida parapsilosis, Aspergillus flavus, Aspergillus fumigatus* and *Fusarium oxysporum*) in different concentrations. Oil showed good antifungal activity against *Candida parapsilosis* and *Aspergillus fumigatus*. It also inhibited spore formation of *Fusarium oxysporum* and *Aspergillus flavus* [180].

Antimicrobial activity of *Cyperus routunds* ethanolic extract was carried out on fungi (*Candida albicans* and *Aspergillus niger*). Ethanolic extract caused 90 % inhibition of *A. niger*, while no zone of inhibition was observed against *C. albican* [181-182].

Dactyloctenium aegyptium

Dactyloctenium aegyptium aerial parts were investigated against fungal strains [*Aspergillus fumigates* (RCMB 02568) and *Candida albicans* (RCMB 05031)]. The ethyl acetate extract was the most active against *C. albicans* compared to that of *n*-butanol [183].

The ethanolic extract of *Dactyloctenium aegyptium* possessed antifungal activity against *Aspergillus niger* [184].

Datisca cannabina

The antimicrobial activity of crude extracts of plants and pigments of *Datisca cannabina* were investigated against *Candida albicans* (ATCC 10231) and *Aspergillus niger* (ATCC 16404). Results revealed that the dyes exerted antifungal effects. The lowest MIC value (78 g/ml) was obtained against *A. niger* [185].

Datura metel

The hexane, chloroform, acetone and methanolic fractions of the plant. were investigated for antifungal properties using pathogenic species of Aspergillus (*A. fumigatus, A. flavus* and *A. niger*). The chloroform fraction was found to be endowed with antifungal activity. The minimum inhibitory concentration

(MIC) of chloroform fraction was 625.0 microg/ml against all the three species of Aspergillus, by microbroth dilution and percent spore germination inhibition assays. The MIC by disc diffusion assay was observed to be 12.5 microg/disc. The chloroform fraction of the pant, when investigated for potency, turned to be 9.2 times less active than amphotericin B [186].

2beta-(3,4-dimethyl-2,5-dihydro-1H-pyrrol-2-yl)-1'-methylethyl pentanoate isolated from the leaves of *Datura metel* was endowed with antifungal activity and its MIC was found to be 87.5 microg/ml [187-188].

Datura stramonium

All the extracts of *Datura stramonium* (chloroform and ethanol extracts of branches and leaves) possessed significant antifungal activity against *Saccharomyces cerevisiae, Aspergillus fumigatus* and *Aspergillus niger* with maximum antifungal activity against *S. cerevisiae* and zone of inhibition was about 16±0.2mm by ethanol extract, 15±0.3mm by chloroform and 14±1.6mm by benzene extract, while minimum antifungal activity was observed against *A. niger*[189].

The antifungal effect of methanol extract from flower, seed and leaf of explant callus was studied against four fungi strains (*Fusarium semithectum, Fusarium colmorum, Ceratocystis ulmi* and *Rhizoctoina solani*). The methanolic extract of the vegetative root and the flower of *Datura stramonium* showed an effective antifungal activity against *Rhizoctonia solani* fungus [190].

The antifungal effects of acetone extracts of *Datura stramonium* seeds were studied against selected phytopathogenic fungi (*Penicillium janthinellum, Penicillium expansum, Aspergillus niger, Aspergillus parasiticus, Colletotrichum gloeosporioides, Fusarium oxysporum, Trichoderma harzianum, Phytophthora nicotiana, Pythium ultimum* and *Rhizoctonia solani*). Extracts exhibited moderate to good antifungal activity, with minimum inhibitory concentrations ranged from 0.125 mg/ml to 2.50 mg/ml [191].

Aqueous and ethanolic extracts of various parts of *Datura stramonium* were examined for their potential antifungal activity against pathogenic fungi such as *Aspergillus flavus*- 525, *Aspergillus niger* (local isolate), *Candida albicans*-3100 and *Rhizopus stolonifer* (local isolate).The results showed that the ethanolic extracts were more potent than the aqueous extracts. Aqueous extract of te leaves showed antifungal activity against *Candida albicans* (10mm) [192].

Four sesquiterpenes daucane esters, one polyacetylene, one sesquiterpene coumarin, and sitosterol glucoside isolated from the roots of the wild *Daucus carota* ssp carota, showed antifungal against *Fusarium oxysporum* and *Aspergillus niger*[193].

The antifungal activity of the essential oils of the flowering and mature umbels with seeds of wild *Daucus carota* L. subsp. carota from two different sites in Tunisia, were assayed by using the broth dilution method on clinical strains of *Candida albicans* and *C. tropicalis* 1011 RM. The MIC values obtained were > 2.5% (v/v) [194].

The *in vitro* antimicrobial activity of essential oils of *Daucus carota* seeds was evaluated, using the disk-diffusion method, against pathogenic yeast (*Candida albicans*). The essential oils exhibited antifungal activities against the assayed microorganism [195].

The antimicrobial activity of the essential oil of *Daucus carota* subsp carota from Portugal was evaluated against *Cryptococcus neoformans*, dermatophytes, and *Aspergillus* strains. The results showed a significant activity towards *Cryptococcus neoformans* (0.16 µl/ml), and dermatophytes (0.32–0.64 µl/ml). The inhibition of the germ tube formation and the effect of the oil on *Candida albicans* biofilms were also unveiled. The oil inhibited more than 50% of filamentation at concentrations as low as 0.04 µl/ml (MIC/128) and decreased both biofilm mass and cell viability [196].

The antifungal effect of wild *Daucus carota* extracts seed (70% and 40% ethanol) were examined against fungi (*Candida albicans ATCC 10231, Candida utilis Lia-01, Saccharomyces cerevisia ATCC 9763* and *Aspergillus brasiliensis ATCC 16404*). The extracts were active against one strain of yeast with MIC: 3.125-6.25 mg/ml [197].

A strongest antifungal activity was observed for carotol, the main sesquiterpenic compound in the carrot seed oil, it inhibited the radial growth of *Alternaria alternata* by 65% [198].

Desmostachya bipinnata

Ethanolic extract of Desmostachya bipinnata also exerted antifungal effect against Candida tropicalis, Candida albicans, Aspergillus fumigates, Aspergillus flavus and Pencillium chrysogenum[199-200].

Dianthus caryophyllus

Two benzoic acid derivatives, protocatechuic acid (3,4- dihydroxybenzoic acid) and vanillic acid (4-hydroxy-3-methoxybenzoic acid), isolated from *Dianthus caryophyllus* were slightly inhibitory towards *F. oxysporum*, while the highly resistant cultivar "Roland" showed the presence of the flavone datiscetin (3,5,7,2'-

tetrahydroxyflavone). which exhibited an appreciable fungitoxic activity towards *F. oxysporum* f. sp. dianthi [201-202].

Dodonaea viscose

The minimum inhibitory concentration and the time taken by *Dodonaea viscosa* var. angustifolia (PLE), chlorhexidine gluconate (CHX) and triclosan (TRN) to kill *Candida albicans* was investigated *in vitro*. 41 strains of *Candida albicans* were used, 20 from HIV-positive patients, 20 from HIV-negative subjects and one *Candida albicans* ATCC 90028. The MICs of an acetone extract of PLE, CHX and TRN were measured using a microtitre double dilution technique, and the time taken to kill 99.5% of the strains was determined. The MICs of PLE, CHX and TRN were 6.25–25, 0.008–0.16 and 0.0022–0.009 mg/ml, respectively. PLE killed all the test strains within 30 s and CHX 40% of the isolates from HIV-positive patients and 20% of strains from HIV-negative subjects in 1 min. During the same time TRN killed 55% and 35% of isolates from HIV-positive and HIV-negative patients [203-204].

The antimicrobial activity of *Dodonaea viscosa* leaf, stem and root using aqueous, methanol and chloroform solvents was studied using disc diffusion method. Regarding the antifungal efficacy of different parts of the plant, maximum efficacy was recorded for the methanol extract. Other solvents like aqueous and chloroform extract showed poor zone of inhibition or no effects. The methanol extract of leaf of the plant showed maximum activity against *Curvularia lunata* and *Fusarium oxysporum*. The methanol extract of root of the plant showed maximum activity against *Aspergillus flavus*, while, the methanolic extract of stem of the plant showed maximum activity against *Penicillium citrinum*. However no significant activity was recorded against *Aspergillus niger* by all extracts studied [205].

The inhibitory effects of the aerial plant part (leaves and bark) extracts of *Dodonaea viscosa* before and during flowering were evaluated against some fungi. Ethanolic extracts of the bark was superior to leaf extracts in the its inhibitory effects on the growth of *C. albicans*. No significant differences between concentrations of 30, 40 or 50 mg/ml were recorded [206].

Antifungal activity of solvent extracts of leaves and shoot of *Dodonaea viscosa* was studied against fungi, *Aspergillus niger, Aspergillus flavus, Paecilomyces varioti, Microsporum gypseum, and Trichophyton rubrum* causing skin diseases. All crude extracts were found to be effective against the tested fungi. However chloroform has strong inhibitory activity against fungi as compared to ethanol, methanol, ethylacetate and aqueous extracts. The maximum inhibitory activity of the ethanol extract was observed against *P.variety, T. rubrum* and *M. gypseum* 81.82%, 80% and 73.34% respectively, while, it possessed moderate inhibitory activity against *A.flavus* 65.72% and minimum inhibitory activity against *A.niger* 62.5%. The maximum inhibitory activity of the ethyl acetate extract was observed against *T. rubrum, M. gypseum* and *P. varioti* 80%, 73.34 and 63.64% respectively, while it possessed moderate inhibitory activity against *A. flavus* 57.15 and minimum inhibitory activity against *A.niger* 50%. The maximum inhibory activity of the chloroform extract was recorded against *P.varioti T. rubrum* and *M. gypseum* 90.91%, 80% and 73.34% respectively, while it exerted moderate inhibitory activity against *A.flavus* 71.41% and minimum inhibitory activity against *A.niger* 50%. The maximum inhibitory activity of the methanol extract was observed against *P.varioti* and *T.rubrum* 81.82 and 80%, while, it possessed moderate inhibitory activity against *A.niger* and *A.flavus* 62.5% and 57.15% respectively and minimum inhibitory activity against *M.gypseum* 53.34%. The maximum inhibitory activity of the aqueous extract was observed against *P.varioti, T.rubrum* and *A.niger* 81.82%, 80% and 75%, while, it exerted moderate inhibitory activity against *M.gypseum* 60% and minimum inhibitory activity against *A. flavus* 57.15% [207].

The fractions derived from hydroalcoholic extract of *Dodonaea viscosa* leaves was evaluated against *Candida albicans* (Cl. I. 4043). With the exception of aqueous fraction, all the fractions exhibited anticandidal activities (zone of inhibition $\geq$ 10 mm). The MIC of n-hexane fraction was 62.5 µg/ml [208].

***Dolichos lablab* (*Syn*: *Lablab purpureus*)**

The antimicrobial activity of crude extracts (chloroform, n-hexane, ethyl acetate) of leaves of *Lablab purpureus* L. were studied using disc diffusion technique against *Saccharromyces cerevaceae, Candida albicans* and *Aspergillus niger*. The extracts showed moderate to good antifungal activity with an average 9 -15 mm zone of inhibition[209].

A protein, dolichin isolated from *Dolichos lablab*, exhibited antifungal activity against Fusarium oxysporum, Rhizoctonia solani, and Coprinus comatus [210].

A 36-kDa alpha-amylase inhibitor was isolated from *Lablab purpureus*. It inhibited the alpha-amylases from several fungi but had little effect on those from animal and plant sources. The protein inhibited conidial germination and hyphal growth of A. flavus. It also agglutinated papain-treated red blood cells from human and rabbit [211-212].

Echinochloa crus-galli

A novel antifungal peptide EcAMP1 was isolated from kernels of *Echinochloa crus-galli*. The peptide adopted a disulfide-stabilized α-helical hairpin structure in aqueous solution, it represented a novel fold among naturally occurring antimicrobial peptides. Micromolar concentrations of EcAMP1 were shown to inhibit growth of several fungal phytopathogens The EC_{50} values were in the range of 1–10 μM. *F. graminearum* and *F. solani* were the most affected species (EC_{50} of ~ 4 μM), whereas *F. oxysporum* appeared to be the least affected. *P. betae* was also highly susceptible to the peptide action (EC_{50} of ~ 6 μM). EcAMP1 also inhibited germination of *A. alternata*, A. *solani*, and *B. sorokiniana* spores and of *P. infestans*, *P. debaryanum*, and *P. ultimum* zoosporangia with EC_{50} in the range of 10–20μM. The peptide induced morphological changes in some of the affected fungi only at higher concentrations (~ 20 μM). *A. niger*, *C. graminicola*, *D. maydis*, and *T. album* all insensitive to the peptide [213-214].

Echium italicum

The antifungal activity of *Echium italicum* oil was studied against *Aspergilus niger* PTCC 5011 and *Candida albicans* PTCC 5027 using the disk diffusion method. *Echium italicum* oil exhibited concentration-dependent antimicrobial activity against the tested fungi [215-216].

Ephedra alata* and *Ephedra foliate

The activity of different extracts of *Ephedra alata* stem was investigated against yeast and fungi. Four fungi, *Aspergillus fumigatus*, *Penicillium italicum Syncephalastrum racemosum*, and *Candida albicans* were used as test microorganisms. Acetonitrile extracts exhibited the most potent antimicrobial effect with a broad spectral range. Thin layer chromatographic separation of active constituents in acetonitrile extracts revealed the presence of seven fractions. All fractions showed antimicrobial activities with four fractions having a potent inhibitory effect [217].

The use of *Ephedra alata* extracts significantly decreased the total lipid, sterols, neutral lipids, phospholipids and fatty acid content of *Aspergillus flavus*. These effects could be represented the mechanism of antifungal activities of *E. alata* [218-219].

Equisetum arvense

The antifungal activity of the *Equisetum arvense* oil was studied against *Aspergillus niger* and *Candida albicans*. The 1:10 dilution of the essential oil of *Equisetum arvense* possessed a dood activity against all the tested fungi [120-221].

Erigeron canadensis

The whole plant was extracted with 80% ethanol and the extract was suspended in water and fractionated with n-hexane, chloroform and ethyl acetate. Two isolated compounds (conyzolide and conyzoflavone) were studied for antifungal effects, against six fungal strains included *T. longifusus* (clinical isolate), *C. albicans* ATCC 2091, *A. flavus* ATCC 32611, *F. solani* 11712 *and C. glaberata* ATCC 90030. Both compounds exhibited significant antifungal activities against the tested fungi. Conyzoflavone also possessed antifungal activity, *T. longifusus* and *C. albicans* were the most susceptible fungal pathogens to conyzoflavone. On the other hand, conyzolide showed comparatively weak antifungal activity [222].

The crude methanolic extract of the plant and its various solvent fractions were evaluated for antifungal effects against *C. albicans, A. niger, M. canis, F. solani* and *C. glabarata*. The maximum fungicidal effect against *C. albicans* was produced by ethyl acetate extract followed by chloroform and methanol extracts with percent inhibitory activity 45, 40 and 35 respectively. The ethyl acetate and chloroform fractions were the most effective against *A. niger* with percent inhibitory activity of 40 and 35% followed by methanolic extract and *n*-hexane with percent inhibitory effect of 30 and 25% [223-224].

The fungistatic activities of the oil of *Erigeron canadensis* were investigated by agar-diffusion method, against *Candida albicans* (UK-NEQUAS4661), *Candida glabrata* (ATCC90030), *Candida parapsilosis* (ATCC22019), *Candida tropicalis* (UK-NEQUAS4893), *Cryptococcus neoformans* (INF5855) reference fungal strains, and Candida kefyr, *Rhodotorula glutinis*, *Trichophyton interdigitalis* and *Aspergillus fumigatus* fungal strains isolated from patients. The oils exhibited moderate-to-strong activity against all fungi with the only exception of *A. fumigatus*. The MIC values varied from 1.25 μg/ml to 20.00 μg/ml for the tested fungal strains. The highest antifungal potency was exhibited by herb and root oils against *Cryptococcus neoformans* with MIC value of 1.25 μg/ml. In addition, substantial efficacy (MIC = 2.50 μg/ml) was detected against other Candida strains (*C. glabrata*, *C. tropicalis*) and *Rhodotorula glutinis* [225].

Essential oil of *Erigeron canadensis* at a concentration of 1600 ppm possessed 22.35±3.63, 12.71±1.28 and 29.27±1.22% inhibition of fungal growth of *R. solani, F. solani* and *C. lindemuthianum* respectively [226].

Erodium cicutarium

The essential oils of *Erodium cicutarium* were tested as antifungal agent. MIC of *Erodium cicutarium* against *A. restrictus* was 0.078 mg/ml, *A. chrysogenum* 0.156 mg/ml, *A. fumigatus* 0.156 mg/ml, and *C. albicans* 0.325 mg/ml and *C. albicans* 0.325 mg/ml [227-228].

Eryngium creticum

The antifungal effect *Eryngium creticum* aqueous extracts (15 micrograms/ml medium) was investigated against *M. canis, T. mentagrophytes* and *T. violaceum*. The percentage of mycelial inhibition was 12.4±4.26, 56.6±7.41 and 38.8±7.98% for the three fungi, respectively [229-230].

***Eucalyptus* species**

The *in vitro* antifungal activity of the essential oil and methanol extracts of *Eucalyptus largiflorens* (*Eucalyptus bicolor*) was studied against *Aspergillus niger* ATCC 16404 and *Candida albicans* ATCC 10231. The essential oil of *Eucalyptus largiflorens* exhibited moderate to high activity against yeast and mold tested [231-232].

Methanolic leaf extracts of *Eucalyptus camaldulensis* were investigated for *in vitro* antifungal activities against *Microsporum canis, Microsporum gypseum, Tricophyton rubrum, Tricophyton schoenleinii, Tricophyton mentagrophytes* and *Epedermophyton floccosum*. *Eucalyptus camaldulensis* showed antifungal activity against all the tested dermatophytes with MIC values ranging from 0.4 to 1.6 mg/ml [233].

The essential oils of *Eucalyptus camaldulensis* were screened for their antifungal activities against common phytopathogenic fungi using the paper disk diffusion method, they showed activity at low doses against the tested fungi [234].

The antifungal activity of the *Eucalyptus microtheca* leaves crude aqueous, ethanolic and methanolic extracts were tested *in vitro* by agar well diffusion method against *Penicillium digitatum* and *Aspergillus niger*. Alcoholic extracts significantly inhibited the mycelial growth of *P. digitatum* and *A. niger* more than aqueous extracts. Methanolic extracts showed higher inhibition activity than ethanolic extracts [235].

The antimicrobial properties of aqueous and alcoholic extracts of Eucalyptus leaves was investigated against *Candida albicans*. At 100 and 150 mg/ml the alcoholic and the aqueous extracts showed more potent effect than 2mg/ml chlorhexidine against *Candida albicans*. Minimum bactericidal concentration for the aqueous extract was 3-7mg/ml, while that of alcoholic extract was 2-6mg/ml against *Candida albicans* [236].

Eupatorium cannabium

Different extracts of *Eupatorium cannabium* (chloroformic, water and hydroalcoholic extract) were tested for their antifungal activity against *Candida albicans* and *Aspergillus niger*. The chloroformic and hydroalcoholic extracts of the *Eupatorium cannabium* showed inhibitory activity against *Candida albicans*, while, no clear inhibition have been noticed against *Aspergillus niger*[237].

The essential oil of *Eupatorium cannabinum* possessed fungicidal action against *Aspergillus niger*, and fungistatic effect against *Trichoderma lignorum* and *Fusarium oxysporum* [238-239].

Euphorbia hirta

The antifungal study showed that the leaf extract of *Euphorbia hirta* inhibited the growth of *C. albicans* and *T. mentagrophytes* with activity index of 0.4 and 0.2 respectively [240-241].

The antifungal activity of aqueous and organic solvent (acetone, chloroform, benzene, butanol, ethanol, dimethylformamide and diethyl ether) leaf extracts of *Euphorbia hirta* were studied against *Aspergillus niger, Aspergillus flavus, Aspergillus fumigatus, Aspergillus erythrocephalus* and *Fusarium* spp. Dimethyl formamide extract showed the highest activity against *Aspergillus niger* (10mm), butanol extract showed the highest activity against *Aspergillus flavus*(12mm), ethanol extract showed the highest activity against *Aspergillus fumigates* (13mm) and benzene extract showed the highest activity against *Aspergillus erythrocephalus* (16mm) [242].

The antimicrobial activity of supercritical fluid crude extracts of the leaves of *Euphorbia hirta* was studied against *Aspergillus niger* and *Candida albicans*. *Euphorbia hirta* extract showed antifungal activities, the diameters of zone of growth inhibition were *A. niger* 7.75 and *C. albicans* 9.25 mm [243].

The ethyl acetate extract of the inflorescence of *Euphorbia hirta* was tested for antifungal activity against *Aspergillus flavus,* it exhibited antifungal effects mediated by damaging of the cell membrane which could result in leakage of cellular proteins [244].

***Euphorbia tinctoria* (syn: *Euphorbia macroclada*)**

The antifungal effects of *Euphorbia macroclada* methanol extracts of the flowering branches was studied against 3 yeasts (*Candida albicans* FMC 17, *Candida glabrata* ATCC 66032, *Candida*

tropicalis ATCC 13803), and 2 dermatophyte species (*Trichophyton* sp., *Epidermophyton* sp.). Inhibition zone diameter (mm) of *Euphorbia macroclada* methanolic extracts of the flowering branches were: *Candida albicans* : 12±0.33, *Candida glabrata* : 11±0.57, *Candida tropicalis* : 13±0.33, *Trichophyton sp*: 23±0.57 and *Epidermophyton sp*.: 23±0.57 mm. The inhibition zone diameter (mm) for *Euphorbia macroclada* latex (500µg/disc) were *C. albicans:* 21±1.15, *C. glabrata:* 15±1.15, *C. tropicalis:* 15±1.15, *Trichophyton* sp.: 15±1.15 and *Epidermophyton* sp.: 8±0.33. The MIC values of *Euphorbia macroclada* methanolic extract of the flowering branches were: *C. albicans*: 2.5, *C. glabrata*: 50, *C. tropicalis* 100, *Trichophyton sp.*: 50 and *Epidermophyton sp.*: 50 µg[245].

The antifungal activities of *Euphorbia macroclada* latex and fluconazole were studied against 150 *Candida* species including *C. albicans*, *C. glabrata*, *C. parapsilosis*, *C. tropicalis*, *C. krusei*, *C. famata*, *C. kefyr* and *C. inconspicua*. The latex of *Euphorbia macroclada* inhibited the growth of 30 out of 150 tested *Candida* isolates with MIC range of 128-512 µg/ml. These isolates were as follows: *C. albicans* (n=2), *C. glabrata* (n=4), *C. parapsilosis* (n=19), *C. krusei* (n=2) and *C. tropicalis* (n=3). Compared to other isolates, higher MIC values noted for *C. albicans* and *C. glabrata* was (512 µg/ml) [246].

Antifungal effect of *Euphorbia macroclada* extracts was studied against the fungi *Verticillium dahliae*, *Fusarium oxysporum*, *Rhizopus stolonifer*, *Penicillium italicum*, *Rhizoctonia solani*, *Alternaria solani*, *Stemphylium solani*, *Cladosporium* sp., *Mucor* sp., and *Pythium* sp. The strongest inhibitory effect of the extracts was observed against *R. solani*, *V.dahliae*, *F. oxysporum*, *Pythium* sp. and *R. stolonifer*, and the weakest effect was recorded against *A. solani*. Extracts from the stems had a stronger inhibitory effect than those from the flowers or leaves. Butanol was superior to chloroform, water and petroleum ether to extract antimicrobial compounds from leaves, stems and flowers [247].

Fagopyrum esculentum

An antifungal peptide with a molecular mass of approximately 4 kDa was isolated from buckwheat. It inhibited mycelial growth of *Fusarium oxysporum* and *Mycosphaerella arachidicola* with an IC_{50} of 35 and 40 microM, respectively. Its antifungal activity was stable between 0 and 70 degrees C, and between pH 1.0/2.0 and 13 [248-249].

Ficus carica

Methanolic, hexanoïc, chloroformic and ethyl acetate extracts of *Ficus carica* latex were investigated for their *in vitro* antimicrobial proprieties against seven strains of fungi. Ethyl acetate and chlorophormic fractions showed a very strong inhibition (100%); methanolic fraction totally inhibited *Candida albicans* (100%) at a concentration of 500 microg/ml, but showed negative effect against *Cryptococcus neoformans*. *Microsporum canis* was strongly inhibited by methanolic extract (75%) and totally with ethyl acetate extract at a concentration of 750 microg/ml. Hexanoïc extract showed medium results [250].

Ficus carica has also evaluated for antifungal activities. A low-molecular-weight protein, isolated from freshly collected latex of the *Ficus carica* was found to possess antifungal activity [251-252].

Ficus religiosa

The antimicrobial activity of the aqueous extract of bark leaf, stem, fruit of *Ficus religiosa* was determined by disc diffusion method against *Aspergillus niger* and *Candida albicans*, The highest zone of inhibition (10-15 mm in diameter) was observed in 100 mg/ml concentration against the tested fungi [253-354].

The oil leaf of *Ficus religiosa* was screened for antifungal activity against *Aspergillus niger* and *Candida albicans*. It was s inactive (MIC = 2500 µg/ml) against *Aspergillus niger*, but marginally active (MIC = 625 µg/ml) against *Candida albicans* [255].

Foeniculum vulgare

Essential oil was investigated for its antifungal activity against *Aspergillus niger* , *Candida albicans* and *Rhizopus stolonifer*. The *Foeniculum vulgare* essential oil showed the diameter of inhibition zone ranging from 19.4 ± 0.07 - 26.4 ± 0.09 mm at a concentration level of 28 µg/disc against strains tested. The minimum inhibitory concentration (MIC) of essential oil against fungal strains was obtained in the range of 7.0 - 56 µg/ml[256-257].

The antimicrobial effect of organic and aqueous leaves extracts of *Foeniculum vulgare* was studied against *Candida albicans*. The aqueous extract was more better than the hexane and dichloromethane extracts against *Candida albicans* (ATCC and CBS) (MIC = 0.78 mg/ ml). *C. albicans* ATCC showed less sensitivity to the ethyl acetate extract[258].

The antifungal effects of *Foeniculum vulgare* were studied against *Aspergillus niger* , *Aspergillus flavus*, *Fusarium graminearum* . *Foeniculum vulgare* showed antifungal activity at a dose of at 4 µl dose. It

was effective against *A. niger* even at 4 µl dose. Moreover, with the using food poison technique, the volatile oil and extract both showed good to moderate zone of inhibition[259].

The *in vitro* antifungal activity of *Foeniculum vulgare* essential oils was investigated against three *Candida albicans* strains of different origin using disc and well-diffusion and microdilution method, and compared to Nystatine and Fluconazole as standard anti-mycotics. The results indicated that the studied essential oils showed antifungal activity against all three isolates of *C. albicans* (MIC values:0.06mg/ml - 0.23mg/ml)[260].

Fraxinus ornus

The antimicrobial activity of the *n*-hexane fraction from the seeds of *Fraxinus ornus* L. was studied against *Asperagillius fumigatus* and *Candida albicans* . The *n*-hexane fraction from the seeds of *Fraxinus ornus* possessed antifungal activities. It exerted antifungal activity against both *C. albicans* and *A. fumigates*[261].

Fumaria officinalis

Disc diffusion and broth micro dilution methods were used to study the antifungal [*Candida albicans* and *Aspergillus niger*] activity of N-octacosan 7β ol isolated from the methanolic extract of whole plant of *Fumaria parviflora*. N-octacosan-7β-ol , possessed significant antifungal activity against *Candida albicans* and *Aspergillus niger in vitro* with MIC of 500 and 250 µg/ml respectively[262-263].

Galium aparine

The antifungal activities of *Galium aparine* herb lipophilic complex were investigated against *Candida albicans* 885-663. The results revealed that *C. albicans* (Zone of growth inhibition: 33.1±0.2 mm, Minimum inhibitory concentration 31.25 µg/ml and Minimum bactericidal concentration 62.50 µg/ml) were highly sensitive[264-266].

Galium verum

The antimicrobial activity of water , alcohol (70%) and chloroform extracts was investigated against *Candida albicans* 885-563. Alcoholic extract showed activity against *Candida albicans*, while, aqueous extracts possessed no antibacterial and antifungal activities[267].

Glossostemon bruguieri

The ethanolic extract of *Glossostemon bruguieri* showed antifungal activity. The zone of inhibition of the extract (5mg/ml in well of 6mm in diameter) against *Aspergillus flavus* was 11mm, *Aspergillus fumigates* 11mm and *Penicillium chrysogenum* 10mm[268].

Glycyrrhiza glabra

The antifungal effect of roots extracts of *Glycyrrhiza glabra* was investigated against *Aspergillus awamorii* and *Rhizopus spp*. The methanolic extract of *G. glabra* showed maximum antifungal activity against *Rhizopus spp* at 500µg/ml (inhibition zone 11 mm)[269].

The antifungal activity of methanolic extract and different fractions (*n*-butanol, ethyl acetate, chloroform and *n*-hexane) of *Glycyrrhiza glabra* root was studied against *Aspergillus niger, Aspergillus flavus* and *Rhizopus solani* using disc diffusion method and minimum inhibitory concentration. 100% methanolic extract showed the least activity against A. *niger* and *R. solani* with the smallest inhibition zones (16.5 and 16mm) and the highest MIC values (150 and 152 mg/ml). 80% methanolic fraction showed magnificent activity against *A. niger* as compared to standard drug fluconazole[270].

The antifungal potential of the hydroalcoholic extract prepared from rhizomes and roots of *G. glabra*, was evaluated against 19 *Candida* strains, using the disc diffusion halo assay. The licorice extract was effective against all the tested *C. albicans, C. glabrata, C. parapsilosis* and *C. tropicalis* strains. The results for the inhibitory zones, at the tested concentration (50 mg/ml), after 24h, were 1.0 – 1.2 cm for *C. albicans* and *C. parapsilosis*, 1.0 – 1.3 cm for *C. tropicalis* and 1.2 cm for *C. glabrata* [271].

Gnaphalium luteoalbum

The acetone leaf extract of the leaves was assayed for antifungal effect against plant pathogenic fungi in vitro (Aspergillus parasiticus, Aspergillus niger, Colletotrichum gloeosporioides, Fusarium oxysporum, Penicillium expansum, Penicillium janthinellum, Phytophthora nicotiana, Pythium ultimum and Trichoderma harzianum). The acetone leaves extract of possessed strong antifungal activity and showed excellent efficacy against Phytophthora nicotiana and Fusarium oxysporum, with MIC values of 20 and 160 µg/ml respectively.The isolated compounds (5,4′-dihydroxy-6-methoxy-7-O- β-glucopyranoside flavone (hispidulin-

7-O-glucopyranoside) and stigmasterol-3-O- β-glucopyranoside) showed high activity against the selected fungal organisms with MIC values ranging from 0.02 to 1.25 mg/ml[272].

***Gossypium* species**

The anifungal activity of *Gossypium hirsutum* oils was investigated against , *Trichophyton rubrum* and *Candida albicans* by agar well diffusion method. *Gossypium hirsutum* oils possessed antifungal activity with diameter of inhibition of 10 and 10.16 mm against , *Trichophyton rubrum* and *Candida albicans* respectively at a concentration of 1 mg/ml[273].

Basic proteins isolated from seeds of cotton (*Gossypium hirsutum*) were found to have selective growth inhibitory activity in vitro against the filamentous fungi *Botrytis cinerea*, *Alternaria brassicicola*, *Chalara elegans* and *Fusarium oxysporum*. These proteins differ, however, from numerous other seed antifungal proteins in being neither substrates nor inhibitors of signal transduction elements such as wheat germ Ca^{2+}-dependent protein kinase (CDPK), rat liver cyclic AMP-dependent protein kinase (PKA) catalytic subunit (cAK), rat brain Ca^{2+}- and phospholipid-dependent protein kinase (PKC) and chicken gizzard calmodulin-dependent myosin light chain kinase (MLCK)[274-275].

***Haplophyllum* species**

Ethanolic extract of the aerial parts of *Haplophyllum tuberculatum* demonstrated an efficient anti-fungal activity against *Aspergillus fumigates, Geotricum candidum* and *Syncephalastrum racemosum* with (MIC 0.49, 0.12 and 1.95 µg/ml)[276].

The antifugal effect of polyphenolic and alkaloid extracts of the plant was investigated against *Aspergillus flavus* NRRL 3251T, *Aspirinillus parasiticus* CBS 100926T, *Aspirgillus fumigatus* and Mucor sp, all the tested microorganisms were resistant[277-278].

Hedera helix

The antifungal activity of triterpenoid saponins was investigated in vitro by the agar dilution method. Monodesmosidic hederagenin derivatives exhibited a broad spectrum activity against yeast as well as dermatophyte species. alpha-Hederin was the most active compound, and Candida glabrata was the most susceptible strain[279].

The mode of anti Candidal action of α-hederin, was investigated by a haploinsufficiency screen. Saponin cytotoxicity is often attributed to membrane damage, however α-hederin did not induce hypersensitivity with an aminophospholipid translocase deletion strain that is frequently hypersensitive to membrane damaging agents. The haploinsufficiency profile of α-hederin is most similar to that reported for drugs such as caspofungin that inhibit synthesis of the fungal cell wall[280-281].

Helianthus tuberosus

The extracts of and phenolic acids from Jerusalem artichoke (*Helianthus tuberosus*) leaves were investigated for antifungal effect and potential use in enhancing preservation of fruits and vegetables in storage. Either crude leaf extract or n-butanol fraction was active against *Botrytis cinerea, Colletotrichum gloeosporioides, Phytophthora capsici* Leonian and *Rhizoctonia cerealis*, with the values of IC_{50} ranging from 2.166 to 2.534 g/l for the crude leaf extract and 0.232–1.911 g/l for n-butanol fraction. The severity of grey mould caused by *B. cinerea* was significantly reduced by n-butanol fraction applied at 1 and 2 g/l (the control efficiency of 71.3% and 77.8%, respectively, compared with commercial preparation Carbendazim. Six phenolic acids were separated from n-butanol fraction. Among them, caffeic acid, 3,4-dicaffeoylquinic acid and 1,5-dicaffeoylquinic acid played a dominant role and were active in bioassays against Gibberella zeae, with respective minimum inhibitory concentrations (MIC) being 108, 60 and 4.2 µg/ml[282].

The antifungal activities of *Helianthus tuberosus* leaves extracts against Rhizoctonia solani, Gibberella zeae, Alternaria solani and Botrytis cinerea were tested. The results showed that the extracts exerted antifungal activity against Rhizoctonia solani, Alternaria solani and Botrytis cinerea, the inhibitory effects of aqueous extracts were significantly less than those of extracts of organic solvents, the extract of ethyl acetate possessed the highest inhibitory activity, and its lowest inhibitory rates were 77.91%, 100 and 100% to *Rhizoctonia solani, Alternaria solani* and *Botrytis cinerea* respectively at a concentration of 20 mg/ml[283-284].

Helicophyllum rauwolffii (Eminium rauwolffii):

The ethanolic *Eminium spiculatum* leave extracts showed antifungal activity against *C. tropicalis* with a diameter of growth inhibition of 12mm, *C. albicanus* 16mm, *C. dublicans* 14mm and *C. krusei* 15mm at concentration 10^{-1} and 12, 8, 11 and 13 mm at concentration of 10^{-3} against the same fungi [285].

The antimicrobial activity of the aqueous and ethanolic extracts of *Eminium spiculatum* was evaluated *in vitro* against *C. albicans*. Stem ethanolic extract exerted anti - *C. albicans* effect with a diameter of inhibition of 25.0 ± 2.0mm[286].

***Heliotropium* Species:**

The antifungal effects of leaves, flowers, and stem extracts of *Heliotropium bacciferum* were against five fungal strains [*Aspergillus niger, Aspergillus flavus, Aspergillus parasiticus, Aspergillus oryzae,* and *Aspergillus fumigates*]. All plant extracts exhibit a range antibacterial effects. Methanol, *n*-hexane, chloroform, ethyl acetate, and *n*-butanol extracts (15 μg) of leaves showed prominent activities against *Aspergillus niger* (17 ± 0.44 mm, 14 ± 0.52 mm, 12 ± 0.28 mm, 15 ± 0.43 mm, and 11 ± 0.43 mm), *Aspergillus flavus* (15 ± 0.38 mm, 17 ± 0.67 mm, 13 ± 0.53 mm, 17 ± 0.32 mm, and 14 ± 0.51 mm), and *Aspergillus oryzae* (11 ± 0.54 mm, 16 ± 0.68 mm, 16 ± 0.45 mm, 17 ± 0.83 mm, and 15 ± 0.57 mm), respectively. Plant methanol, chloroform, and *n*-butanol extracts (15 μg) of flowers revealed noteworthy activities against *Aspergillus niger* (14 ± 0.25 mm, 11 ± 0.26 mm, and 13 ± 0.47 mm) and *Aspergillus flavus* (17 ± 0.63 mm, 14 ± 0.46 mm, and 11 ± 0.23 mm), respectively. Significant activities were recorded by *n*-hexane and ethyl acetate extracts of plant flowers against *Aspergillus niger* (17 ± 0.63 mm and 16 ± 0.59 mm), *Aspergillus flavus* (15 ± 0.48 mm, 15 ± 0.59 mm), and *Aspergillus oryzae* (12 ± 0.27 mm and 15 ± 0.44 mm), respectively. Methanol and chloroform extracts (15 μg) of plant stem were active against *Aspergillus niger* (16 ± 0.54 mm and 15 ± 0.54 mm) and *Aspergillus fumigatus* (15 ± 0.51 mm and 14 ± 0.37 mm), respectively. Excellent activities were shown by *n*-hexane and ethyl acetate extracts (15 μg) against *Aspergillus flavus* (11 ± 0.31 mm and 18 ± 0.50 mm), *Aspergillus oryzae* (17 ± 0.54 mm and 15 ± 0.55 mm), and *Aspergillus fumigatus* (12 ± 0.33 mm and 16 ± 0.54 mm), respectively[287].

The crude (methanol fraction) and n-hexane, ethyl acetate, butanol and aqueous fractions of *Heliotropium bacciferum* were subjected to antifungal activities against Trichoderma longibrachiantum, Aspergillus flavus, Aspergillus niger, Fusarium solani and Candida albican. Excellent inhibitory effect was observed against all fungal strains. The minimum inhibitory concentrations (MICs) of the investigated plant fractions ranged from 0.5- 2.00 mg/ml[288].

Hibiscus rosa-sinensis

The antimicrobial activity of *Hibiscus rosa sinensis* extracts was examined against fungal strains by measuring zone of inhibition. The leaf extract showed high activity against *Candida parapsilosis* at a very low concentration (2.5µg/ml) compared to *Aspergillus niger*. Root extract showed high activity against *Candida parapsilosis* and *Aspergillus niger* at a very low concentration (2.5µg/ml) compared to *Trichophyton rubrum.* Flower extract also showed high activity against *Candida parapsilosis* and *Aspergillus niger* at a very low concentration (2.5µg/ml)[289-290].

The methanol, chloroform, n-hexane and aqueous extracts of *Hibiscus rosa-sinensis* (25, 50 and 100 mg/ml) showed antifungal activity against *C albicans* (12-20 mm), *A flavus* (10-17mm) and *C glabreta* (0-19mm). It appeared that the methanolic extract was the most potent antifungal extract, its diameters of inhibition for the concentration 100, 50 and 25 mg/ml were 15-19mm against *C glabreta*, 14-17 mm against *A flavus* and 15-20 mm against *C albicans*[291].

Hibiscus sabdariffa

The antimicrobial potential of leaves and seeds methanolic extracts of *Hibiscus sabdariffa* was studied against some fungal strains. The leaves methanolic extracts of *H. sabdariffa* showed an intermediate antifungal activity against two reference fungal strains (*Candida albicans* ATCC: 7596 and *Aspergillus niger* ATCC: 9765). The seeds methanolic extracts of *H. sabdariffa* did not show any activity against the tested fungal strains[292].

The antifungal effect of Hibiscus sabdariffa extract was evaluated against Candida albicans, and the biofilm forming capacity of Candida albicans strains in the present of the H. sabdariffa extract was also studied. The minimum inhibitory concentration values of Hibiscus sabdariffa extract were ranged from 0.5 to 2.0 mg/ml. Time-kill experiment demonstrated that the effect was fungistatic. Furthermore H. sabdariffa extract inhibited biofilm production of all the isolates[293].

The antifungal effect of *H. sabdariffa* extract, in combination with voriconazole or fluconazole was evaluated against *C. albicans* isolates. Six strains of fluconazole-resistant *C. albicans* isolates were obtained from patients with recurrent candiduria. When the extract was used in combination with voriconazole, a high degree of synergism was observed and it proved[294-295].

***Hyoscyamus* Species**

The methanolic extracts of the seeds of *Hyoscyamus niger* were investigated for anti fungal activity against six *Candida* species (*C. albicans* ATCC 10231, *C. tropicalis* ATCC 13808, *C. guilliermondii* ATCC

6260, *C. krusei* ATCC 20298, *C. glabrata* ATCC 2001 and *C. parapsilosis* ATCC 22019) and two *Cryptococcus species* (*C. neoformans* ATCC 90112 and *C. laurentii* ATCC 34142) The extract possessed strong antifungal potency. Greater activity was observed against both *Cryptococcus* species, with MIC values of 15 μg/ml[296].

The antifungal activity of a crude steroidal glycoside extract, fractions of spirostanoles and individual glicosides was investigated *in vitro* against [Eight reference yeast strains: *Candida albicans* ATCC 90029, *Candida albicans* Y0109, *Candida albicans* 38248, *Candida tropicalis* IP 1275-81, *Candida parapsilosis* ATCC 22019, *Candida glabrata* ATCC 90030, *Candida kefyr* Y 0106, *Candida krusei* ATCC 6258 and *Candida lusitaniae* CBS 6936; Dermatophytes (one isolate of each species: *Trichophyton mentagrophytes, Trichophyton rubrum, Trichophyton soudanense, Microsporum canis, Microsporum gypseum, Epidermophyton fl occosum,* and *Cryptococcus neoformans*; filamentous fungi (one isolate of each species: *Aspergillus fumigatus, Aspergillus fl avus,Scopulariopsis brevicaulis*)]. *In vitro* spirostanol fraction and glycosides showed a broad spectrum of antifungal activity. Only slight differences in their fungicidal profi les were observed[297-298].

Hypericum triquetrifolium

The essential oils of Hypericum triquetrifolium from five different Tunisian localities (Fondouk DJedid, Bou Arada, Bahra, Fernana and Dhrea Ben Jouder) were evaluated for their antifungal effects against (*Aspergillus niger, Fusarium solani, Botrytis cinerea, Candida albicans. Candida glabrata* and *Candida krusei*). The essential oils showed antifungal activity with MIC values ranging between 0.39 μg/ml and 12.50 μg/ml; MFC values ranged between 3.12 μg/ml and 25.00 μg/ml[299].

H. triquetrifolium showed anticandidal effect with diameter of growth inhibitionof (12 mm,40μg/disc)[300-301][(42)].

Inula graveolens

Anti-candida activity of the volatile oil of the aerial parts of *D. gravolence* against different isolates of *Candida albicans* was studied *in vitro* using serial dilutions of volatile oil in Sabouraud's dextrose agar MIC of the volatile oil for 10 *Candida albicans* isolates was 30.675 mg/ml[302-303].

Iris pallida

Iridal, a triterpenoidic compound was tested against *Candida albicans* and *C. parapsilosis* strains. The minimal antifungal inhibitory concentrations were higher than to 50 microg/ml, whatever the strain of yeast tested[304].

Jasminum officinale

The *Jasminum officinale* flowers extracts were evaluated for antifungal activity against *Candida albicans* and *Aspergillus niger*. Butanol fraction showed more activity than the standard drug with zone of inhibition of 20.9 ±1.2mm for *Candida albicans* and almost equal to the effect of the standard drug against *Aspergillus niger* with zone of inhibition of 18.2±1.1mm. Chloroform fraction showed moderate activity against both *Candida albicans* and *Aspergillus niger* with zone of inhibition of 13.1±1.3 and 12.3±0.6mm respectively, and n-hexane fraction showed very poor antifungal activity 2.1±1.3 3.2±1.8mm[305].

The antifungal activity of different solvent extracts (methanol, DCM) of the flowers and whole plant (leaves, barks and roots) was studied against two fungal species (*Candida albicans, Aspergillus niger*). Whole plant extract (methanol) showed significant antifungal activity with relative percentage of inhibition of 61.15, while flowers extract (methanol) showed 51.97 relative percentage of inhibition. The diameters of growth inhibition were 10.95-11.95mm against fungi for DCM flowers extract, 11.45-12.25mm for methanol flowers extract, whereas, the diameters of growth inhibition were 15.45-16.60 mm for DCM whole plant extract, and 16.15- 17.00 mm for methanol whole plant extract[306-307].

Jasminum sambac

The methanol extract and essential oil from the flowers and leaves of J. sambac were evaluated for antifungal activity against *Malassezia* sp. and non-*Malassezia* sp. isolated from human skin samples. The methanol extract of flowers and leaves of J. sambac and essential oil of flowers showed potential antifungal activity with inhibition zones of 11.10 ± 1.92, 12.90 ± 1.68, and 13.06 ± 0.26 mm, respectively, and minimum inhibitory concentration (MIC) values of 80mg/ml to 160mg/ml and 50%, respectively[308].

The methanolic leaves extract of Jasminum sambac showed antifungal activity against Alternaria sp isolated from foot infections in cancer patients, with a zone of inhibition of 40mm[309-310].

Juglans regia

The antifungal effects of an extract of the leaves of a walnut and several fractions obtained during the separation by column chromatography were studied against *Ascosphaera apis*. The antifungal activity was attributed mainly to juglonu and eugenol[311].

The antifungal potential of four extract fractions (methanolic, ethyl acetate, alkaloid, and hydrolyzed methanolic) of *Juglans regia* leaves was evaluated against 140 pathogenic *Candida albicans* isolate. Methanolic extract from walnut leaves characterized by the highest anticandidal activity, the alkaloid fraction possessed a slightly lower antifungal efficacy, while ethyl acetate and hydrolyzed methanolic preparates inhibited the growth rate of examined fungal pathogens in the lowest degree [312-313].

Juniperus communis

Many fractions as well as essential oil obtained from *Juniperus communis* were investigated against *Candida albicans*, *Alternaria* sp., *Aspergillus nidulans*, and *Aspergillus niger*, the essential oil, showed strong inhibitory effects to yeast and fungi[314-315].

Juniperus oxycedrus

The methanolic extract of the leaves of five plants included *Juniperus oxycedrus* was tested for their antifungal activities against *Alternaria tenuis, Aspergillus niger*, *Fusarium oxysporum* and *Penicillium coryophilum*. The methanol extract of *J. oxycedrus* leaves possessed highest inhibition (8.5 cm inhibition zone) against *A. tenuis*. *J. oxycedrus* leaf extract was more effective in decreasing the protein contents for all tested fungal species, it also stimulated fungal species to produce more sugars in the culture filtrates. The productivity of amylase and lactase enzymes by the tested fungal species were also inhibited[316].

Cade oil showed antifungal activity against against *Trichophyton rubrum* with MIC of 100 µg/ml[317].

Aqueous and methanol extracts of the leaves of *Juniperus oxycedrus* were investigated for antifungal activity against *Candida albicans*. The methanol extract had inhibitory effects on the growth of 11 *Candida albicans* isolates at a concentration of 31.25-250 micro g/ml[318-319].

Lagerstroemia indica

The antifungal effect of the methanol extract of Lagerstroemia indica leaves was evaluated against *Candida albicans* yeast (ATCC 10231). The minimum lethal concentration of the compound against C. albicans was (32 µg/ml)[320].

The antifungal activity of the barks, leaves and fruits of *Lagerstroemia indica* extracted by petroleum ether, chloroform, methanol and distilled water was studied against two fungal strains (*A. oryzae*and *A. niger*). A significant antifungal activity was exerted by all the extracts of *Lagerstroemia indica* against both fungal strains. The largest zone of inhibition (36 ± 3.21mm) against *A. oryzae*was exhibited by aqueous extract of bark, while the highest antifungal activity against *A. niger* (40.33 ± 0.88 mm) was possessed by chloroform bark extract[321].

Lagerstroemia speciosa

The various extracts of the fruits of *Lagerstroemia speciosa* (50, 100 and 150 µg/ml) were screened for antifungal activity. The extracts were active against all the tested fungi, MIC values against *A.niger* were (16-38 µg/ml), *A.flavus* (18-39 µg/ml) and *C.albicans* (16-38µg/ml)[322].

Lallemantia royleana

The methanolic seed extract of *Lallemantia royaleana* (100 µg, 200 µg, 300 µg and 500 µg) was tested against [*Aspergillus flavus* (NCIM 524), *A. niger* (NCIM 773), *A. parasitic* (NCIM 898),*Candida albicans* (NCIM 3471) and *Saccharomyces cervisiae* (NCIM 3090)**].**Almost all the fungal strains growth was found to be inhibited by the crude plant extract. The methanolic seed extract of *Lallemantia royaleana* showed inhibition in the growth of *Aspergillus flavus* and *Aspergillus parasiticus* at 200 µg concentration and more. *Saccharomyces cervisiae* growth was inhibited at 100 µg concentration, while the growth of *Aspergillus niger* was inhibited at 500 µg concentration. The *Candida albicans* strain showed significant growth inhibition in the presence of methanolic extract of *Lallemantia royleana* seed. The zone of inhibition was 6 mm, 8 mm, 12 mm and 14 mm at 100 µg, 20 µg, 300 µg and 500 µg concentrations of methanolic seed extract respectively[323].

The antifungal screening of the essential oil of *L. royleana* showed that the oil significantly inhibited the growth of *Candida albicans* and *Aspergillus niger* (MIC = 3.1 and 2.5 µg/ml, respectively)[324].

Lantana camara

The antifungal activity of the petroleum ether, methanolic extract and water extract of Lantana camara was investigated against *Candida albicans*. At conentration of 250 mg and more, petroleum ether and methanolic extracts of the leaves showed potent antifungal ativity[325].

The antifungal activity of crude methanolic and acetone extracts of *Lantana camara*, was studied against *Candida albicans, Candida tropicalis, Saccharomyces cerevisiae, Aspergillus niger, Aspergillus flavus, Penicillium spp., Fusarium oxysporum, Alternaria alternata, Sclerotium rolfsii* and *Curvularia lunata*. No inhibition zone was observed for any species of Candida sp. The fungitoxic spectrum of leaf and stem extracts indicated maximum percentage growth inhibition at 1000µg/ml concentration against *Alternaria alternate* [326].

Methanol, ethanol and water L. camara leaves extracts were evaluated against two fungal strains (*Aspergillus fumigatus* and *Aspergillus flavus*). The methanol leaf extract of L. camara exhibited significant inhibition (71%) and (66%) against *Aspergillus fumigatus* and *Aspergillus flavus* respectively[327].

The antifungal activities of the leaf extract of Lantana camara in different solvents (acetone, chloroform, ethanol and methanol) were studied against *Aspergillus flavus* and *Aspergillus niger*. Methanol leaf extract of L. camara showed broad antifungal activity against both fungal strains[328].

The antifunal efficacy of flavonoids (free and bound) and crude alkaloids of Lantana camara was studied against Candida albicans and Trichophyton mentagrophytes. C. albicans was the most susceptible microorganism followed by T. mentagrophytes[329].

Lawsonia inermis

The antifungal activity of methanol, ethanol and aqueous dried *Lawsonia inermis* extract was studied against some fungal isolates (*A. niger, A. flavus* and *Fusarium*) using disc diffusion and well diffusion method. The maximum activity was produced by methanol and ethanolic extracts against the human fungi tested[330].

The antifungal activity of the aqueous extract from leaves of *Lawsonia inermis* (130, 260, 390, 520, 650, 780 and 910 ppm) was studied against three fungal isolates (*Aspergillus niger, Aspergillus flavus,* and *Penicillum notatum*). Growths of all fungal isolates were inhibited by henna extract at a concentration of 1300 ppm[331].

The antimicrobial effect of water, methanol and chloroform crude extracts of Lawsonia inermis leaf was studied against 6 human pathogenic fungi (*Epidermophyton floccosum, Mirosporum audouinii, Trichophyton rubrum, Trichophyton concentricum, Trichophyton tonsurans and Candida albicans*) and 4 types of bacteria (*Staphylococcus aureus, Bacillus subtilis, Escherichia coli* and *Pseudomonus aeruginosa*). The water extract was the more potent followed by methanol, while chloroform extract showed the least antimicrobial effect. The growth of all pathogens was inhibited to varying degrees by increasing the concentration of the extract[332].

The antifungal effect of the of aqueous and methanolic extracts (25µl from the extracts, 250 mg/ml crude extract) of Lawsonia inermis was studied against *Candida albicans* and *Microsporum* species. The of aqueous was showed antifungal effects against *Candida albicans* with MIC of 15mm, while methanolic extracts was active against *Candida albicans* with MIC of 14mm[333].

333-The antifungal effect of ethanolic extract of crude lawsone was tested in comparison with listerine mouth wash in known diabetics and wearing dentures.Each subject was given distilled water at baseline and Colony Forming Units (CFU) of candidal species was determined. Post therapeutic samples were then collected 1hr and 1week following drug usage and they were further advised to use given mouth washes twice daily with volume of 5ml/rinse for 30 seconds and CFU was evaluated. Crude lawsone mouthwash showed superior antifungal activity when compared to listerine mouthwash. Lawsone was appeared more effective in reducing CFU, at 1hr and 1week of using the mouth wash ($p<0.01$). Subjective symptoms like taste and smell were determined by chi square test where good taste was felt for lawsone and olfactory satisfaction was good with listerine ($p<0.01$). Burning sensation was found to be more with listerine mouth wash[334].

The Lawsonia bark extract possessed fungistatic against Microsporum gypseum and Trichophyton mentagrophytes at concentration of 1:30 (W/V), however, it became fungicidal at 1:10 (W/V) concentration. Furthermore, the extract showed broad fungitoxic spectrum when tested against 13 ring worm fungi. Fungitoxicity of the extract remained unaltered at high temperature, on autoclaving and after lon storage[335].

Anti-*candida* activities of ethanol extracts of *Lawsonia inermis* leaf was studied versus nystatin and fluconazole. The minimum inhibitory concentration (MIC) 90 value for *L. inermis* in *Candida albicans* was 0.1 µg/ml and in *Candida glabrata* was 0.05 µg/ml, while, the MIC90 value for nystatin for both species was 0.035 µg/ml, and MIC90 value for fluconazole for *C. albicans* was 0.5 µg/ml and for *C. glabrata* was 2 µg/ml[336].

L. inermis ethyl acetate extract completely inhibited the growth of C. albicans. It also exhibited dose-dependent inhibitory activity against two major virulent enzymes of C. albicans, proteases (27-33%) and

phospholipases (44.5%). In addition to it, this extract completely inhibited both the isoforms of constitutive candidal enzyme aspartate dehydrogenase, and affecting amino acid biosynthesis[337].

The antifungal effect of Lawsonia inermis (vaginal creams of 2% or 4% of L. inermis) was studied in rats infected vaginally with C. albicans. Before the treatment, the mean colony forming units (CFU) was 213.6±10.08 and 334.42±20.32 in the 2% and 4% henna groups, respectively, one week after treatment, the mean CFUs were zero for all groups except for the 2% henna and zero in all groups two weeks after the treatment ($P<0.001$)[338].

The antifungal activity of L. inermis was investigated against clinical dermatophytes specie (70 clinical isolates) of dermatophytes representing six different species; *Trichophyton rubrum, Trichophyton mentagrophytes, Microsporum canis, Trichophyton tonsurans, Epidermophyton floccosum , and Trichophyton violaceum.* The agar diffusion method showed high antifungal activity against all dermatophytes species (20 to 50mm inhibition zone)[339].

In vitro antifungal effect of the chloroform, methanol and aqueous extracts of *Lawsonia inermis* was evaluated against four dermatophytic species. MIC of 100mg/ml of chloroform, methanol and aqueous extracts were 10-14, 13-17, 19-26mm, against *Trichophyton mentagrophytes*, *Trichophyton rubrum*, *Microsporum gypseum* and *Microsporum fulvum* respectively[340].

The antifungal activity effect of lawsone and DMSO, ethanol, chloroform, ethyl acetate, and di-ethyl ether *L. inermis* extracts were investigated against filamentous fungi. The results revealed that lawsone showed potent antifungal effect, its MICs against *Fusarium oxysporum* was 12 µg/ml and against *Aspergillus flavus* 50 µg/ml. The ethanol extract showed the only interesting MIC (230 µg/mL of crude extract) against *F. oxysporum* compared with other extracts[341].

The antifungal activities of the aqueous and ethanolic extracts of the leaves of *Lawsonia inermis* was investigated against different strains of *Candida albicans*. Compared with aqueous and ethanolic pomegranate peel and seed extract, *Lawsonia inermis* leaves extracts showed the maximum zone of inhibition (mean 20 mm), aqueous extracts of henna was more potent than ethanolic extracts[342].

Lemna minor

The antifunal activity of the lyophilized water extract and ethanol extract of duckweed was studied against *Candida parapsilosis* and *Candida glabrata*. The *Candida* growth was inhibited by both extracts[343].

Lepidium sativum

The antifungal activities of methanolic seed extract of Lepidium sativum was studied against fourteen fungal strains (Aspergillus niger, Aspergillus terreus, Aspergillus flavus, Aspergillus fumigatus, Candida albicans, Saccharomyces cerevisiae, Fusarium sp., Microsporum canis, Streptococcus faecalis, Mucor sp., Penicillium expansum, Trichoderma viride, Trichoderma horzianum and Trichophyton mentagrophytes). The results showed that the methanolic seed extract of Lepidium sativum was active against Aspergillus flavus, Aspergillus fumigates, Candida albicans and Saccharomyces cerevisiae with zones of inhibition of 7.01±0.11, 7.00±0.11, 6.99±0.14 and 7.00±0.17mm, respectively[344].

The antifungal effect of extracts of Lepidium sativum was investigated against Candida albicans and Aspergillus niger. The methanolic extract of Lepidium sativum possessed antifungal activity against Candida albicans (21mm),with no activity against Candida albicans and Aspergillus niger. The water extract showed antifungal activity against Candida albicans and Aspergillus niger[345].

The antifungal effect of seed extracts of Lepidium sativum was investigated against Candida albicans (MTCC No.3017) L. sativum ethanolic seeds extracts were ineffective against the fungal isolate. Methanol extract showed anticandidal effect and exhibited high zone of inhibition against Candida albicans (15.5 mm), while, ethanol extract showed greater zone of inhibition (16 mm)[346].

The petroleum ether extracts of Lepidium sativum seeds in different concentrations showed anti Candida activity at the concentration of 2.5 and 10%. The methanolic extract had no activity against Candida albicans at the concentration of 5%, while it resisted the concentration of 2.5 and 5% water extracts, and 5% methanolic extract[347].

The methanolic extract of Lepidium sativum seed was studied for antifungal activity at different concentrations of 10, 30, 60 and 90 mg/ml against human pathogenic and opportunistic fungi such (Aspergillus flavus, Aspergillus fumigatus, Candida albicans, Fusarium sp, Penicillium sp and Penicillium marneffi). The Aspergillus flavus was the most sensitive fungi, inhibited at 30 mg/ml. Rhizopus sp. showed slow and weak growth on 30 mg/ml and 60 mg/ml slant and was completely inhibited at 90 mg/ml. At a concentration of 90 mg/ml the fungi Aspergillus fumigatus, Candida albicans, Fusarium sp, Microsporum sp, Penicillium sp, Penicillium marneffi were completely inhibited[348].

The antifungal activity of ethanolic extract of *Lepidium sativum* seeds (2-8 mg) was evaluated against *Fusarium equiseta, Aspergillus flavus* and *Alternaria alternate*. The diameter of inhibition zone ranged from 4 to 22 mm against the tested fungi[349].

Linum usitatissimum

The antifungal effect of seeds extracts of *Linum usitatissimum* (100 mg/ml) was investigated against *Candida albicans* and *Aspergillus nig*er. Water extract exerted activity against only *Candida albicans* (14mm)[350].

Lippia nodiflora

The antifungal activity of of the stem and leaves extracts of *phyla nodiflora* was studies against *Aspergillus niger* and *Candida albicians.* The ethanol extracts showed a significant antibacterial and antifungal activity. The zones of growth inhibition produced by aqueous fraction was against all tested fungi were 10-12mm[351].

The antimicrobial activity of hexane, chloroform, ethyl acetate and methanol extracts of aerial parts of *Phyla nodiflora* was evaluated against *Candida albicans, Candida krussie, Candida tropicalis, Trichophyton mentagrophytes, Microsporum gypseum* and *Malassezia pachydermatis*, using disc diffusion assay. All the extracts possessed inhibitory effects on fungi. Ethyl acetate extract showed the most potent antifungal activity. The minimum bactericidal concentration **(**MBC) of ethyl acetate extract from aerial parts against *Malassezia pachydermatis* was 0.625 mg/ml[352].

The methanolic extract from the leaves and flowers of Lippia nodiflora showed concentrations – dependent anticandidal effects[353].

The methanolic extract from *Lippia nodiflora* showed antifungal effect, against *A. niger* and *C. albicans.* Fungi showed the same zone of inhibition (11 at 250 µg per disc) for both *Aspergillus niger* and *Candida albicans,* in 500 µg per disc, highest zone of inhibition (14 mm) occurred against *A. niger* and lowest zone of inhibition (11 mm) occurred against *C. albicans*[354].

The methanol extract of whole *Lippia nodiflora* was studied for antifungal effect. The extract exerted antifungal activity against *Candida albicans* and *Cryptococcus neoformans* at 400 and 500µg/ml[355].

Five medicinal plants (*Phyla nodiflora, Lawsonia inermis, Cassia fistula, Vernonia cinerea* and *Aristolochia bracteolate*) were tested as antifungal therapy against fungal pathogen isolated from infected nail (*Candida* sp.). Ethanol extracts of Phyla nodiflora leaves exhibited complete inhibitory effect against the tested nail fungus, while, aqueous extract showed 75% inhibition after 48 hrs[356].

The crude extracts of *L. nodiflora* were tested for antifungal effects against *Aspergillus niger, A. flavus, Paecilomyces varioti, Microsporum gypseum* and *Trichophyton rubrum*. All crude extracts including ethanol, methanol, ethyl acetate, chloroform and aqueous extracts showed high activity against test organisms. Ethanol and aqueous extracts appeared to be the most effective antifungal agents as compared to methanol, chloroform and ethyl acetate[357].

Lithospermum officinale

Shikonin also possessed antifungal effects against Saccharomyces cerevisiae, Trichophyton rubrum, T. mentagrophytes, T. tonsulans var. sulfureum, Microsporum gypseum, Epidermophyton fluccosum, Candida albicans, Candida krusei and C. glabrata[358-359].

Luffa acutangula

The ethanolic extract of Luffa acutangula showed inhibitory zones of 8mm against *Candida albicans*[360].

The antifungal activity of methanolic and aqueous extracts of different *Luffa acutangula var.amara* parts (fruits, leaves, roots and seeds) were evaluated against *Candida albicans, Aspergillus niger, and Fusarium species,* by in vitro well diffusion assay. Methanolic and aqueous extracts of different parts showed antifungal activity at significant levels. Methanolic extracts of fruit and root were effective against *Fusarium sp.* Both aqueous and methanolic extracts of leaf possessed inhibitory action against *Aspergillus niger.* Seeds showed the least antifungal activity[361].

The antifungal activity of the dried leaves extract was investigated against *Candida albicans* and *Candida tropicalis.* The highest zone of inhibition recorded for the alcoholic extracts of *Luffa acutangular* leaves was recorded against *Candida albicans*. The lowest combined MIC and MFC values was recorded against *Candida albicans*[362].

The antifungal effect of the extract of *Luffa acutangula* var *amara* fruits was studied against Candida albicans (ATCC 2091), Aspergillus niger (ATCC 6275) and Aspergillus fumigatus (ATCC 13073). Chloroform and aqueous extracts showed weak antifungal activities[363].

The antifungal (against *Curvularia lunata, Drechslera hawaiiensis, Fusarium equiseti* and *Phoma sorghina*) activities of fruits and leaves extracts of *Luffa acutngula* were studied in vitro. The fruit extract of *Luffa acutangula* possessed more antifungal activity than the leaf extract. *Curvularia lunata* (22 and 31mm respectively) and *Drechslera hawaiiensis* (20 and 28 mm respectively) showed high sensitivity to leaf and fruit extract, while *Phoma sorghina* (9 and 13 mm respectively) and *Fusarium equiseti* (10 and 4 mm respectively) showed poor sensitivity[364].

Luffa cylindrica

The extract of the seeds of Luffa cylindrical showed antifungal activity against Candida albicans , with a zone of growth inhibition of 20.00 to 27.00 mm[365-366].

The antifungal activity of petroleum ether and chloroform extract of whole plant of Luffa cylindrica was investigated against *Aspergillus flavus, Aspergillus niger, Aspergillus fumigates* and *Aspergillus rhyzobus*. The significant antifungal activity was possessed by chloroform extract at 266.66µg/ml[367].

The antifungal activity of ethanolic extract of *Luffa cylindrica* fruit (50-150 mg/ml) was evaluated against *Aspergillus fumigates, Aspergillus niger* and *Candida albicans*. The ethanolic extract showed antifungal activity with a zone of growth inhibition of 45-92.5mm[368].

The butanol fraction of *L. cylindrica* showed significant antifungal activity against *Fusarium solani* (85%) and *Trichophyton longifusus* (80%). The crude methanolic extract and ethyl acetate fraction presented good linear growth inhibition against *Microsporum canis* (70%). The ethanolic fraction of *L. cylindrica* displayed moderate growth regulation of 41.66% against *Lemna minor* at 1000 µg/ml[369].

The petroleum ether extract of the fruits of Luffa cylindrica was tested for antimicrobial activity against *Candida albicans, Aspergillus niger* and *Aspergillus niger.* The zone of inhibition produced by crude petroleum extract was found to be 7 – 10 mm at a concentration of 500 µg/disc. The fungi *Sacharomyces cerevisiae* was found to be resistant[370].

A triterpenoid sapogenin, echinocystic acid extracted from Luffa cylindrica possessed antimicrobial activity against *Candida albicans*[371].

Lycopus europaeus

The acetylated highly oxygenated abietane-type diterpenoid (euroabienol) isolated from Lycopus europaeus was screened for in vitro antimicrobial activity against six fungal strains. It showed a broad spectrum antimicrobial activity[372].

The antifungal activity of the *Lycopus europaeus* essential oil was studied against many fungi. Minimum inhibitory concentrations (MIC) of the essential oil against *P. chrysogenum* isolate: 10.0 mg/ml; *A. restrictus* isolate: 5.00 mg/ml; *A. chrysogenum* isolate: 10.0 mg/ml; *A. fumigates* isolate: 0.625 mg/ml; *C. albicans* ATCC 10231: 10.0 mg/ml and *S. cerevisiae* ATCC 9763: 2.50 mg/ml[373].

Lythrum salicaria

L. salicaria hydromethanolic extract moderately suppressed *Candida albicans* growth[374].

The antifunal effect of *L. salicaria* extracts was investigated against *Candida albicans. Candida albicans* was sensitive to 50% ethanol in water extract. MICs of 50% ethanol in water extract of *L. salicaria* was 5 mg/ml against *Candida albicans*[375].

Lythrum salicaria extracts showed antifungal activity against the phytopathogenic fungus *Cladosporium cucumerinum*. The antifungal activity was attributed to triterpenoids, oleanolic and ursolic acid[376].

The activity of calluses extracts, wild plant, gallic acid, and 3,3',4'-tri-O-methylellagic acid-4-O-β-D-glucopyranoside (TMEG) as the main phenolic compounds identified in Lythrum salicaria calli were studied against *Candida albicans* using cup plate diffusion method. Anti-candida activity of callus extract was similar to the wild plant extract. Minimum inhibitory concentration values of gallic acid and TMEG were 0.312 and 2.5 mg/ml, respectively[377].

Mangifera indica

The antifungal property of Mangifera indica peel and seed by-products was determined using agar diffusion and broth micro-dilution assays against 18 yeast species of the genera Candida, Dekkera, Hanseniaspora, Lodderomyces, Metschnikowia, Pichia, Schizosaccharomyces, Saccharomycodes and Zygosaccharomyces. All mango extracts showed antifungal activity. The minimum inhibitory concentration and the minimum fungicidal concentration values were lower for seed than for peel extracts. MICs and MFCs ranged from values <0.1 to 5 and 5 to >30 mgGAE/ml, respectively[378].

Antifungal activities of five flavonoides compounds (at 100, 300, 500, 700, 900 and 1000 ppm) isolated from the leaves were evaluated against five fungal species, namely *Alternaria alternata* (Fr.) *Keissler,*

Aspergillus fumigatus Fresenius, Aspergillus niger van Tieghem, Macrophomina phaseolina (Tassi) Goid. and Penicillium citrii. All concentrations of the five test flavonoids significantly suppressed fungal growth. However, the antifungal activity of the flavonoids was gradually increased by increasing their concentrations[379].

The antifungal activity of leaves extract was studied against three fungal species (*Aspergillus ustus, Aspergillus niger* and *Aspergillus ochraceus*). The leaves extract of *Mangifera indica* showed antifungal activity against (*Aspergillus ustus, Aspergillus niger* and *Aspergillus ochraceus*) with a diameter of inhibition of 29, 21 and 19 mm respectively[380].

The antifunal activity of chloroform, methanol and aqueous extracts of *Mangifera indica* seeds kernel was investigated against *Aspergillus niger* and *Candida albicans*. The extracts possessed high activity against the tested organisms[381].

The alcoholic extracts of *Mangifera indica* seed kernel and isolated fractions were evaluated for their antifunal activity against *Aspergillus niger* and *Candida albicans*. The methanol extract of the seed kernel possessed potent antifungal effects at 50% concentration against *Candida albicans*. Out of the three solvents used for liquid extraction, the minimum inhibitory concentration of ethyl acetate extract against *Candida albicans* was 4.5 μg /ml[382].

III. CONCLUSION

The resistance of pathogenic fungi to antifungal drugs is one of the major public health problem. Plant extracts have shown inhibitory effect on the growth of wide range of fungi. They are represented a good alternative for prevention and treatment of fungal diseases. The current review highlighted the antifungal effects of medicinal plants.

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